Study on Plant Protection in Cocoa Production:

Côte d'Ivoire

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Please note, comments from the last meeting of the Accompanying Group on the difference between pesticides used by farmers in different regions and about pest management in PRO PLANTERURS and other farmers have still to be integrated!

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Executive summary

Côte d'Ivoire is the world's largest producer of cocoa, producing over 2 million tonnes of cocoa beans a year and the sector employing over 1,000,000 rural families. As the most important agricultural export crop, cocoa contributes significantly to Côte d'Ivoire economy generating more than US$6 billion in export earnings annually. In the regions were cocoa is grown globally it is susceptible to many pest and diseases, West Africa is no exception with losses being estimated at 30-40% annually due to diseases such as black pod, cocoa swollen shoot virus and insect pests, such as mirids, shield bugs and stem borers. In order to manage these constraints many farmers have become reliant on the use of chemical pesticides.

GIZ, in collaboration with the German Initiative on Sustainable Cocoa (GISCO), commissioned CABI to undertake a study to explore the current status of the use of pesticides, current implementation of integrated pest management (IPM) and associated regulatory framework in cocoa cultivation and post-harvest protection in the two main cocoa producing countries Ghana and Côte d'Ivoire, in response to major concerns about the uncontrolled use of plant protection products and lack of implementation of IPM in cocoa production. For each country, the study covered the legal framework for pesticide use and pest management practices for cocoa. The study in Côte d'Ivoire was conducted through a desk study, questionnaires with extension agents and farmers, and interviews with major stakeholders.

Key findings

Analysis of the legal frame work for pest and pesticide management has revealed that Côte d'Ivoire has relatively extensive regulatory framework but there are some gaps which need to be addressed. The pesticide registration process seems to be in line with international standards but legislation does not allow for a separate registration pathway for biopesticides, it currently follows the same pathway as chemical pesticides. The disposal of unused and empty pesticide containers is not covered under the national regulations and there is weak enforcement of the regulations and inadequate monitoring of markets, traders and pesticide quality due the enforcing agency (DPVCQ) having insufficient operational funds and critically low human capacity. There is also insufficient countrywide monitoring of the impact of pesticides on human health (pesticide poisoning) and the environment.

Availability of counterfeit and unapproved pesticides still seems to be a big issue with estimates putting the proportion of illicit products on the open market as high as 30%.

There does not appear to be a specific national policy to promote IPM in agriculture. There are however several projects linked through the National Agricultural Investment Plan for certain regions and cropping systems in the country unfortunately, cocoa does not seem to be a focal crop. The national research Institute (CNRA) have published technical guidelines for cocoa pest and diseases providing both chemical and non-chemical management options but farmers often see these non-chemical options as less effective than chemical pesticide, more time consuming and if additional labour needs to be employed, uneconomical.

Three hundred and fifty-six pesticide products were registered for use on cocoa in Côte d'Ivoire. The corresponding 54 active ingredients (AL) differed in terms of their overall hazard level. Five of the AI allowed for use met one or more of the FAO global criteria for HHPs. Seventeen AI are categorised as "danger" (one or more of the associated human health hazard statements indicate that the AI is "toxic" or "fatal if inhaled or swallowed"); 23 AI are categorised as falling into the "warning" category; one AI was categorized in the "low-hazard" category (there are no known human health hazard statements associated with the AI); and key human health hazard data is missing for eight AI.

Using the PAN criteria for HHPs (latest version 2021) 25 of the AI registered for use on cocoa are considered to be HHPs, 15 AI are no longer approved for use in the EU and 9 AI prohibited for use under the Rainforest Alliance (RA) certifications scheme and a further 22 AI require additional risk mitigation measures under (RA) certification. Only eight biopesticide AI are registered nationally for use on cocoa.

Of the 256 insecticides registered for cocoa 206 of these products contain a mixture of 2 or more AI. Of the 206 "mixtures"187 products contain a combination of a noenicitinoid and a pyrethroid, the

reliance on the use of these two modes of action combined has potential to for the lead to an increased risk of resistance build up in insect populations.

Interviews with farmers revealed that more minor pests such as shield bugs and stem borers are having a much greater impact on cocoa production than they once did. It has been suggested that resurgence of minor pests may be due to excessive use of insecticides (i.e. mirid management) and the loss of non-target beneficial insect populations which would normally have kept pest population under damaging levels.

Although many did report using non-chemical control methods just over half stated that they rely on calendar treatments of pesticides to control pests and diseases. Just over 30% said that they applied pesticides when a pest or disease was seen. None of the farmers interviewed had information on economic threshold levels to guide them on when to carry out pesticide applications. All of the pesticide products reportedly applied by farmers were registered for use on cocoa.

According to AEAs the main constraints to the adoption of IPM was the lack of knowledge of producers (> 60%), followed by the lack of support from state/research and the time required to implement IPM in cocoa fields. When asked about the farmers ability to identify the major cocoa pests and diseases 70% of the AEAs stated that more than 80% of farmers had trouble identifying major pests and diseases on their farms.

A large proportion of producers (79%) have received some sort of training on IPM. These trainings focused mainly on good agricultural practices, in particular sustainable management, pruning techniques, the production of biopesticides, good practices in the use of pesticides and agroforestry.

Recommendations

- GISCO to encourage private sector members to take a pre-competitive approach on the issue of management of cocoa pests and diseases with increased collaboration and sharing of research outcomes.
- Government agencies to invest additional operational funds to improve enforcement of pesticide regulations with agro-input dealers.
- Encourage relevant government agencies and the CCC to start to develop a policy for the IPM of cocoa pests and diseases.
- Relevant government agencies to review AI approved for use on cocoa in light of the high number of HHPs and higher risk AI currently registered. A small study could also be commissioned to investigate which products are actually available to farmers on the open market and identify if lower risk products are available at competitive prices.
- NGO’s, private sector and national research institutes to collaborate more effectively to create a unified approach to provide training for extension and farmers on the safe use of pesticides including how to use pesticide labels, identifying AI and how to select lower risk products.
- Improve access to training materials for farmers, the majority of farmers to not have access to reliable internet and smart phones.
- Research into the development of applicable economic thresholds for the major cocoa pests and diseases to reduce reliance on calendar application of pesticides.
- Additional training for farmer on the recognition of pest and disease symptoms and reinforce knowledge of IPM and the worth of basic non-chemical management practices.
- Encourage the formation and participation of producers in farmer-based organisation as this seemed to improve technical advice received and awareness of safe use of pesticides.
- Support for the regulatory agency and services responsible for testing the effectiveness of new products, in order to reduce the approval time for biopesticides compared to synthetic pesticides.

- All stakeholders (private industry partners, NGO's, national governments and research organisations) to improve collaboration and secure investment for the development of less hazardous alternative for management of cocoa pests and disease at a regional level.

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Acronyms

AEA	Agricultural Extension Agent
AI	Active ingredient
ANADER	Agence Nationale d'Appui au Développement Rural
ANASSA	Agence Nationale de la Sécurité Sanitaire des Aliments
BMZ	Federal Ministry for Economic Cooperation and Development
CABI	Centre for Agriculture and Bioscience International
CCC	Conseil du Café-Cacao
CEDEAO	Communauté économique des États de l'Afrique de l'Ouest (En: ECOWAS)
CIAPOL	Centre Ivoirien Antipollution
CILSS	Comité permanent Inter-états de Lutte contre la Sécheresse au Sahel
CRIG	Cocoa Research Institute of Ghana
CSP	Comité Sahélien des Pesticides
CSSV	Cocoa Swollen Shoot Virus
CSSVD	Cocoa Swollen Shoot Virus Disease
DCVSA	Direction des Cultures Vivrières et de la Sécurité Alimentaire
DDISC	Direction des Déchets Industriels et Substances Chimiques
DPVCQ	Direction de la Protection des Végétaux, du Contrôle et de la Qualité
ECOWAS	Economic Community of West African States (Fr: CEDEAO)
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
FIRCA	Fonds Interprofessionnel pour la Recherche et le Conseil Agricoles
FRAC	Fungicide Resistance Action Committee
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HHP	Highly hazardous pesticide
HRAC	Herbicide Resistance Action Committee
ICRAF	International Centre for Research in Agroforestry
ILO	International Labour Organization
INHP	Institut National d'hygiène Publique
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRAC	Insecticide Resistance Action Committee
ISO	International Organization for Standardization
ITC	International Trade Centre

KII	Key Informant Interview
LANADA	Laboratoire National d'Appui au Développement Agricole
LANEMA	Laboratoire National d'Essais de Qualité Métrologique et d'Analyses des Pollutions
MEMINADER	Ministère d'Etat, Ministère de l'Agriculture et du Développement Rural
MINEDD	Ministère de l'Environnement et du Développement Durable
MRLs	Maximum residue levels
MSHP	Ministère de la Santé et de l´Hygiène Publique
NPPO	National Plant Protection Organisation
ODS	Ozone Depleting Substances
OEC	Observatory of Economic Complexity
PAN	Pesticide Action Network
PIC	Prior informed consent
POP	Persistent organic pollutant
PPE	Personal Protective Equipment
RA	Rainforest Alliance
SACO	Société Africaine de Cacao
UEMOA	Union économique et Monétaire Ouest Africaine (En: WAMEU)
WAMEU	West African Monetary and Economic Union (Fr: UEMOA)
WAPRC	West African Pesticide Registration Committee
WHO	World Health Organisation

Introduction

Côte d'Ivoire is the largest producer of cocoa in the world, now producing over 2 million tonnes of cocoa beans a year and employing 1,000,000 rural families. As the most important agricultural export crop, cocoa contributes significantly to Côte d'Ivoire economy generating more than US$6 billion in export earnings annually. In the regions were cocoa grows it is susceptible to pest and diseases, West Africa is no exception with losses being estimated at 30-40% annually due to diseases such as black pod, cocoa swollen shoot virus and insect pests, such as mirids, sink bugs and stem borers. In order to manage these constraints many farmers have become reliant on the use of chemical pesticides.

The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ), in collaboration with the German Initiative on Sustainable Cocoa (GISCO), commissioned CABI to undertake a study to explore the current status of the use of pesticides, current implementation of integrated pest management (IPM) and associated regulatory framework in cocoa cultivation and post-harvest protection. The study was carried out in two countries in West Africa, Côte d'Ivoire and Ghana, in response to major concerns expressed about the uncontrolled use of plant protection products and lack of implementation of IPM in cocoa production. Overall guidance for the study was provided by the GISCO Steering Committee, a group comprising of GIZ staff and selected individuals of GISCO members.

The findings of the study will assist in supporting the achievement of the German Initiative on Sustainable Cocoa (GISCO) Goal 4, "To promote the development and use of sustainable and diversified farming systems, especially agroforestry systems that conserve natural resources and eliminate the use of hazardous or unauthorised pesticides".

A desk study, including an analysis of the legal framework and a literature review of pest management practices for cocoa, was conducted for both countries. The analysis of the legal framework compared each country's regulations and policies against the best practices. The legal framework analysis also included an analysis of the registered pesticides and of the hazards linked to their use. The study was also complemented by in-country data collection and included key informant interviews and group discussion with major stakeholders in the cocoa value chain, including government officials, as well as questionnaires with extension agents and farmers.
The information gathered in-country complemented and validated the findings of the legal framework analysis and provided a snapshot of pest management knowledge and practice in each country. This covered non-chemical and chemical pest management practices, pesticide management, as well as knowledge of integrated pest management (IPM).

Based on the results of the study, CABI drafted, for each country, recommendations for consideration by the GISCO members. Additionally, CABI identified areas where further training of farmers or extension agents would be required and identified gaps in national regulations and policies. Overall, the present study contributes to the implementation of sustainable management practices for pests and diseases affecting cocoa, the reduction of pesticide use and the promotion of IPM.

Methodology

The methodology for the study was designed so that it could be implemented in Côte d'Ivoire and Ghana without a major change to the approach. Approaches and tools used for the desk study and data collection in both countries have been developed by CABI, based on experience from previous studies. Based on the findings of the desk review, adaptations were made to data collection tools in both countries to ensure that information gaps were filled.

Desk study

A review of the literature available and to which CABI has access was conducted to provide an overview of the agricultural sector in Côte d'Ivoire, to map the value chain for cocoa and to assess the institutional and regulatory arrangements for the management of pests, diseases and pesticides. Existing literature on cocoa crop protection, studies and advisory documents were also reviewed to identify cocoa field protection methods currently used within the cocoa value chain.

The most recent version of the national list of registered pesticides in Côte d'Ivoire was analysed to determine the complete list of active ingredients (AI) recommended for use on cocoa using a tool developed by CABI[1]. For each registered AI, a profile has been developed including the chemical class, the type of use and the associated hazards for human health and the environment.

The criteria of the FAO (2016) guidelines on Highly Hazardous Pesticides (HHPs) or "pesticides which are known to present particularly high levels of acute or chronic risks to health or the environment, according to international classification systems accepted" were used to determine whether an AI is an HHP or not. With the support of national partners, national pesticide laws, subsidiary legislation and other policies relevant to pest and pesticide management were identified, followed by an analysis of the existing legal framework for pest and pesticide management. The results where then compared with international guidelines and other regulatory best practices.

Information from the desk study was used to compile a preliminary description of the policy-making process in Côte d'Ivoire. The state of implementation and the adequacy of the application of the regulations were then confirmed and supplemented by data collected during interviews in the country with representatives of the public services in charge of the regulation of pesticides, extension, research, as well as with other actors of the Ministry of Agriculture and Rural Development and Conseil du Café-Cacao involved in cocoa production. Interviews were also organized with cocoa producers and producer organizations, agricultural input distributors and pesticide service providers.

Limitations of the methodology and data

An overview of the national legal and policy framework, with links to many of the legal documents relating to agriculture, food and the environment, was accessed through the Côte d'Ivoire country profile in the FAOLEX database[2]. Other policy and legal documents were downloaded from ministry websites. The remaining gaps were filled during key informant interviews (KIIs). The fieldwork was conducted in a limited number of regions, these regions were agreed in collaboration with GIZ-PRO-PLANTEURS and the GISCO steering committee. Interviews were conducted with selected farmers and extension staff through in-country GIZ-PRO-PLANTEURS staff. No comparison between certified and non-certified farmers could be made in this study as all farmers belonged to certification scheme. The sample size of farmers, extension staff and key informants interviewed was very small and from a narrow geographic range and cannot be used to draw conclusions on a wider scale. Not all stakeholders in Côte d´Ivoire responsible for cocoa

[1] An excel tool that brings together the findings of a global market survey of pesticide active ingredients (AI) and commercial products registered in over 20 countries. The tool highlights the HHP status of the AI based on hazard classification systems of the EU, Japan, New Zealand and Australia

[2] FAOLEX http://www.fao.org/faolex/en/

production were available or receptive to receive the CABI expert. In addition, some stakeholders also considered information too sensitive and was therefore not provided during interview.

Background

Agriculture sector characteristics and key stakeholders

Overview of agriculture sector performance and contribution to the economy

Like most countries of sub-Saharan Africa, Côte d'Ivoire has a predominantly agricultural economy. Agriculture is a key sector of the Ivorian economy and contributes significantly to the country's GDP, employment, and foreign exchange earnings. According to the World Bank (Table 1. General characteristics of the agricultural sector in Côte d'Ivoire), agriculture in 2021 accounted for approximately 20% of Côte d'Ivoire's GDP and employed 40% of the country's active population. The agricultural sector also accounted for around 60% of the country's exports at a value of nearly US$6 billion[3], with cocoa products (including beans, cocoa paste, powder and butter) being the main agricultural export crop, followed by cashew nuts, bananas/plantain, coffee, palm oil and fresh fruit[3].

Despite being heavily dependent on agriculture the sector faces several challenges including: low productivity, inadequate infrastructure, and climate change. However, the government has implemented several measures to improve the sector's performance, including investment in irrigation systems, providing subsidies to farmers, and promoting crop diversification. In recent years, Côte d'Ivoire's agriculture sector has shown significant growth, with the country experiencing a 7% growth rate in 2021, despite the challenges posed by the COVID-19 pandemic[4]. This growth was mainly driven by increased cocoa production, which accounts for approximately 40% of the country's total agricultural output[3].

Table 1. General characteristics of the agricultural sector in Côte d'Ivoire

Selected indicators – agriculture sector generally	2010	2015	2020	2021
Total area of land under agriculture (1000 ha)	20,600*	21,200*	21,200*	No data
Arable land per person (ha)	0.14	0.15	0.13	No data
GDP per capita (current US$)	1,654	1,942	2,288	2,549
Agricultural value added (% of GDP)	17.5	18.4	21.1	19.9
Agricultural value added (annual % growth)	-4.1	2.9	4.4	1.9
Agricultural labour force (% of total labour force)	47	44	40 (2019)	No data
Rural population (% of total)	53	51	48	48
Value of total agriculture production (constant gross value 2014–2016, thousand US$)	6,729,369*	9,811,576*	12,038,277*	No data

Source of data: The World Bank[5], *FAOSTAT[6]

Key crops, both domestic and for export

The main cash crops grown in Côte d'Ivoire for export are cocoa, rubber, cashew nuts, cotton, palm oil and tropical fruits. Cocoa is by far the biggest export with cocoa beans and semi-finished cocoa products accounting for 45% of all exports and at a value of US$5.5 billion in 2021[3]. The

[3] OEC (2023) The Observatory of Economic Complexity Country Profile: Côte d'Ivoire https://oec.world/en/profile/country/civ?depthSelector1=HS2Depth
[4] World Bank (2023) Country Overview: Côte d'Ivoire. https://www.worldbank.org/en/country/cotedivoire/overview#1
[5] World Bank (2023) World Development Indicators. http://databank.worldbank.org/data/home.aspx
[6] FAOSTAT (2023) Database. http://www.fao.org/faostat/en/#data/QC

main market for Ivorian cocoa beans is Europe with nearly a 50% share, other large markets include USA (20%) and Malaysia (12%). The main staple food crops produced in Côte d'Ivoire for local consumption are yams, rice, cassava, plantain/banana and maize. These are produced predominantly in rainfed systems by smallholder farmers. Production and yields are generally low and Côte d'Ivoire depends heavily on imports of rice to supplement the country's current demand although, the government has shown recent support to aid in the development of the rice sector[7].

General information about the cocoa value chain in the country

Characteristics of the cocoa sector and main stakeholders

Africa produces 75% of the world's cocoa[8], with Côte d'Ivoire being the largest producer with an estimated production of 2,121,000 tonnes during the 2021/2022 growing season (Table 2), slightly down on estimates for 2020/2021[9] - this accounts for approximately 40% of global production. Exports of cocoa beans and paste represent respectively 36 and 10% of exports from Côte d'Ivoire. The cocoa supply change is estimated to employ 1 million families at the producer level and an additional 6 million people countrywide.

Table 2. Production and export data for cocoa and cocoa products at 5-year intervals between 2005 and 2021

	2005	2010	2015	2020	2021
Area harvested (ha)	2,193,548	2,278,786	3,458,163	4,774,875	4,214,608
Yield (Kg/Ha)	586	571	519	461	522
Production (tonnes)	1,286,330	1,301,347	1,796,000	2,200,000	2,121,000†
Value of export of cocoa beans (US$)	1.5 billion	2.5 billion	3.6 billion	3.9 billion	4.1 billion
Value of export of cocoa butter, fat and oil (US$)	174 million	301 million	425 million	399 million	406 million
Value of export of cocoa paste not defatted (US$)	224 million	599 million	738 million	710 million	1.2 billion*
Value of export of cocoa powder and cake (US$)	46 million	113 million	60 million	64 million	69 million

Source of data: FAOSTAT[6], *ITC (2023); †ICCO estimate for 2021/2022 season[9]

The cocoa production areas in Côte d'Ivoire are predominantly located in the south of the country where rainfall is high and can reach 2500 mm per year. The crop is grown predominantly by smallholder farmers, many of whom (40-50%) are organised and belong to farmer-based organisations (FBOs). Large exporters prefer to source cocoa beans from cooperatives and intermediaries/middlemen (pisteurs) tend to buy from individual less well organised producers. Over 3,000 cooperatives operate in Côte d'Ivoire often providing additional services to cocoa producers such as inputs, training and credit schemes.

Cocoa is a significant contributor to the economy of Côte d'Ivoire however, low yields of cocoa in the country have been a persistent problem. There are several factors contributing to this issue including aging cocoa trees, poor soil fertility and pests and disease. Due to high incidence or pests and diseases, scarcity and high cost of labour farmers have become reliant on the use chemical pesticides to manage pests and disease problems.

Pests and diseases affecting cocoa

Theobroma cacao is not a native tree to West Africa, it originates from the forests of the Amazon. Being an introduced species and cultivated outside of its natural habitat, cocoa has become susceptible to many indigenous (new encounter) pathogens and insect pests present in West Africa. The exact annual yield losses caused by pests and diseases are unknown but estimates put losses

[7] GYGA (2023) Global Yield Gap and Water Productivity Atlas. www.yieldgap.org
[8] ICCO (2020) Quarteley Bulletin of Cocoa Statistics, Vol. XLVII, No.2, Cocoa year 2020/21
[9] ICCO (2022) Quarteley Bulletin of Cocoa Statistics, Vol. XLVIII, No.4, Cocoa year 2021/22

due to diseases alone at nearly 40%[10]. Even if these figures are overestimated the revenues lost to national economies are considered substantial.

Major pests and diseases

Black pod disease is caused by the oomycete *Phytophthora* and is considered to cause the greatest loss of cocoa worldwide. Several species of *Phytophthora* cause BP and cankers on cocoa trees. In Côte d'Ivoire two species cause disease on cocoa: *P. megakarya* and *P. palmivora*. *P. palmivora* is present globally but *P. megakarya* is indigenous to Central and West Africa and causes more severe symptoms than *P. palmivora*. *P. palmivora* can be found in all cocoa growing regions of Côte d'Ivoire but *P. megakarya* is still in an invasive phase present in a higher proportion in Indénié-Djuablin, du Guémon and Sud-Comoé with Nawa and San Pedro also have a strong presence. *Phytophthora* infection starts on the pod surface and progresses to rot the beans inside. The pathogen can also infect roots, stems and branches causing cankers which weaken the tree and can eventually kill it if left untreated. Production losses in Côte d'Ivoire due to black pod are typically between 20-45% but can reach 60% where management is not carried out effectively[11].

Cocoa Swollen Shoot Virus Disease (CSSVD) is caused by a badnavirus transmitted by several different species of mealy bug vectors during feeding. The disease was first reported in Côte d'Ivoire in 1943 in the central-west region and eastern region on the border with Ghana. Measures taken to halt the spread seem to have been successful until the disease re-emerged in Bouaflé and Sinfra in 2003[12]. Today CSSVD can be found in most cocoa growing areas in Côte d'Ivoire. Symptoms of the disease can be seen on the leaves, stem, roots and pods. The most obvious symptoms are red/yellow vein clearing patterns and green vein banding on the leaves, and swellings develop on stems and shoots[13]. As the disease progresses tree can lose their leaves and branches dieback from the tip. Trees can die in 2-3 years with yield loss of up to 70% depending on the virus strain and the susceptibly of the tree[14].

Mirids are considered to be the most damaging insect pests on cocoa in West Africa. There are two main species in Côte d'Ivoire *Sahlbergella singularis* and *Distantiella Theobroma*. They are sap sucking insects that feed on the pods, shoots, choupons and leaves. Feeding damage on pods is easily recognised by the small black circular lesions that develop. On older pods the damage is superficial but feeding on young pods is more damaging and can cause wilting and severe distortion of the pod as it grows. Feeding on young stems causes tissue necrosis, preventing sap from circulating drying the tips of the branches. Severe infestation can cause leave fall and drying of the canopy, the tree usually recovers during the next flush but numerous cankers weaken the branches and make the tree more susceptible to secondary fungal infections. Losses are difficult to quantify but it has been estimated that the two species together can cause annual losses of 200,000 tonnes annual[15].

Other pests and diseases

The **Green stink bug** (*Bathycoelia thalassina*) first appeared on cocoa in the 1960's[16] and seems to be re-emerging as a serious pest of cocoa. Once considered a minor pest it has been reported in all cocoa growing regions of Côte d'Ivoire and losses during serious outbreaks can be up to 60% in central parts of Côte d'Ivoire[17]. The relatively recent resurgence may be caused by the use of insecticides for mirid management and the loss of natural enemies. The stink bug causes

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[10] Marelli et al., 2019 https://apsjournals.apsnet.org/doi/10.1094/PHYTO-12-18-0477-RVW
[11] CNRA, 2021 https://cnra.ci/nos-fiches-techniques/
[12] Kouakou K, Kébé BI, Kouassi N, Aké S, Cilas C, Muller E (2012) Geographical distribution of Cacao swollen shoot virus molecular variability in Côte d'Ivoire. Plant Disease. 96 1445-1450.
[13] Ameyaw GA, Dzahini-Obiatey HK, Domfeh O (2014) Perspectives on cocoa swollen shoot virus disease (CSSVD) management in Ghana. Crop Protection 65: 64-70.
[14] Muller E (2016) Cacao Swollen Shoot Virus (CSSV): History, Biology, and Genome. In: Cocoa Diseases A History of Old Enemies and New Encounters. Eds. Bailey BA and Meinhardt LW. Springer. DOI 10.1007/978-3-319-24789-2
[15] Bateman, 2015 https://www.icco.org/new-pesticide-use-in-cocoa-manual-now-available/
[16] Wood GAR, Lass RA (1985) Cocoa. Fourth Edition, Longman, New York
[17] N'Guessan et al., 2018 http://www.isca.in/IJBS/Archive/v7/i8/1.ISCA-IRJBS-2018-019.php

damage to the cocoa beans when it inserts its long inserts its long stylet into the pod during feeding.

Defoliating caterpillars of several species of lepidopteran (*Achaea catocaloides*, *Anomis Leona*, *Earias biplaga*, *Lophocrama* sp.) have been always been considered a minor pest on cocoa but have become a more serious constraint in recent years. In 2016 an outbreak in Central Côte d'Ivoire. The caterpillar consumes cocoa leaves but will also feed on flowers, cherelles but to a lesser degree on pods. It was reported that whole plantations were completely defoliated in 14 days and being a major threat to cocoa producers[18].

The **Cocoa stem borer** (*Eulophonotus myrmeleon*) once a minor problem is now a major problem in cocoa producing areas in Côte d'Ivoire. The female moth lays eggs on the bark of the cocoa tree. The eggs hatch and the larvae burrow into the cocoa tree. The caterpillar excavates galleries in the cocoa stems and branches before it pupates and emerges as an adult. The damage and yield losses are difficult to estimate but the infestation weakens the cocoa tree and reduces the number of cocoa pods they can produce[19].

Epiphytes and parasitic plants are considered to be serious problems in many cocoa producing regions of West Africa. Epiphytic plants grow on the surface of the trunk and branches impeding the development of flower cushions and damaging the epidermal layer of trunks and branches. Parasitic plants or mistletoes draw water and nutrients from the trees and cause weakening of the branches and can eventually kill the tree[20].

Current recommended best practice for management of cocoa pests and diseases

A series of 103 technical sheets have recently been produced by CNRA, the Direction de la Recherche Scientifique et de l'Appui au Développement (DRSAD) and the Direction des innovations et des Systèmes d'Information (DISI) providing agronomic and pest and disease management advice on a range of crops grown in Côte d'Ivoire and hosted on the CNRA website (https://cnra.ci/nos-fiches-techniques/). Twelve technical sheets have been produced for cocoa, seven relating to pest and disease management and the others on topics such as cultivation, fertilization and nursery set up. Information appears to be updated regularly. A variety of management practices are recommended many of which are non-chemical including the use of improved planting material, preventative/monitoring methods as well as phytosanitation and cultural controls. A summary of the best practice management recommendations from the technical sheets for pests and diseases are outlined below:

Management of major pests and disease

Black pod disease

Resistant/tolerant planting material

- Research conducted at CNRA has produced hybrids with good tolerance to BP and provides this material to producers in the form of coated beans. The hybrids have a production potential of 2.5 to 3 tonnes / ha.

Cultural control

- Maintain recommended planting density (1333 plants per hectare, with 3m between the lines and 2.5m between plants).
- Maintain shade trees density (15 to 18 trees per hectare) and choose suitable trees. Avoid Cola, Ceiba, mango as shade trees (note: probably due to Cola, Ceiba and other species acting as alternative hosts for CSSV)

[18] N'Guessan et al., 2017 https://www.icco.org/wp-content/uploads/T3.195.LA-CHENILLE-ACHAEA-CATOCALOIDES-GUENEE-LEPIDOPTERA-EREBIDAE-UNE-NOUVELLE-MENACE-POUR-LA-CACAOCULTURE-EN-COTE-DIVOIRE.pdf

[19] N'Guessan et al., 2014 https://www.ajol.info/index.php/jab/article/view/112027

[20] Akrofi AY, Acheampong K (2016) Epiphytic and parasitic plants associated with cacao. In: Cocoa Diseases A History of Old Enemies and New Encounters. Eds. Bailey BA and Meinhardt LW. Springer. DOI 10.1007/978-3-319-24789-2

- Phytosanitary pruning maintain ventilation. Remove all disease pods away from the production plots. In areas were losses are less than 25% sanitation is considered sufficient to control BP

Chemical control

- In the areas where annual losses are greater than 25% the use of fungicides can improve disease control.
- Two types of fungicides are recommended – i) contact products containing copper-based products to be applied every 14 days with 8-12 applications per year ii) systemic/contact mixtures (metalaxyl + copper oxide and metalaxyl-M + copper hydroxide) with an application every 21 days with 4-6 applications per year. The user is referred to the label for recommended rates of application and trade names are listed in a table in the technical sheet.

CSSVD

- Management should not be carried out before a diagnosis is confirmed by a supervisory agent from ANADER or a CNRA specialist.
- There is no chemical control available for management of the virus and insecticides are not recommended for management of the mealybug vectors.
- Management is based on cultural control - removing trees that are infected and non-symptomatic trees neighbouring the visibly infected trees. The approach is based on the numbers of tees affected: 1-10 trees with symptoms, remove visibly healthy trees within 6 metre radius of the infected trees; 11-100 infected trees, remove healthy trees within a 12m radius; more than 100 infected trees, remove healthy trees within an 18m radius.
- Trees are cut at ground level and recommended herbicide applied to the trunk. Cut cocoa trees are left to dry for 2 months then removed from the plantation.
- Other hosts of CSSV (shade trees, crop plant and weeds) are eliminated using similar methods –a list of alternative hosts is given in the technical sheets.
- Plant a barrier around the cocoa trees at a width of 10-15m which do not harbour the virus such as coffee, teak, oil palm, rubber
- Carry out inspections for CSSVD symptoms 5 times a year
- Avoid introducing plants or tools from areas/farms known to have the disease
- Avoid grafting from plantations with CSSVD
- When replanting use 'resistant' varieties produced by CNRA (Note: as far as the authors know there are no resistant varieties currently available for CSSVD)
- Follow all good agricultural practices

Insect pests

Nursery/young plantation: defoliating caterpillars, psyllids, thrips, leafhoppers, leaf beetles, weevils, longhorn beetles, locusts

Producing plantations: mirids, stemborers, green stink bugs, variegated stink bugs

Cultural control

- Shade management with 10-20 compatible trees/ha. All trees which harbour mirids should be removed from the plantation
- Regular weeding

Chemical control

- Use crop protection products approved by MEMINADER (table provided) and dose rates and recommended timings specified on the product label
- Application in young plantations generally carried out every 2 months
- In mature plantations apply July-August and December-January
- Application for young plants before crowning should be carried out with a knapsack sprayer; application for mature plants should be Carried out using a motorised mist blower
- Alternate insecticides every 2 years based on the active ingredients

- Management of termites can be carried out if necessary within a radius of 50cm
- Information on preparation, application and health and safety are also provided

Management of other pests and diseases

Defoliating caterpillar *Achaea catocaloides*

Preventative measures

- Inspect the plantation regularly for presence of caterpillars
- Report presence of caterpillar to AEAs to confirm diagnosis

Cultural control

- weeding of cocoa plots to eliminate all potential hosts of the caterpillars
- Regular pruning to aerate the plantation to also facilitate insecticide applications

Chemical control

- Apply insecticides using a motorised mist blower when the caterpillars are most active 6-10am and 4-6pm
- Use insecticides approved by MEMINADER. Examples given in the technical sheet are commercial mixtures containing pyrethroids and noenicitinoids, using prescribed doses on the product label
- PPE instructions given and advice on cleaning equipment and storing pesticides

Stem borer *Eulophonotus myrmeleon*

Cultural control

- Plug borer holes with wooden rods when they are observed on stems and branches
- This technique stops the adult immerging and reduces the number of adults for the next generation

Chemical control

- Application of insecticides reduces the population of egg laying adults in the plantation
- Use products recommended by MEMINADER from management of mirids. Table of products provided: mixtures of systemic (noenicitinoids) and contact (pyrethroids)
- Apply early in the morning using a motorised mist blower in the months of July, August, December and January, following the doses prescribed by the manufacturer
- Applicators must use personal protective equipment (PPE) including masks protective glasses, gloves and boots

Green moss

Preventative control

- Correct cocoa planting density (1333 plants/ha, 3m between rows and 2.5m between plants
- Carry out regular maintenance pruning of cocoa trees in March and August to allow for aeration of the canopy
- Correct density of shade trees (15 to 18 trees/ha)

Cultural control

- Gently strip the moss from the trunk using a machete or stiff bristled plastic brush avoiding damage to the bark

Chemical control

- Apply a solution of sodium chloride (kitchen salt) at 1kg/10L using a pressure sprayer early morning of late afternoon
- This should be done outside the main flowering period (May-June and November-December) to avoid disrupting flowering

Mistletoes, Loranthaceae

Cultural control

- Prune mistletoe with a machete, secateurs or loppers from the canopy after harvest (February-April)

- After removing the mistletoe cut the branch carrying the parasite 10 cm from the point of attachment
- Carry out the same procedure on shade trees bearing mistletoes

Pesticide use and cocoa production

Pesticide use in West Africa has increased rapidly over the 15 years. It is difficult to find accurate figures for pesticides applied to agricultural crops in Côte d'Ivoire but import data available from FAOSTAT (Figure 1) from 1995 to 2020 illustrates the huge increase in import and presumable use of pesticide products

There is very little disaggregated data for import of insecticides/fungicides/herbicides – data from OEC for 2021 shows that pesticide imports into Côte d'Ivoire represent US$ 181 million and account for 1.3% of all imported goods, official figures according to FAOSTAT put the market for 2020 at a slightly higher value of US$ 201 million. When broken down by import value herbicides have the greatest value (US$ 92.7 million) followed by insecticides (US$ 75.8 million) then fungicides (US$ 8.5 million). The origin of the greatest proportion of these pesticides is China (herbicides 85%; insecticides 45%; fungicides 45%), other significant origins include India, Nigeria and Europe.

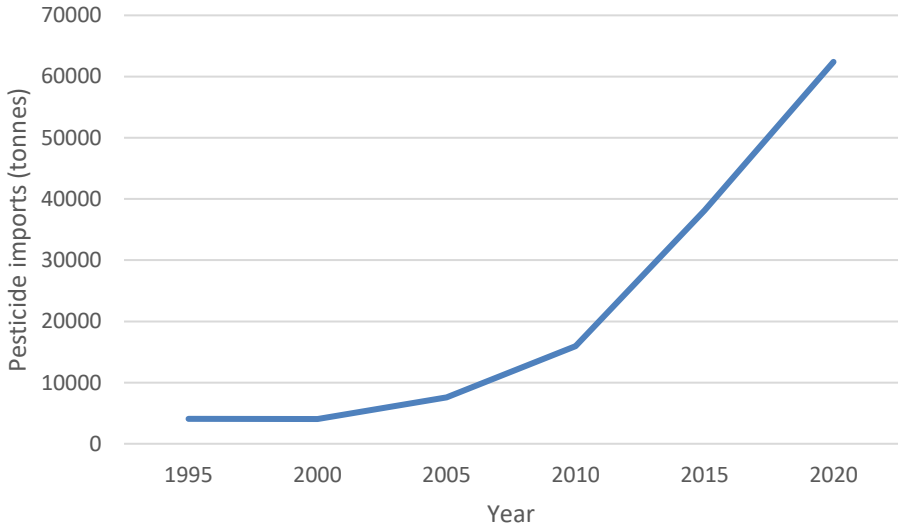

Figure 1. Quantity of pesticides imported into Côte d'Ivoire since 1995 (Source: FAOSTAT)[6]

Regulatory framework for pest and pesticide management

Analysis of existing legal framework for pest and pesticide management

The section below (Table 3) provides an overview of the most important national legislation related to pest and pesticide management. In Côte d'Ivoire, pesticides applied in agriculture are subject to several regulations. These regulations should normally prevent prohibited or non-registered pesticides being available on the market, ensure safe use of pesticides and avoid introduction of plant pests to the country. Though there is currently no specific policy for IPM in agriculture, it is gaining prominence and several initiatives are underway to develop IPM strategies for a variety of cropping systems in different agro-ecological zones in the country (Plan de Gestion des Pestes). At this time there is no specific plan for cocoa IPM but considering the importance of cocoa as an export commodity, the complex nature of the pests and diseases affecting the crop and the need to reduce the reliance of pesticides to manage cocoa pests and diseases it should be high on the priority list for the government.

Table 3. The main legal texts forming the regulatory framework for pest and pesticide management

Regulatory actions	Legal texts	Description
Plant protection	Loi No. 64-490 du 21 décembre 1964 relative à la protection des végétaux Law No. 64-490 of December 21, 1964 relating to the protection of plants	Law to protect plant health Any material brought into the territory requires a phytosanitary certificate Authorisation for the use of plant protection substances
Approval of pesticides	Décret No. 74-388 du 7 août 1974 relatif à l'agrément des pesticides Decree No. 74-388 of August 7, 1974 relating to the approval of pesticides	All pesticides require prior approval Commission to review documents and advise Minister of Agriculture on the proposed pesticides
Enforcement	Loi No. 81-640 du 31 juillet 1981 instituant le Code pénale Law No. 81-640 of 31 July 1981 instituting the criminal code	• States that any person responsible for pollution by chemicals or hazardous waste can be subject to punishment under the law
Public health and environmental protection	Loi No. 88-651 du 7 juillet 1988 relative à la protection de la santé publique et de l'environnement contre les déchets toxiques et les substances nocives Law No. 88-651 of July 7, 1988 on the protection of public health and the environment against toxic and nuclear waste and harmful substances	Establishes the penalties for offenses in relation to the marketing, transit, transport, deposit or storage of toxic and nuclear industrial waste and harmful substances
Registration and control of pesticides	Décret No. 89-02 du 04 Janvier 1989 relatif à l'agrément, la fabrication, la vente et l'utilisation des pesticides Decree No. 89-02 of 04 January 1989 relating to the approval, manufacture, sale and use of pesticides	Establishes the Pesticides Committee (CP) which decides on registration applications Approval required for producers, sellers and applicators of pesticides Outlines disposal procedures for empty containers Gives CP authorisation to carry out controls on any site where pesticides are manufactured, sold or applied
Sanitary and phytosanitary controls	Arrêté No. 027/MINAGRI/CAB du 25 février 1993 relatif aux contrôles sanitaires	Border control entrusted to the regional directorates of the Ministry of Agriculture

	Order No. 027/MINAGRI/CAB of February 25, 1993 relating to sanitary controls	
Environmental protection	Loi-cadre No. 96-766 portant Code de l'environnement Framework law No. 96-766 establishing the Environmental Code	Framework to manage and protect the environment against all forms of degradation including pollution The specific terms of application of this law are subject of successive decrees
Prohibits the use of certain active ingredients	Arrêté No. 159/MINAGRI du 21 juin 2004 portant interdiction d'emploi en agriculture de substances actives entrant dans la fabrication des produits phytopharmaceutiques Order No. 159/MINAGRI of 21 June 2004 prohibiting the use in agriculture of active substances used in the manufacture of plant protection products	Prohibits the import, manufacture, packing and use of active substances contained in the appendix (66 substances)
Control of national ports of entry and exit	Arrêté interministériel No. 509/MINAGRI/MEMIS du 11 novembre 2014 relatif au contrôle des pesticides aux portes Order No. 509/MINAGRI/MEMIS of November 11, 2014 relating to the control of pesticides at national ports of entry	Organise the control of pesticides on import Phytosanitary inspection of plants and any other materials carrying organisms harmful to plants Outlines responsibilities of 39 entry points responsible for inspecting pesticides and collecting data Defence and security forces responsible for assisting Ministry of Agriculture inspectors
Importation of pesticides	Circulaire No. 1751 /MPMBPE/DGD / du 18 janvier 2016 relatif à l'importation de substances actives de pesticides et de produits phytopharmaceutiques Circular n° 1751/MPMBPE/DGD/ of January 18, 2016 on the import of active substances of pesticides and plant protection products	Linked to Décret No. 89-02 and Arrêté Interministériel n°509/MINAGRI/MEMISDGD Imports of active substances of pesticides and phytopharmaceutical products are subject prior import authorization issued by the Department of Plant Protection and Quality Control (DPVCQ)
Environmental protection	La Loi No. 2016-886 du 08 novembre 2016 portant Constitution de la République de Côte d'Ivoire Law No. 2016-886 of 08 November 2016 on the Constitution of the Republic of Côte d'Ivoire	In articles 15, 27 and 40 relate to the protection of the environment and promotion of the quality of life as a duty of all

Adapted from information available from[2,21,22]

International and regional agreements relating to pesticides

International agreements and conventions signed and ratified by Côte d'Ivoire include:

[21] 2PAI-Nord, Rappport – Plan de gestion des pestes https://2pai-belier.ci/2021/07/13/etude-dimpact-environnemental-et-social-du-projet-de-developpement-du-pole-agro-industriel-dans-la-region-nord-de-la-cote-divoire-2pai-nord-ci/

[22] Traoré and Haggblade (2017) https://www.canr.msu.edu/resources/mise-en-oeuvres-des-politiques-regionales-sur-les-pesticides-en-afrique-de-l-ouest-rapport-de-l-etude-de-cas-en-c-te-d-ivoire

- The Montreal Protocol[23] on substances that deplete the ozone layer, most notably banning the sale and use of Methyl Bromide was ratified in 1992
- The Rotterdam Convention[24] on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, signed in 1998 and ratified in 2004. The Convention sets out the obligations of Parties with respect to the future import of chemicals listed in Annex III of the Convention and subject to the prior informed consent (PIC) procedure
- The Stockholm Convention[25] on Persistent Organic Pollutants, signed in 2001 and ratified in 2004
- The Basel Convention[26] on Control of Transboundary Movements of Hazardous Wastes and their Disposal was ratified in 1994
- The Bamako Convention[27] is a treaty of African nations prohibiting the import into Africa of any hazardous waste, ratified in 1994. Came into force in 1998 to address the failures of the Basel Convention in prohibiting trade of hazardous waste to less developed countries due to the realisation many developing nations were exporting hazardous waste to Africa
- La Résolution N°7/17/CM/92 la Réglementation sur l'homologation des pesticides commune aux Etats membre du Le Comité inter-États de lutte contre la sécheresse au Sahel (CILSS). Aims to combine expertise in the evaluation and management of plant protection products from all CILSS Member States for the registration of pesticides and bio-pesticides at a sub-regional level led by the Sahelian Pesticides Committee (CSP). Côte d'Ivoire became a member of CILSS in 2011 and participates in the meetings of the Sahelian Pesticides Committee as an observer but has not adopted the legislative texts of CILSS therefore pesticides registered by the Committee are not authorised in Côte d'Ivoire, which continues with its own national legislation for pesticide registration[22]
- The Economic Community of West African States (ECOWAS) initiated regional regulations for agricultural inputs (including pesticides) in 2008 (ECOWAS Regulation N^{o}C/REG.3/05/2008) as part of its common agricultural policy. As well as the Sahelian countries ECOWAS includes the costal countries (or Humid Zone) of West Africa including Côte d'Ivoire, who has been a member of since it was founded in 1975. As part of the regulation the West African Pesticide Registration Committee (WAPRC) was formed. Under WAPRC the CSP will continue to function as the registration body for the Sahelian countries and the yet to be created WAPRC-Humid Zone would form the joint registration body for the Costal Countries. The main constraint to the implementation of the sub-committee is the well-developed national pesticide regulations in the Costal Countries[28].

Overview of national organisational arrangements and regulation related to pest and pesticide management

The registration of pesticides is the responsibility of **Direction de la Protection des Végétaux, du Contrôle et de la Qualité (DPVCQ)** under Ministère d'Etat, Ministère de l'Agriculture et du Développement Rural (MEMINADER). The DPVCQ is responsible for protecting plant health and ensuring the quality of agricultural products in Côte d'Ivoire. This includes monitoring and controlling pests and diseases of crops, ensuring that agricultural inputs such as seeds and fertilizers are of good quality, and establishing and enforcing regulations related to plant health and agricultural product quality. The responsibilities of the

[23] https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol
[24] http://www.pic.int/
[25] http://chm.pops.int/
[26] http://www.basel.int/
[27] https://www.unep.org/explore-topics/environmental-rights-and-governance/what-we-do/meeting-international-environmental
[28] Haggblade et al. (2022) https://onlinelibrary.wiley.com/doi/epdf/10.1111/dpr.12545

DPVCQ were outlined according to the Décret n°2003-14-141 du 27 mai 2003 under MEMINADER and updated in Décret n° 2016-563 du 27 juillet 2016:

- To participate in the development of regulations on the protection of crop production and to ensure its application
- To ensure the protection of plant resources and to carry out the plant disease control programmes
- To ensure the application of phytosanitary agreements and conventions
- Carry out the sanitary inspection of imported or exported plants and derivatives
- Ensure the coordination of actions aimed at the qualitative improvement and intensification of crop production
- Ensure quality control and packaging of agricultural products
- To ensure the control of the professions of the vegetable foodstuffs sector
- Organize and coordinate health control and inspection as well as the quality of foodstuffs intended for consumption
- Participate in the development and ensure the application of rules, of hygiene and sanitation standards
- To ensure the application and adaptation of texts governing trade internationally in terms of quality and ethics, in liaison with the Management Legal Affairs, Litigation and International Cooperation

DPVCQ is also responsible for the enforcement of pesticide regulations, monitors the use of pesticides and enforce regulations related to their use, including safety standards and environmental impact assessments.

Through Décret 89-02 du 04 Janvier 1989 for the approval manufacture, sale and use of pesticides, DPVCQ is responsible for the registration and authorization of plant protection products in Côte d'Ivoire. It is also the responsibility of the Crop Protection Sub-directorate to lead the Pesticide Committee. The Pesticides Committee is an inter-ministerial committee established by Décret No 89-02 du 04 Janvier 1989. It is made up of representatives of the Ministries in charge of Scientific Research, Health, Environment, Trade and Industry, Interior, Economy and Finance, Transport, Animal Resources, Water and Forests, Defence, internal Security. The MEMINADER provides the permanent secretariat through DPVCQ. The Committee is responsible for:

- Applications for approval of pesticides
- Carry out any experimentation necessary for the assessment of the files presented
- Monitor approved products
- Opinion on the installation of any establishment manufacturing and/or packaging pesticides
- With the Ministry of Trade to approve resellers of pesticides
- Offer approvals to pesticide product applicators

Where products are already approved:

- Approvals of new formulations
- Extensions of use of formulations already approved
- Provisional sales authorizations
- Renewals of approvals
- Transfers of ownership of approvals
- Modifications to the compositions of formulations already approved
- Product name changes
- The approvals of phytosanitary professionals (phytosanitary firms, distributors or resellers and applicators
- Phytosanitary regulations

The Pesticides Committee is responsible for drawing up a list of phytosanitary products authorized for sale in the country, this is supposed to be performed on an annual basis. The list of approved pesticides is not publicly available but a copy can be requested from the

DPVCQ and is sometimes available from the decentralized offices of MEMINADER. Due to the limited availability of the list many cocoa stakeholders and even phytosanitary inspectors are unaware of the most recent updates. In addition to the list of authorised phytosanitary products, the DPVCQ also draws up the list of phytosanitary products prohibited for use in agriculture in Côte d'Ivoire.

The pesticide registration process begins with an application for testing made by the brand holder or the distributor of the product. The file is registered by the Permanent Secretariat of the Pesticide Committee, then an acknowledgment of receipt is issued to the applicant, followed by a proposal for testing. Experimental Research Institutes or other organisations send their proposal for research protocols to the Pesticide Committee. After acceptance of the research protocols, the institute mandated for the research sets up the trials in the presence of the DPVCQ agents. The research results are sent by the mandated research institute in the form of a technical report to the Permanent Secretariat of the Pesticide Committee.

The second stage of the approval procedure is the application for approval of the pesticide with the submission of a completed file by the brand holder or the distributor of the product to the Permanent Secretariat of the Pesticide Committee. The file is recorded if it is admissible and then submitted to the members of the Pesticides Committee and possibly to experts from outside the committee. After an in-depth examination of the file, a proposal for a decision is taken and then sent to MEMINADER. This decision can be formulated in the form of an order granting approval, an order granting prior authorization for sale, a notification of the start of the study or a notification of refusal of approval. The decision is documented then distributed after the signature of MEMINADER.

The procedure described above is valid for any pesticide, including pesticides intended for cocoa which are subject to registration. In Côte d'Ivoire, there are still no specific regulations for the registration of biopesticides as well as biological control agents (macroorganisms).

According to the DPVCQ, (and farmers), unapproved phytosanitary products are circulating in Côte d'Ivoire and said to come mainly from Ghana across the land border. In order to reduce the influx of unregistered products, the DPVCQ initiated a collaboration with the NPPO of Ghana (PPRSD). The customs services of Côte d'Ivoire also organised, in collaboration with their counterparts in Ghana, workshops in 2012 and 2013 to develop a strategy to reduce the movement of fraudulent plant protection products entering the country.

Côte d'Ivoire is a signatory to the International Plant Protection Convention (IPPC), DPVCQ is also responsible for reporting on the following:

- Phytosanitary requirements, restrictions and prohibitions currently in force
- Specific points of entry
- List of regulated pests
- Reporting on pest occurrence, outbreaks and spread
- Emergency actions

The responsibility for food safety falls under several government agencies and ministries but the **Ministère de la Santé et de l´Hygiène Publique (MSHP)** is responsible for regulating and enforcing food safety standards, monitoring food quality, and ensuring the safety of food imports. **The Institut National d'hygiène Publique (INHP)** under the MSHP works with other government agencies (MEMINADER and ANASSA) to ensure that pesticides are used safely and responsibly in agriculture and other sectors and is responsible for conducting research and providing technical guidance on the health effects of pesticide exposure, as well as developing and implementing programs to promote the safe use and handling of pesticides. INHP also plays an important role in monitoring and responding to pesticide related health incidents, such as cases of poisoning or other adverse health effects.

Agence Nationale de la Sécurité Sanitaire des Aliments (ANSSA) was established in 2012 under the authority of MSHP and is responsible for developing and implementing food safety regulations and guidelines in Côte d'Ivoire, conducting risk assessments and monitoring of food and food-related products to ensure compliance with food safety standards. ANSSA also provides training and education to stakeholders on food safety issues and conducts research and development activities to improve food safety practices and technologies.

La Direction des Déchets Industriels et Substances Chimiques (DDISC) was created in 2016 by décret n°2016-595 du 03 Août 2016 under the Ministère de l'Environnement et du Développement Durable (MINEDD). Its main mission is to monitor and implement the national policy for the management of industrial waste and chemical substances by ensuring the application of the conventions and protocols ratified by Côte d'Ivoire. It is the focal point for Basel and Bamako Conventions, technical secretariat of the National Committee for record analysis of transboundary movement/transfer of waste within the framework of the Basel Convention. It is responsible for regulating and monitoring industrial waste and application of provisions of waste/chemical conventions. The DDISC also promotes research and technologies for management of industrial waste and chemicals, develop awareness programmes on rational management of waste and chemicals and encourages compliance of labs and companies with international standards for management of industrial waste and chemicals.

The management of obsolete chemical, including pesticides, is a problem for most developing countries. In Côte d'Ivoire, the management of obsolete pesticides is becoming a serious concern for the state, as it requires the mobilization of significant resources, especially financial. One of the key achievements was the Obsolete Pesticides Management Project in Côte d'Ivoire (PROGEP-CI) which was implemented by MINEDD from 2016 to 2021. This project enabled the government to locate 4,071 depots of obsolete pesticides across the country and destroy by incineration 329 tons of obsolete pesticides and other chemicals.

Centre Ivoirien Antipollution (CIAPOL) was established by Décret n°91-662 du 09 Octobre 1991, CIAPOL is a Public Administrative Establishment placed under the administrative and technical supervision of MINEDD. Main responsibilities include monitoring and controlling environmental pollution including air, soil and water, managing and controlling the disposal of hazardous waste. CIAPOL is also responsible for promoting environmental education to raise awareness about environmental issues and promote environmental education and collaborates with other government agencies, NGOs, and international organizations to implement environmental policies and programs in the country.

National analytic laboratory services are provided by the **Laboratoire National d'Appui au Développement Agricole (LANADA)** and the **Laboratoire National d'Essais de Qualité Métrologique et d'Analyses des Pollutions (LANEMA)**.
LANADA was created in 1991, then reorganized in 1999 by Decree n°99-439 of July 07, 1999, itself modified by Decree n°2013-329 of May 22, 2013. LANADA is composed of five laboratories. i) Central Laboratory for Food Hygiene and Agro-industry located in Abidjan ii) the Central Laboratory of Agrochemistry and Ecotoxicology located in Abidjan iii) Bingerville Central Veterinary Laboratory iv) Bouaké Regional Laboratory v) Korhogo Regional Laboratory. LANADA operates under the technical supervision by MEMINADER and close links with Ministère des Ressources Animales et Halieutiques and is the official laboratory network for analysis relating to:

- the hygiene and quality of food products
- the quality of agricultural products
- animal health, feed and reproduction
- veterinary pharmacy and phytosanitary products
- plant protection and plant production
- environmental protection

LANEMA under the technical supervison by the Ministère du Commerce et de l'Industrie was created in 1985 as a central department of the Ministère du Commerce et de l'Industrie, as of 1991 LANEMA operates as a commercial enterprise with a mission:

- microbiological and parasitological analysis of water
- analysis of agro-industrial products
- consumer protection
- support for industrial development
- Quality of agro-industrial products, particularly fertilizers

The Conseil du Café et du Cacao (CCC) was created under the terms of article 18 of l'Ordonnance n°2011-481 du 28 décembre 2011 which outlines the rules relating to the marketing of coffee and cocoa. The CCC is responsible for regulation, stabilisation and development of the coffee/cocoa sector under the supervision of MEMINADER and the Ministère de l'Economie et Finances. The goals of the CCC are to strengthen good governance and transparency in resource management; develop a sustainable cocoa and coffee economy through the reorganization of production and the improvement of productivity; secure the income of producers by setting up a guaranteed minimum price as well as improving internal and external consumption; set up a strong inter-branch organization based on credible producer organizations. The CCC was instrumental in developing the Program to intensify the fight against Swollen-shoot disease, a 5-year project launched in 2018 in collaboration with ANADER, CNRA, FIRCA and other stakeholders. The main objective is to stop the progression of the disease in the orchard and replant all the foci of infection.

Agricultural extension is predominantly carried out by **L'Agence Nationale d'Appui au Développement Rural (ANADER)**. Created in 1993 through the implementation of the National Support Program for Agricultural Services resulting from the Structural Adjustment Program conducted by the State of Côte d'Ivoire with funding from the World Bank. ANADER has been a public limited company since April 1998. Its main objective is to support the development of the rural sector in the country by promoting agricultural productivity, rural entrepreneurship, and the empowerment of rural communities. ANADER operates under the supervision of MEMINADER and has a Board of Directors from state, civil society, commodity boards and private sector. The main functions of ANADER include:

- Providing technical assistance and advisory services to rural communities, including farmers, rural entrepreneurs, and community-based organizations
- Promoting the adoption of best practices in agriculture and rural entrepreneurship, including the use of improved technologies and management practices
- Supporting the development of rural infrastructure, such as roads, irrigation systems, and market facilities
- Facilitating access to finance and other resources for rural entrepreneurs and farmers
- Fostering collaboration and partnerships between rural communities, private sector actors, and other stakeholders in the agricultural sector

It has 10 Regional Directorates, 57 Zones and 1,046 Extension Centres, ANADER also operates 4 Operational Training Centres of which two provide services for cocoa farmers. The Gagnoa-Lakota Training Centre provides training in sustainable cocoa and coffee farming and The Kotobi Training Centre offer training for perennial crops and food crops. Cocoa related training includes plantation establishment, GAP, IPM including CSSVD management, cocoa rehabilitation, farmer field schools, cooperative management, farmer business schools and also developing digital tools such as e-extension. ANADER is the main implementing partner for extension related cocoa projects/programmes in collaboration with international development agencies, NGOs, and industry partners.

The national agricultural research organisation is the **Centre National de Recherche Agronomique (CNRA)** is a public limited company, funded by the state and private entities.

It was founded in 1998 after the merger of three other research organisations, CNRA has several research stations and other sites across the country focusing on different crops depending on the region. Research covers a wide range of topics including:

- Improvement of crops intended for export
- Improving productivity of food crops essential to food security
- Promotion and development of new exportable products
- Intensification and stabilization of livestock systems and regional systems based on food crops, by integrating livestock farming and the introduction of various utility trees, through a modernization of exploitation, through sustainable soil management, the integral management of pests, water management,
- the revitalization of technological research, in particular the conservation, processing of agricultural products and the adaptation of small technology in rural areas

Much of the countries research on cocoa is carried out by CNRA. The main research station for cocoa is located in Divo and its Cocoa Program aims to contribute to the sustainable production of cocoa, to improve farm productivity and the technological quality of marketable cocoa beans with a mission to:

- Develop a selection of high yielding cocoa plant material resistant to the constraints of the environment and with Improved quality
- Development of plant material and methodologies for the regeneration old cocoa orchards
- Development of integrated control methods against cocoa diseases and insect pests
- Training of extension workers, producers and other actors in the sector in good agricultural practices for sustainable cocoa production

CNRA carried out a study in 2007 which revealed that only 2.5% of farmers followed their recommendations for pest and disease management. Since then CNRA has developed several management strategies for cocoa pests and diseases and have recently published a series of technical sheets for pest and disease management based on IPM practices that now available on their website (see section on Management of pests and diseases). Other research activities include identifying pest and disease distribution and severity level and population dynamics studies. Selection methods based on the screening of resistant varieties have been used to improve the quality of cocoa trees and their tolerance to certain diseases. One example is the development of a disease-resistant cocoa variety called “Mercedes” now available to cocoa producers throughout the country. CNRA has worked closely with other regional cocoa research institutes in West Africa, most recently with CRIG in Ghana to try and combat the spread of CSSVD in the countries border region. CNRA’s activities are currently 90% funded by the CCC but receive additional revenue through pesticide bio-efficacy testing activities.

CNRA’s current concerns in relation to pests and diseases are finding solutions for the effective management and reducing the spread of CSSVD and managing the green moss that grows over flower cushions on cocoa stems, reducing pod set and therefore reducing production. Issues around under investment in research facilities and staffing were also discussed.

Analysis of registered pesticides and identification of HHPs

Overview

As mentioned in the previous section, the government of Côte d'Ivoire, through the DPVCQ and its Pesticides Committee, annually registers pesticides and provides a list of phytosanitary products authorized for sale in the country. Stock-taking of the pesticides registered for use on cocoa in Côte d'Ivoire was carried out using the most up to date national registered pesticide list published in August 2021. The full list contains just over 2000 commercial pesticide products: 818 products for use primarily as insecticides (some combined acaricides, nematicides, fungicides and rodenticides), 780 herbicide products, 279 fungicide products, 79 growth regulator products, 38 nematicides, 24 rodenticides and 7 molluscicides (Figure 2). Those registered for use on cocoa were predominantly insecticides (256) and fungicides (98) although a target pest or pathogen was not indicated in the national list.

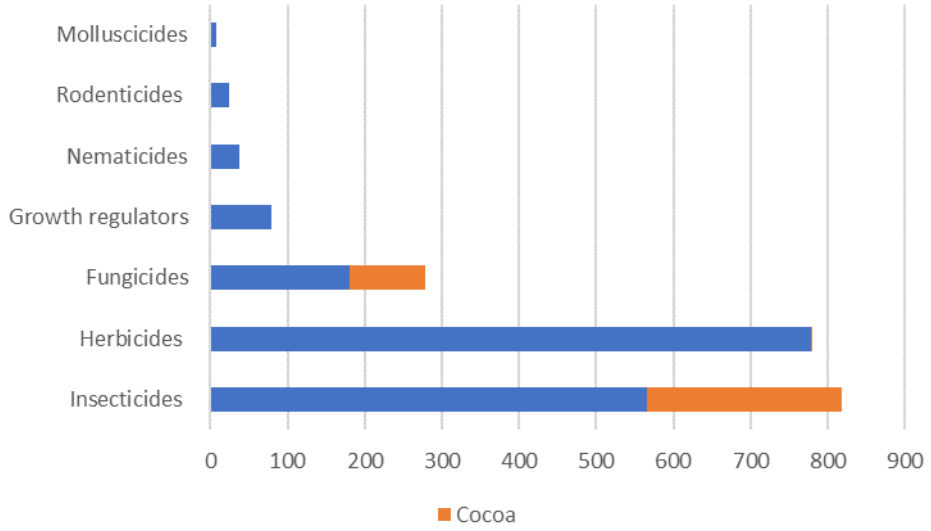

Figure 2. Total number of commercial pesticide products registered nationally in Côte d'Ivoire showing the proportion of those recommended for use on cocoa

Only two herbicide products were specifically specified for use on cocoa (glyphosate ammonium salt and metsulfuron-methyl), 214 other herbicides were registered for "Touts Cultures" (all crops) but it is unclear from the registered list if these are approved for use on cocoa. Further analysis showed that 54 AI were registered for use on cocoa: 29 insecticides, 23 fungicides and 2 herbicides. The 54 AIs were categorised by their hazard category for each AI was identified using the following criteria:

- HHP were defined as having one or more of the following characteristics based on FAO's International Code of Conduct on Pesticide Management Guidelines on HHPs[29]
    1. WHO acute toxicity Ia or Ib
    2. GHS carcinogenicity 1A or 1B
    3. GHS mutagenicity Categories 1A or 1B
    4. GHS reproductive toxicity categories 1A or 1B
    5. Stockholm Convention POPs
    6. Rotterdam Convention PICs Annex III
    7. Montreal Protocol ODS

[29] Based on FAO HHP Criteria 1-7, International Code of Conduct on Pesticide Management Guidelines on Highly Hazardous Pesticides (2016) https://www.fao.org/3/i5566e/i5566e.pdf

- Danger: one or more of the associated human health hazard statements indicate that the AI is “toxic” or “fatal” if inhaled or swallowed
- Warning: one or more of the associated human health hazard statements indicate that the AI is “harmful” if inhaled, causing allergy etc. or very toxic to aquatic life and/or with very toxic to aquatic life long lasting effects
- Low risk: no known human health hazard statements associated with the AI
- Missing data: hazard data unavailable

The AI hazard category was also compared to the criteria for HHPs developed by PAN, approval for use in the EU, Rainforest Alliance pesticide management standards and AI mode of action, a full list can be found in the table in Appendix II and III.

AI hazard category

The 54 AI registered for use on cocoa in Côte d’Ivoire differed in terms of their overall hazard level (Figure 3). Five of the AI registered for use met one or more of the HHP criteria. Seventeen AI were categorised as “danger” (one or more of the associated human health hazard statements indicate that the AI is “toxic” or “fatal if inhaled or swallowed”); twenty three AI were categorised in the “warning” category; one AI (pyrimethanil) was categorized in the “low-hazard” category (there are no known human health hazard statements associated with the AI); and key human health hazard data is missing for eight AI.

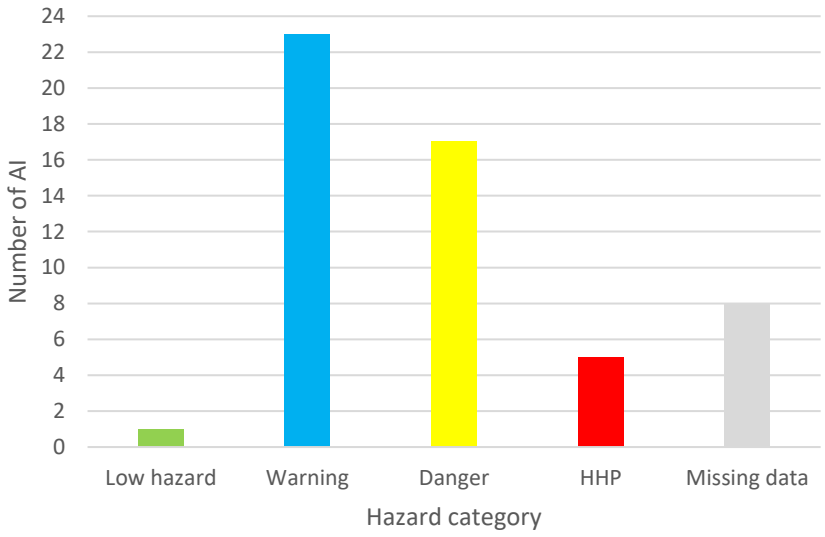

Figure 3. Number of AI in each hazard category

Of the five AI categorised as HHPs, two were fungicides (dimethomorph and mancozeb) and three insecticides (abamectin, chlorpyrifos and thiacloprid). Abamectin, because of its acute toxicity (WHO 1b); chlorpyrifos, dimethomorph, mancozeb and thiacloprid are considered reproductive toxins, category 1A/1B. Key human health hazard data was missing for 18 of the AI (Appendix II) and none of the currently registered AI are listed as candidate POPs, PICs or ozone depleting substances.

Pesticide Action Network (PAN)

Twenty five of the 54 AI registered were categorised as HHPs according to the PAN 2021 list (Figure 4). Five AI were in Group 1 for acute toxicity, eight in Group 2 causing long term (chronic) effects and twenty in Group 3 causing significant harm to the environment. Twenty nine of the 54 AI, just over half, were not considered to be HHPs according to the PAN criteria. Five AI were listed in two PAN group categories (abamectin, aluminium phosphide, bifenthrin,

alpha cypermethrin and deltamethrin) and three AI listed in three group categories (chlorpyrifos, lambda cyhalothrin and beta cypermethrin).

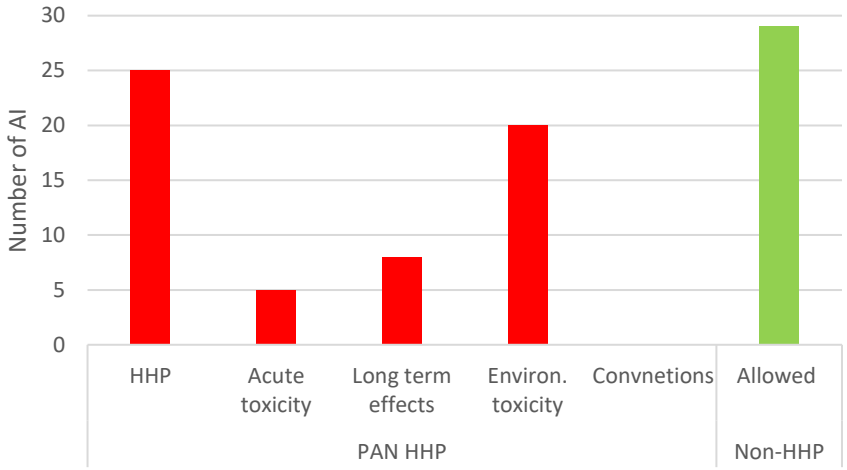

Figure 4. Number of HHPs and non-HHPs as categorised by PAN

European Union (EU)

Seventy per cent of the AI (38) were approved for use in the EU (Figure 5). Nearly 30% AI (15) were not approved for use in the EU and one was not listed (Horse tail extract). Refer to Annex III for information on specific AI.

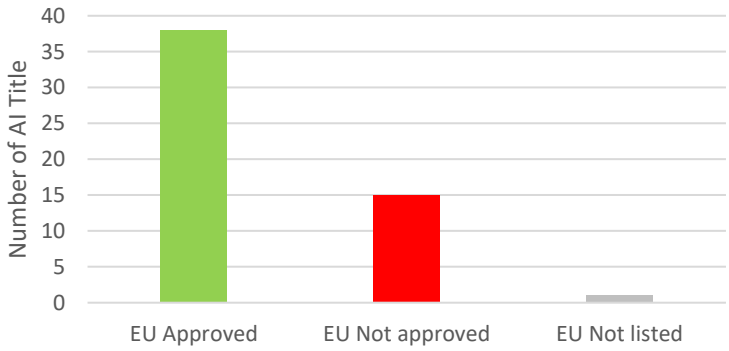

Figure 5. Approval and non-approval in the EU

Rainforest Alliance (RA)

For pesticide management the RA publishes three pesticide lists for the certification criteria, the latest was update in 2022: i) prohibited pesticides ii) obsolete substances iii) risk mitigation pesticides and the measures required for their use. The prohibited pesticides for pesticide management is based on FAO International Code of Conduct Guide for HHPs. Twenty-two AI registered in Côte d'Ivoire for use on cocoa are approved under RA without additional restrictions for use, nine AI are on the prohibited list and a further twenty-two are only permitted for use under the certification scheme in the context of IPM when additional risk mitigation measures are implemented (Figure 6; Annex III for a full list of AI).

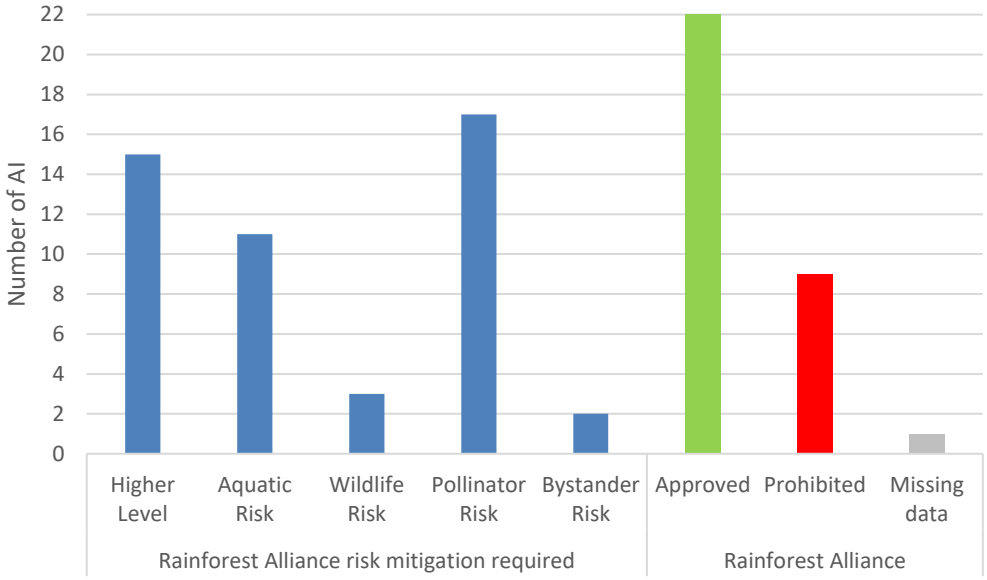

Figure 6. Number of AI permitted, prohibited and require additional risk mitigation measures under RA certification

Fairtrade International (FTI)

For pesticide management the FTI has three pesticide lists for agro-chemical use: i) red list for prohibited pesticides ii) orange list for restricted substances due to be phased out or moved to the red list iii) Yellow list for 'flagged' chemicals, those being hazardous and to be used with extreme caution. The red list chemicals criteria are based on being either listed in the conventions, being acutely toxic, cause long term chronic effect or of environmental concern (very persistent, bioaccumulative or highly toxic to aquatic organisms) Twenty-nine AI registered in Cote d'Ivoire for use on cocoa are approved under FTI, seven AI are on the prohibited/red list, nine on the restricted list and a further seven on the flagged list (Figure 7; Annex III for a full list of AI).

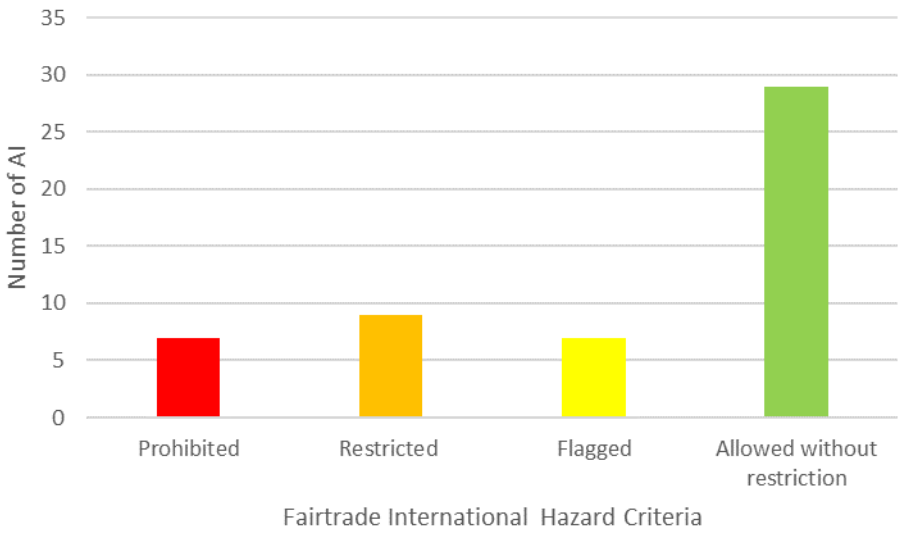

Figure 7. Number of AI prohibited, restricted, flagged and permitted under FTI production

Biopesticides

There are eight AI registered for use on cocoa that are considered to be biopesticides (botanicals/plant oils/microorganisms). Orange oil, tea tree extract, *Equisetum arvense* (horsetail extract), *Bacillus amyloliquefaciens* and *B. subtilis* all have key human health hazard data is missing but are either considered safe for use by one of all of PAN/RA/EU. Azadirachtin, pyrethrin/pyrethrum

and clove oil (eugenol) all fall under the “warning” category when considering GHS classification either for human health or as an environmental hazard. Pyrethrin/pyrethrum is also considered under the PAN as an HHP and requires additional risk mitigation measures under RA certification.

Pesticide AI resistance and mode of action (MOA)

Of the 256 insecticide products approved for use on cocoa in Côte d’Ivoire 206 of these are combinations with two or more AI; 199 insecticides contain two AI and seven products contain a combination of three AI. Of the 199 with two AI 180 of these are a combination of a noenicitinoid and a pyrethroid, the seven products with three AI also contain a combination of a noenicitinoid and a pyrethroid. Of the products containing single AI 34 contain noenicitinoids of which 28 are imidacloprid (PAN HHP, prohibited under RA, not approve EU). For the fungicide products the majority contain a mixture of AI (80 out of 98), 34 of these contain a mixture of metalaxyl-M and copper oxide and 22 contain the HHP mancozeb.

As well as toxicity (acute and chronic) it is important to take into consideration the MOA of AI and the potential for the development of resistance - resistance management is an important part of pest management and IPM. It is recommended that AI with three different MOA should be rotated to avoid resistance when managing cocoa pests[30]. It could be argued that whilst using a mixture of AI in a single product it offers better protection against a range of pests but it is likely to have a greater impact on non-target organisms. IRAC[31] states that most mixtures are not used for the purpose of insecticide resistance management and by broadening the spectrum of activity can quickly compromise IPM.

The majority of insecticides approve for use on cocoa in Côte d’Ivoire are mixtures that contain the same AI with the same two modes of action and increases the risk of building up insecticide resistance in cocoa pests. Other products are registered with alternative MOA but it is unknown how widely available or economical they are compared to the more generic and more readily available products.

[30] Cocoa Pesticide Manual (2023) 4th Ed, Eds Bateman and Crozier. In press
[31] IRAC https://irac-online.org/

Results from the in-country interviews with farmers and extension

Farm characteristics and production practices for cocoa

Overview of cocoa farmers in the study area

Nineteen cocoa farmers were interviewed from cocoa growing regions in the southeast and south west of the country. Ten farmers were interviewed in communities near Niablé and Abengourou in the Indénié-Djuablin Region of the Comoé District and nine cocoa farmers were interviewed in Bas-Sassandra District - four in the community of Méagui, Nawa region and five in the community of Soyoubakro, Gblôkle region (Figure 8). Focus group discussions (FGD) were also carried out with additional farmers in each of the communities. All farmers interviewed were members of cooperatives and those from the Comoé District were taking part in the PRO-PLANTEURS Programme.

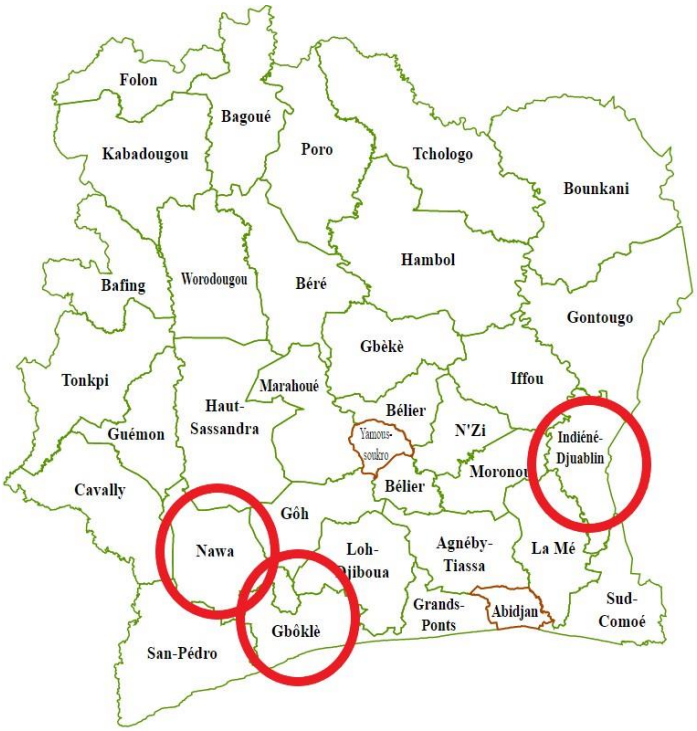

Figure 8. Regions in Côte d'Ivoire where farmer communities and extension services were selected for interview

Of the producers interviewed a large proportion were male (80%). The proportion of men to women was corroborated as representative of the wider farmer population by the agricultural extension agents (AEAs) as well as PRO-PLANTEURS monitoring figures (S. Lehmann GIZ, personal communication). Although these proportions may hide the real contribution of women in cocoa production, they can be justified by the fact that cocoa plantations were mainly owned by heads of households who were generally men. All the producers interviewed own their cocoa fields and around 80% of them were over 40 years old. Farmers had a range of education levels ranging from no education (5), primary (6), secondary (7) and university level (1).

Average farm size was 5ha with two producers farming 10ha. Forty per cent of the farms grew cocoa under shade whilst the remaining 60% were full sun without shade. Just over 50% of the cocoa planted was between 3-20 years old and the remainder over 21 years with the majority of those farms over 31 years, with 5 farms over 40 years old. All of the producers interviewed belonged to a cooperative and all belonged to one or more certification schemes, the most prevalent being Rainforest Alliance. This was not unexpected as PRO-PLANTEURS and PRO-CIV work mainly with certified farmers, the national average for production of certified cocoa approximately 30% (S. Lehmann GIZ, personal communication).

Reported pest and disease problems in cocoa

The majority of producers (more than 80%) confirmed that they visit their fields and nurseries on a daily or weekly basis to monitor for the presence of pests and diseases. This is not the case for harvested cocoa, once fermentation and drying has been carried out the producers send them to the cooperative store from where they are transported to the exporters' facilities.

In the nursery the main pests encountered by producers were caterpillars (70%), followed by mirids (32%) and mealybugs (17%). Other minor cocoa nursery pests such as rodents, snails, termites and locusts were also reported.

In the field, the most frequently reported pests were stem borer (85% of producers). According to producers, infestation by stem borer can lead to the death of cocoa trees if no control measures are implemented. Other frequently reported pests and diseases include mirids and shield bugs by 80% of farmers, black pod (68%), weeds (58%) and caterpillars, CSSVD and termites by 42% of producers (Figure 9).

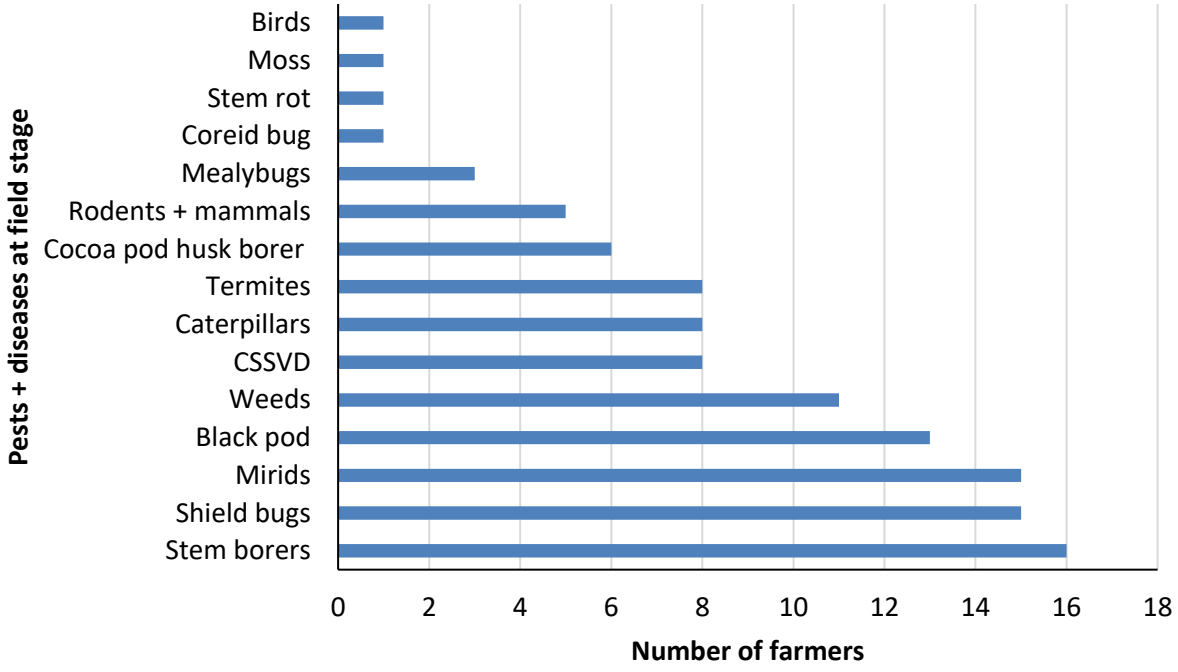

Figure 9. Most frequently reported pests and diseases in cocoa fields

Pests of stored cocoa beans were reported by a small proportion of growers (<12%) these included caterpillars, rodents and mould. It should be noted that all the producers interviewed belonged to cooperatives to which they entrust their dried cocoa beans for storage. It is therefore the responsibility of the management committee of these cooperatives to take adequate measures for better conservation of the cocoa beans placed in their stores.

Description of crop protection methods

The majority of farmers used some non-chemical methods for the management cocoa pests and diseases during production (Table 4). Manual weeding was the most frequently used non-chemical management method (37% farmers). Other methods were using sticks to seal stem borer exit holes in cocoa stems (32% farmers), the removal of chupons for management of mirids (21% farmers), shade management and removal of diseased pods for black pod control was only practiced by 10% of farmers. This is surprising as these are effective basic methods (if carried out correctly) in managing levels of mirids and black pod.

No biopesticides were reported to be used for pest and disease management with the exception of one farmer who reported using plant extracts for management of black pod and stem borers. There are reports that some cocoa marketing companies are trying to initiate, in collaboration with research centres in Côte d'Ivoire, efficacy tests for certain biopesticides, in particular products based on *Beauveria bassina* and essential oils of plants against cocoa pests.

Table 4. Non-chemical control methods used in the field

Cocoa pest/disease	Control method	No. farmers using method	% of farmers using method
CSSVD	Uprooting trees	3	16%
Black pod	Phytosanitary harvest of pods	2	10%
	Pruning	2	10%
	Manual weeding	4	21%
	Plant extracts (neem, ginger, onion, garlic, chilli)	1	5%
Caterpillars	Manual weeding	1	5%
Shield bugs	Pruning	2	10%
Mammals	Ants (*Oecophylla* sp.)	2	10%
Mirids	Phytosanitary harvest	1	5%
	Pruning / pruning chupons	4	21%
	Ants (*Oecophylla* sp.)	1	5%
Moss/parasitic plants	Remove with tool	3	16%
	Palm wine	1	5%
Shield bugs	Weeding	2	10%
	Pruning	2	10%
	Mechanical control?	1	5%
Stem borers	Close entry hole with a stick	6	32%
	Cut infested branch	1	5%
	Weeding/pruning	2	10%
	Plant extracts (neem, ginger, onion, garlic, pepper)	1	5%
Weeds	Manual weeding	7	37%

For chemical management the decision by producers to apply pesticides is made in different ways (Figure 10). Just over 30% of producers base pesticide application on monitoring for the presence of pests and diseases in the field. For a small proportion of producers (5%) the pesticide treatment decision is taken by the lead producer, or when they have had access to pesticides. The highest proportion of producers (50%) rely on calendar spraying, this is carried out in the months of July to August then again in December and January. Producers stated that this approach was advised by AEAs from ANADER and certain pesticide distribution companies based on the periods when cocoa pest populations generally begin to proliferate. It's important to highlight whether such an approach is appropriate in a context of climate change when seasons vary from one year to the next.

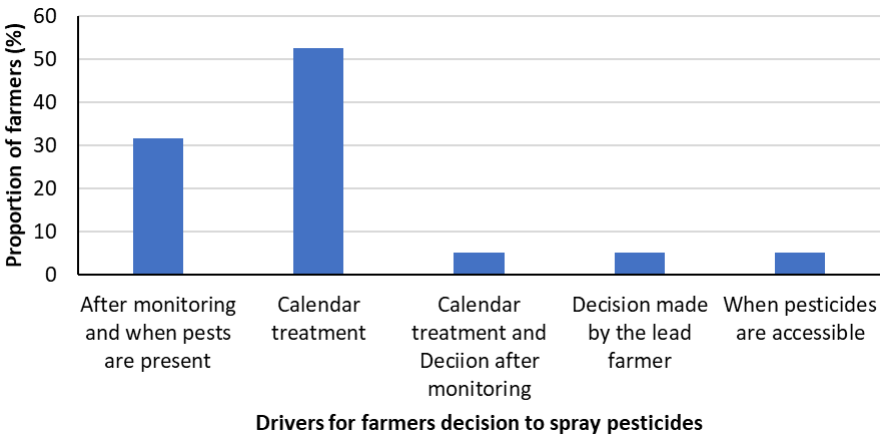

Figure 10. Factors influencing the decision of farmers to apply pesticides

It should be noted that according to cooperatives of well-organized cocoa producers and especially those whose producing certified beans the decision to apply pesticides is supposed to follow a set procedure:

- When a pest/disease outbreak is detected the producer report it to the applicator (a member of the cooperative who has received training on pesticides and their application)
- The applicator conducts a farm visit to confirm the pest/disease and assess its importance

- If treatment needs to be applied the applicator recommends a product for the producer to purchase
- The producer can then obtain the pesticide prescribed from the cooperative store or an input supplier
- Once the producer has the recommended pesticide the applicator arranges for the farm to be sprayed

The field study showed that the applicators of phytosanitary products have for the most part a primary or secondary education level. They are trained in the use of phytosanitary pesticides and according to some of them receive annual trainings updates. They use pesticide application equipment (mistblowers) and personal protective equipment (PPE) provided by their cooperative. Their interventions constitute an adequate solution for respecting good practices in the use of pesticides and for reducing the exposure of producers to their toxic effects. Surveys have shown that in well-organized cooperatives, pesticides are most often applied by the applicators. However, the number of applicators in cooperatives is often not sufficient to cover all of the members farmers in a timely fashion. Faced with this situation, some producers organise their own pesticide treatments without waiting for the availability of the applicator in charge of the production area.

All of the farmers interviewed either used pesticide application services provided by a cooperative, applied pesticides themselves, hired service or a combination of the different methods. A list of the products applied either by the farmer or on their behalf can be found in Table 5 below.

Type	Commercial name	Active ingredients (AI)	Registered for use on cocoa CDI	HHP FAO	PAN HHP	EU approved	Target use by farmers	No. of farmers using it
F	Boncacao	Mancozeb + Metalaxyl-M	Yes	**Yes**	**Yes**	**No**	Mirids; Pod husk borers; Shield bugs; Stemborers; Termites	1
F	Fongicao Plus	Mancozeb + Cymoxanil	Yes	**Yes**	**Yes**	**No**	Black pod	1
F	Fungicide	Unknown AI	-	-	-	-	Black pod	1
F	Ridomil Gold*	Metalaxyl-M + Copper oxide/hydroxide*	Yes	No	**Yes***	Yes	Black pod	1
I	Cacao Massa**	Bifenthrin + Acetamiprid/Imidacloprid**	Yes	No	**Yes****	**No****	Mirids; Pod husk borers; Shield bugs; Stemborers	2
I	Cacaoare Super	Acetamiprid + Bifenthrin + Imidacloprid	Yes	No	**Yes**	**No**	Shield bugs	1
I	Callifan Super	Acetamiprid + Bifenthrin	Yes	No	**Yes**	**No**	Caterpillars; Mirids; Pod husk borers; Shield bugs; Stemborers; Termites	2
I	Decis	Deltamethrin	Yes	No	**Yes**	Yes	Stemborers	1
I	Messi	Lambda cyhalothrin + Thiamethoxam	Yes	No	**Yes**	**No**	Mirids; Pod husk borers; Shield bugs; Stemborers; Termites	3
I	Sivanto Energy	Flupyradifurone + Deltamethrin	Yes	No	**Yes**	Yes	Mirids; Pod husk borers; Shield bugs; Stemborers; Termites	2
I	Super Cao	Acetamiprid + Cypermethrin	Yes	No	**Yes**	Yes	Mirids; Caterpillars; Stemborers	1
FF	Coco Plus		-	-	-	-	Caterpillars; Mealybugs; Mirids; Shield bugs; Stemborers; Black pod; CSSVD	1
FF	Yiri Fla		-	-	-	-	Caterpillars; Mirids; Pod husk borer; Shield bugs; Stemborers; Termites	3

Table 5. Pesticide used on cocoa as reported by farmers

Type: F=fungicide; I=insecticide; FF=foliar fertilizer. MD=missing data
*** Ridomil Gold Plus 65WP (Metalaxyl-M + Copper hydroxide) and Ridomil Gold Plus 66WP (Metalaxyl-M + Copper oxide)**
**** Cacao Massa 40EC (Bifenthrin + Acetamiprid) and Cacao Massa 50EC (Bifenthrin + Imidacloprid)**

Insecticides were predominantly used to manage insect pests although some farmers did report using fungicides for management of black pod disease. All of the commercial products reportedly

used were approved for use on cocoa in Côte d'Ivoire. However, Mancozeb included in the formulation of Boncacao and Fongicao Plus is classified as an HHP by FAO and PAN criteria and is also not approved for use in the EU or by RA. One or more of the AI in all of the insecticides are also considered to be HHPs under PAN criteria and several of these are not approved for use in the EU (highlighted in red in the table). As many farmers did not apply the pesticides themselves they were unsure of the name of the products being used or incorrectly identified the wrong target organism, examples of this can be seen highlighted in yellow in the table.

There seemed to be some confusion about Coco Plus and Yiri Fla which are foliar fertilizers but some farmers identified them as insecticides to be used in the treatment of insect pests. Another source of potential confusion is the similarity in the commercial names of the products and different formulations an example of this is Ridomil Gold Plus, formulation 65WP contains AI Metalaxyl-M and Copper hydroxide whereas 66WP contains AI Metalaxyl-M and Copper hydroxide. Copper hydroxide is considered an HHP by PAN whereas Copper oxide is not. Some farmers know the commercial names of the pesticides applied in their farms but they have little understanding of the AI or differences in formulations. However, it is encouraging to see that all of the pesticides reported to be used by the producers are at least approved for use on cocoa by the government.

Only 30% of the producers were aware of the national list of approved pesticides but knew some sort of list of approved products was provided by the cooperative or through input suppliers.

At least 70% of the cocoa producers reported that they had participated in some sort of cocoa pest and disease management programme. These programs generally relate to good agricultural practices (GAP), sanitary harvesting, the proper use of pesticides, the management of weeds and parasitic plants use of agroforestry systems.

Almost all producers (95%) reported that they did not have any information on economic threshold levels for the main cocoa pests in Côte d'Ivoire. This is one of the biggest challenges for cocoa producers and why many still rely on calendar spraying.

Pesticide sources and availability of pesticides

Access to pesticides was one of the main issues raised by producers during the consultation. This problem was exacerbated for individuals belonging to poorly organized cooperatives or who do not belong to any cooperative. It should be noted that the CCC, supports producers through the free distribution of pesticides (insecticides, fungicides, etc.) each year. However, the quantity of pesticides distributed annually is generally insufficient in relation to the needs of producers.

To facilitate access to inputs (including pesticides) buying/exporting companies have supported producer groups through guarantee and microfinance schemes. An example of this is the Société Africaine de Cacao (SACO)/Barry Callebaut which supports the COOPUK cooperative of Gabiadji, San Pedro to access inputs by allowing them to paying only 20% of the purchase cost upfront and then reimbursing the 80% remaining on the sale of their cocoa beans.

Very few lower risk options, such as biopesticides, are available for use on cocoa in Côte d'Ivoire. This situation leaves producers with little choice but to use synthetic pesticides. According to the DPVC, pesticides are approved at the request of input distribution companies and there seems to be little appetite to provide biopesticide options for use on cocoa.

Pesticide handling and use

According to the farmers, plastic gloves, goggles, respiratory masks and coveralls are worn by the majority of those (64-100%) who carry out pesticide application. Very few farmers have a good overall level of understanding about pesticide information (Figure 11), even if application of pesticides are outsourced the farmer should still have a good understanding of what has been applied to their cocoa and significance of this. Approximately 50-60% of the farmers interviewed had a good understanding of the pre-harvest and re-entry interval. The majority of farmers lacked knowledge on pesticide residues, AI, resistance and mode of action.

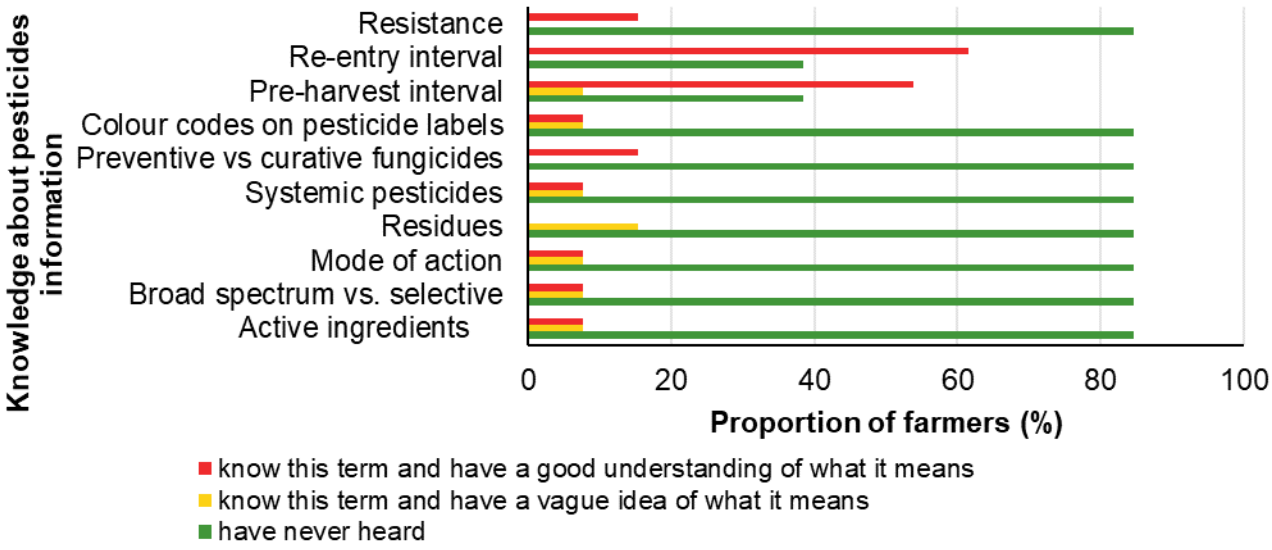

Figure 11. Level of understanding of cocoa farmers about pesticides information

Knowledge of IPM

More than 80% of producers stated that IPM is a requirement for certification of cocoa beans. Indeed, by adopting IPM, producers are supposed to implement benign control methods such as tolerant/resistant planting material, mechanical and cultural control and only pesticides when necessary and even then, select the less hazardous options available. Through IPM, the problem of pesticide residues in cocoa beans and finished products will also be mitigated. During interviews with producers they confirmed that they had received training on IPM recent years by AEAs from ANADER, certain cocoa marketing companies, GIZ and cooperatives.

It should be noted that incentives are also given to producers who adhere to the various types of certification schemes (Figure 12). These incentives consist of supporting producers in the implementation of IPM through:

- Training on GAP

- Agroforestry seedlings, cocoa seedlings, pesticides, tools for mechanical control

- Premium prices for certified cocoa beans

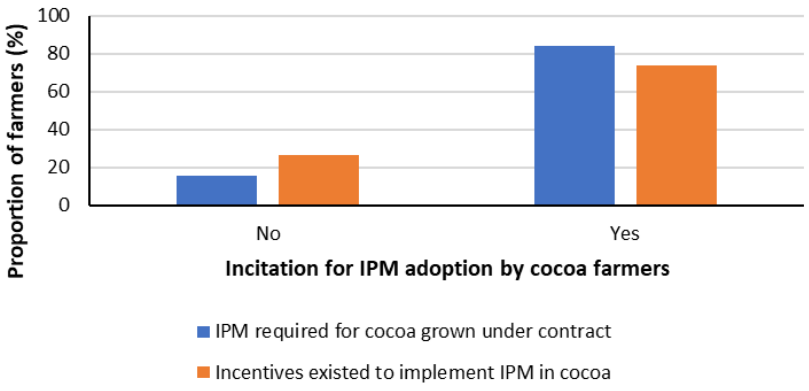

Figure 12. Incentives for IPM adoption

Many producers (40%) think that the implementation of IPM is too expensive and a significant proportion (just over 20%) stated that IPM takes up too much time and a further 15% raised the issue of labour availability to implement IPM. With regard to this last constraint the shortage of skilled labour has pushed up the price and practices such as the use of herbicides for clearing weeds in cocoa fields has become more attractive than manual practices.

Training and sources of information

A large proportion of producers (79%) have received some sort of training on IPM. These trainings focused mainly on good agricultural practices, in particular sustainable management, pruning techniques, the production of biopesticides, good practices in the use of pesticides and agroforestry. Training on IPM was organized using the Farmer Field School method and have only been available to producers during the last five years (2017 to 2022).

The majority (about 70%) of producers would prefer training events is to be carried out as a group exercise using model farms. A large proportion (58%) would prefer for the trainings to be conducted by AEAs. E-learning and farm days were preferred by a minority as these are probably more suitable as refresher trainings. Methods such as e-learning or online training were seen to be unsuitable as this would require access to a suitable phone and internet and also require a certain level of literacy and able to speak French. In Côte d'Ivoire more than 50% of male farmers and over 80 % of women are not literate (S. Lehmann GIZ, personal communication).

Advisory service characteristics and the advice they provide

The nineteen AEAs who consented to take part in the study were all employed by ANADER. Half of the AEAs had extensive experience, working with cacao farmers for 26 to 35 years. Thirty per cent of the AEAs had relatively limited experience with only 1-3 years in the profession. In addition, 39% of extension agents are aged 55 to 59, 39% from 31 to 40 and 23% from 24 to 30 years old. All this indicates that the extension agents interviewed have quite a long experience in the field of extension in Côte d'Ivoire and should contribute, within the framework of this study, to a better knowledge of the situation in the field. Their level of education is also high, with 78% of them having reached university level. Just over half of the AEAs mentioned that they had received additional training in areas relating to cocoa farming, IPM, GAP, certification, agroforesty mainly supported by ANADER and Cargill.

The methods used by the AEAs for the transfer of knowledge to producers were mainly personal exchanges, the use of demonstration fields and group trainings. In addition, other methods such as agricultural days and radio programs were also used. When asked about the farmers ability to identify the major cocoa pests and diseases 70% of the AEAs stated that more than 80% of farmers had trouble identifying major pests and diseases on their farms

When asked for their opinion major issues related to the use of pesticides on cocoa farms 79% of AEAs mentioned that there excessive and repeated use of the same pesticide (MOA),74% mentioned the lack of PPE used and inadvertent contamination of the environment. Other major issues were the use of fraudulent pesticide products (63%), application of pesticides at the wrong time (58%) and the wrong dosage being used (53%)

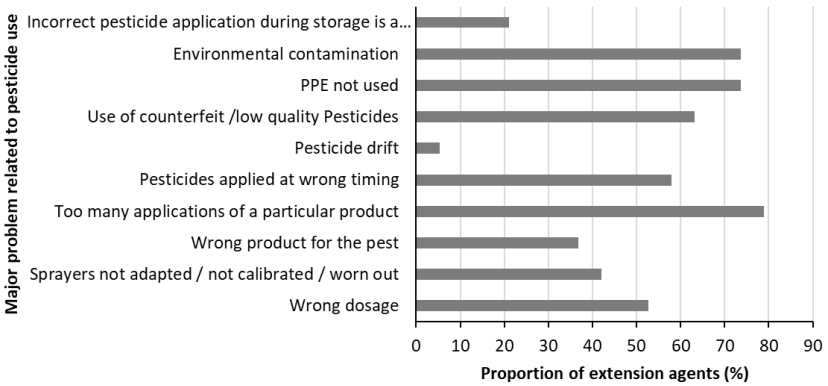

Figure 13. Major issues relating to pesticide use in cocoa farms from an AEAs perspective

According to AEAs the main constraints to the adoption of IPM was the lack of knowledge of producers (> 60%), followed by the lack of support from state/research and the time required to implement IPM in cocoa fields. AEAs were generally knowledgeable on the main pests and diseases in their regions and their management methods. Although, responses about non-chemical control methods were very general, a greater emphasis was placed on pesticide use.

Pesticide distribution and retail

As part of the in-country interviews discussions were held with pesticide distribution companies and retailers. CropLife Cote d'Ivoire and the Association of National Phytosanitary Companies of Côte d'Ivoire (AMEPHCI), representatives for distribution companies, recognise that the DPVCQ controls pesticide distribution activities in Cote d'Ivoire. The distribution of pesticides is conditional on obtaining an authorization as an agricultural pesticide distributor. The DPVCQ also reserves the right to make unannounced visits to the pesticide distribution site, in order to see if the phytosanitary standards are upheld.

Distributors receive training on the responsible use of pesticides throughout their life cycle (e.g. Croplife Stewardship) and a photocopy of the CropLife or AMEPHCI training certificate is mandatory for the accreditation application file. The Distributor is approved for five (05) years after which the certificate has to be renewed.

They confirmed that the information on the packaging of phytosanitary products must be in French, according to national standards, although many of the products they source originate from China. For the dosage and application of pesticides, the distributors organise training for retailers and applicators in collaboration with the DPVCQ. These trainings take into account the knowledge of pests, good practices for the use of pesticides, the safe transport of pesticides and the risks to health and the environment.

Distributors also supply PPE and some even claimed to supply this for no fee with large products purchases. Management of empty pesticide containers is not often carried out by pesticide distributors with the exception of CropLife, whose Syngenta member has a pesticide incinerator. CropLife launched a project in January 2021 to manage empty pesticide packaging – and it was reinforced by the distributors is that there is no law in Cote d'Ivoire that obliges pesticide distributors to collect their empty containers and destroy them.

Concerning the registration of biopesticides, the associations of distributors do not think that the legislation in this area is very clear and pointed out that "so-called" biopesticide products do exist on the market but have not been properly approved. Distributors prefer synthetic chemical pesticides rather than biopesticides, this is mainly due to the sort shelf life and storage requirement for biopesticides in order to maintain their effectiveness over long periods of time.

Concerns about counterfeit pesticides was also raised, the distributors estimated that counterfeit products could represent around 30% of pesticides sold on the open market in Côte d'Ivoire. In order to combat the counterfeit pesticide products, the organisations of distributors work closely with the DPVCQ to help strengthen control.

It was also noted that distributors can be contracted by cocoa exporting companies in order to supply pesticides directly to the partner cooperatives of these companies.

All of the pesticide retailers (input dealers) visited acknowledged having been trained by CropLife or AMEPHCI on (i) the use and handling of pesticides, (ii) the hazardous effects of pesticides on the environment (iii) the importance of using PPE and all retailers were aware of the registered pesticide list. When advice is given to farmers by the retailer it generally relates to the correct dosage of the products to use and the general preparation of the products. PPE is sold by retailers but they mentioned that it is rarely purchased by farmers. None of the retailers interviewed gave advice on the management of empty pesticide containers.

The personnel in most of the shops were not well protected, exposing themselves to the risk of pesticide poisoning. It was also observed that some shops or stores are not sufficiently ventilated, thus leading to the rapid saturation of the air by pesticides.

Key findings

Analysis of the legal framework for pest and pesticide management has revealed that Côte d'Ivoire has relatively extensive regulatory framework but there are some gaps which need to be addressed. The pesticide registration process seems to be in line with international standards but legislation does not allow for a separate registration pathway for biopesticides, it currently follows the same pathway as chemical pesticides. The disposal of unused and empty pesticide containers is not covered under the national regulations and there is weak enforcement of the regulations and inadequate monitoring of markets, traders and pesticide quality due the enforcing agency (DPVCQ) having insufficient operational funds and critically low human capacity. There is also insufficient countrywide monitoring of the impact of pesticides on human health (pesticide poisoning) and the environment.

Availability of counterfeit and unapproved pesticides still seems to be a big issue with estimates putting the proportion of illicit products on the open market as high as 30%.

There does not appear to be a specific national policy to promote IPM in agriculture. There are however several projects linked through the National Agricultural Investment Plan for certain regions and cropping systems in the country unfortunately, cocoa does not seem to be a focal crop. The national research Institute (CNRA) have published technical guidelines for cocoa pest and diseases providing both chemical and non-chemical management options but farmers often see these non-chemical options as less effective than chemical pesticide, more time consuming and if additional labour needs to be employed, uneconomical.

Three hundred and fifty-six pesticide products were registered for use on cocoa in Côte d'Ivoire. The corresponding 54 active ingredients (AL) differed in terms of their overall hazard level. Five of the AI allowed for use met one or more of the FAO global criteria for HHPs. Seventeen AI are categorised as "danger" (one or more of the associated human health hazard statements indicate that the AI is "toxic" or "fatal if inhaled or swallowed"); 23 AI are categorised as falling into the "warning" category; one AI was categorized in the "low-hazard" category (there are no known human health hazard statements associated with the AI); and key human health hazard data is missing for eight AI.

Using the PAN criteria for HHPs (latest version 2021) 25 of the AI registered for use on cocoa are considered to be HHPs, 15 AI are no longer approved for use in the EU and 9 AI prohibited for use under the Rainforest Alliance (RA) certifications scheme and a further 22 AI require additional risk mitigation measures under (RA) certification. Only eight biopesticide AI are registered nationally for use on cocoa.

Of the 256 insecticides registered for cocoa 206 of these products contain a mixture of 2 or more AI. Of the 206 "mixtures"187 products contain a combination of a noenicitinoid and a pyrethroid, the reliance on the use of these two modes of action combined has potential to for the lead to an increased risk of resistance build up in insect populations.

Interviews with farmers revealed that more minor pests such as shield bugs and stem borers are having a much greater impact on cocoa production than they once did. It has been suggested that resurgence of minor pests may be due to excessive use of insecticides (i.e. mirid management) and the loss of non-target beneficial insect populations which would normally have kept pest population under damaging levels.

Although many did report using non-chemical control methods just over half stated that they rely on calendar treatments of pesticides to control pests and diseases. Just over 30% said that they applied pesticides when a pest or disease was seen. None of the farmers interviewed had information on economic threshold levels to guide them on when to carry out pesticide applications. All of the pesticide products reportedly applied by farmers were registered for use on cocoa.

According to AEAs the main constraints to the adoption of IPM was the lack of knowledge of producers (> 60%), followed by the lack of support from state/research and the time required to implement IPM in cocoa fields. When asked about the farmers ability to identify the major cocoa pests and diseases 70% of the AEAs stated that more than 80% of farmers had trouble identifying major pests and diseases on their farms.

A large proportion of producers (79%) have received some sort of training on IPM. These trainings focused mainly on good agricultural practices, in particular sustainable management, pruning techniques, the production of biopesticides, good practices in the use of pesticides and agroforestry.

As a final note, when reviewing the findings of this study it needs to be taken into consideration that the farmer sample was very small and all of the farmers were members of cooperatives and enrolled in certification schemes (many also had the support of sustainability programmes) so they probably represent a “a best-case scenario” for cocoa production in Côte d’Ivoire.

Recommendations

- GISCO to encourage private sector members to take a pre-competitive approach on the issue of management of cocoa pests and diseases with increased collaboration and sharing of research outcomes
- Government agencies to invest additional operational funds to improve enforcement of pesticide regulations with agro-input dealers
- Encourage relevant government agencies and the CCC to start to develop a policy for the IPM of cocoa pests and diseases
- Relevant government agencies to review AI approved for use on cocoa in light of the high number of HHPs and higher risk AI currently registered. A small study could also be commissioned to investigate which products are actually available to farmers on the open market and identify if lower risk products are available at competitive prices
- NGO’s, private sector and national research institutes to collaborate more effectively to create a unified approach to provide training for extension and farmers on the safe use of pesticides including how to use pesticide labels, identifying AI and how to select lower risk products
- Improve access to training materials for farmers, the majority of farmers to not have access to reliable internet and smart phones
- Research into the development of applicable economic thresholds for the major cocoa pests and diseases to reduce reliance on calendar application of pesticides
- Additional training for farmer on the recognition of pest and disease symptoms and reinforce knowledge of IPM and the worth of basic non-chemical management practices
- Encourage the formation and participation of producers in farmer-based organisation as this seemed to improve technical advice received and awareness of safe use of pesticides
- Support for the regulatory agency and services responsible for testing the effectiveness of new products, in order to reduce the approval time for biopesticides compared to synthetic pesticides
- All stakeholders (private industry partners, NGO’s, national governments and research organisations) to improve collaboration and secure investment for the development of less hazardous alternative for management of cocoa pests and disease at a regional level

Annexes

Annex I: Banned pesticides in Côte d'Ivoire

List of substances used in pesticide formulations, prohibited from use in agriculture and public health in Côte d'Ivoire from 31 August 2021

No	Active substance	Function	Crop concerned
1	1,4,5-T	Herbicide	All crops
2	Acetochlor	Herbicide	All crops
3	Aldicarb	Insecticide-Nematicide	All crops
4	Aldrin	Insecticide	All crops
5	Aminotriazole	Herbicide	All crops
6	Amitraz	Insecticide	Cocoa
7	Arsenic	Herbicide-Insecticide	All crops
8	Atrazine	Herbicide	All crops
9	Binapacryl	Fungicide	All crops
10	Polybrominated biphenyls (PBBs)	Flame retardant	All crops
11	Polychlorinated biphenyls (PCBs)	Flame retardant	All crops
12	Calciferol	Rodenticide	All crops
13	Camphechlor (Toxaphene)	Insecticide	All crops
14	Captafol	Fungicide	All crops
15	Carbaryl	Insecticide	Cocoa
16	Carbofuran	Insecticide-Nematicide	All crops
17	Carbosulfan	Insecticide	All crops
18	Cartap	Insecticide	Cocoa
19	Chloramphenicol	Bactericidal	All crops
20	Chlorbenzilate	Miticide	All crops
21	Chlordane	Insecticide	All crops
22	Chlordecone and Perchlordecone	Insecticide	All crops
23	Chlordimeform	Miticide	All crops
24	Chloropicrin	Fungicide	All crops
25	Chlorpuriphos	Insecticide	All crops
26	Choline	Insecticide	All crops
27	Cholecalciferol	Rodenticide	All crops
28	Coumachlor	Rodenticide	All crops
29	Crime	Rodenticide	All crops
30	Crocidolite	flame retardant	All crops
31	Cyhexatin	Miticide	All crops
32	DBCP	Nematicide	All crops
33	DDD	Insecticide	All crops
34	DDT	Insecticide	All crops
35	Diazinon	Insecticide	Cocoa
36	1,2-Dibroethane (EDB)	Insecticide	All crops
37	Dichlorvos	Insecticide-Acaricide	All crops
38	Dicofol	Miticide	All crops
39	Dieldrin	Insecticide	All crops
40	Dimeton	Insecticide	All crops

41	Diniconazole	Fungicide	All crops
42	Dinoseb and Dinoseb Salt	Biocide (In-Ac-He-Fo)	All crops
43	Diquat	Herbicide	All crops
44	Endosulfan	Insecticide	Cocoa
45	Endrin	Insecticide	All crops
46	Fenitrothion	Insecticide	Cocoa - Storied foodstuffs
47	Fenobucarb (BPMC)	Insecticide	Cocoa
48	Fenvalerate	Insecticide	Cocoa
49	Fluoroacetamide	Rodenticide	All crops
50	Gamma BHC	Insecticide	All crops
51	HCH	Insecticide	All crops
52	Heptachlor	Insecticide	All crops
53	Hexachlorophene	Fungicide-Acaricide	All crops
54	Meleic hydrazide	Growth regulator	All crops
55	Imazapyr	Herbicide	All crops
56	Isoprocarb	Insecticide	Stored commodity
57	Kelevan	Insecticide	All crops
58	Leptophos	Insecticide-Fungicide	All crops
59	Lindane	Insecticide	All crops
60	Malathion	Insecticide	Cocoa
61	Inorganic Mercury	Fungicide	All crops
62	organic mercury	Fungicide	All crops
63	Metalaxyl	Fungicide	All crops
64	Methamidophos	Insecticide	All crops
65	Methomyl	Insecticide	All crops
66	Methoxychlor	Insecticide	All crops
67	Methy-parathion	Insecticide	All crops
68	Metolachlor	Herbicide	All crops
69	Mirex	Insecticide	All crops
70	Monocrotophos	Insecticide	All crops
71	Nitrophene	Solvent	All crops
72	Ethylene Oxide	Fungicide	All crops
73	paraquat	Herbicide	All crops
74	Parathion-ethyl	Insecticide	All crops
75	Parathion-Methyl	Insecticide	All crops
76	Pentachlorophenol (PCP)	Fungicide	All crops
77	Permethrin	Insecticide	Stored commodity
78	Phosphamidon	Insecticide	All crops
79	Tri-2,3 dibromopropyl phosphate	flame retardant	All crops
80	Phoximus	Insecticide	All crops
81	Picloram	Herbicide	All crops
82	Promecarb	Insecticide	Cocoa
83	Propoxur	Insecticide	Cocoa
84	Quintozene	Fungicide	All crops
85	Resmethrin	Insecticide	Stored commodity
86	Shradane	Insecticide	All crops

87	Sodium fluoro-acetate	Rodenticide	All crops
88	Strichnine	Rodenticide	All crops
89	strobe	Herbicide	All crops
90	TCA	Herbicide	All crops
91	Telodrin	Insecticide	All crops
92	Polychlorinated terphenyls (PCT)	Flame retardant	All crops
93	Tetraethyl-Pyrophosphate	Insecticide	All crops
94	Tetramethrin	Insecticide	Stored commodity
95	Thallium sulphate	Insecticide-Rodenticide	All crops
96	Tri-phosphinoside	Growth regulator	All crops

Annex II: List of HHP AI registered for use in Côte d'Ivoire

HHP AI	Type	WHO Acute toxicity[32]	GHS Carcinogen	GHS Mutagen	GHS Reproductive toxin	POP[33]	PIC[34]	ODS[35]	PAN HHP[36]	EU Approved[37]
Abamectin	Insecticide	**Ib**	No	No	2	No	No	No	**Yes**	Approved
Chlorpyrifos	Insecticide	II	No	No	**1A/1B**	No	No	No	**Yes**	**Not approved**
Thiacloprid	Insecticide	II	2	No	**1A/1B**	No	No	No	**Yes**	**Not approved**
Dimethomorph	Fungicide	III	No	No	**1A/1B**	No	No	No	No	Approved
Mancozeb	Fungicide	U	2	No	**1A/1B**	No	No	No	**Yes**	**Not approved**

WHO acute toxicity Ib = Highly hazardous; II = Moderately hazardous; III = Slightly hazardous; U = Unlikely to present acute hazard in normal use; FM = Fumigant
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
POP = Persistent Organic Pollutant
PIC = Prior Informed Consent
ODS = Ozone Depleting Substance

[32] WHO Recommended Classification of Pesticides by Hazard (2019) https://www.who.int/publications/i/item/9789240005662
[33] Stockholm Convention http://chm.pops.int/Home/tabid/2121/Default.aspx
[34] Rotterdam Convention http://www.pic.int/
[35] Montreal Protocol https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol
[36] PAN international List of Highly Hazardous Pesticides (March 2021) https://www.pan-uk.org/site/wp-content/uploads/PAN-HHP-List-2021.pdf
[37] EU Pesticide Database https://food.ec.europa.eu/plants/pesticides/eu-pesticides-database_en

Annex III: List of AI which are registered in Côte d'Ivoire and associated hazard summary

Active ingredient (AI)	Type	Hazard Summary[38]	WHO[32]	Proposed POP[39]	Rotterdam notifications[40]	PAN HHP [36]	PAN score	Rainforest Alliance[41]	Fairtrade International[42]	EU approved[3] [7]	Mode of Action[43,44,45]
Abamectin	Insecticide	HHP	Ib	No	No	✓	2 (G1+G3)	✗	✗ AT	✓	**6**
Acetamiprid	Insecticide	Danger	II	No	No	✗		RM (AR)	✓	✓	**4A**
Aluminium phosphide	Insecticide	Danger	FM	No	Yes	✓	2 (G1+G3)	✗	✓AT	✓	**24A**
Azadirachtin	Insecticide	Warning	Not listed	No	No	✗		✓	✓	✓	**UN**
Bifenthrin	Insecticide	Danger	II	No	Yes	✓	2 (G2+G3)	RM (AR+PR)	✓ LT-CE	✗	**3A**
Chlorpyrifos	Insecticide	HHP	II	Yes	Yes	✓	3 (G2+G3)	✗	✗ HES	✗	**1B**
Cyhalothrin, lambda	Insecticide	Danger	II	No	No	✓	3 (G1+G2+G3)	RM (HL+AR+PR)	✗ AT/LT-CE	✓	**3A**
Cypermethrin	Insecticide	Warning	II	No	Yes	✓	1 (G3)	✓	✓ HES	✓	**3A**
Cypermethrin, alpha	Insecticide	Danger	II	No	No	✓	2 (G3)	RM (HL+AR+PR)	✓ HES	✗	**3A**
Cypermethrin, beta	Insecticide	Danger	Not listed	No	Yes	✓	3 (G3)	RM (HL+AR+PR)	✓ HES	✗	**3A**
Deltamethrin	Insecticide	Danger	II	No	No	✓	2 (G2+G3)	RM (HL+AR+PR)	✓ LT-CE/HES	✓	**3A**
Dinotefuran	Insecticide	Warning	III	No	No	✓	1 (G3)	RM (HL+AR+PR)	✓ HES	✗	**4A**
Emamectin benzoate	Insecticide	Danger	II	No	No	✓	1 (G3)	RM (HL+AR+PR)	✓	✓	**6**
Fipronil	Insecticide	Danger	II	No	Yes	✓	1 (G3)	✗	✓ HES	✗	**2B**
Flupyradifurone	Insecticide	Warning	II	No	No	✓	1 (G3)	RM (PR)	✓	✓	**4D**
Imidacloprid	Insecticide	Danger	II	No	No	✓	1 (G3)	✗	✗ HES	✗	**4A**
Indoxacarb	Insecticide	Danger	II	No	No	✗		RM (PR)	✓ HES	✗	**22A**
Novaluron	Insecticide	Danger	U	No	No	✗		RM (AR)	✓	✗	**15**

[38] Based on FAO HHP Criteria 1-7, International Code of Conduct on Pesticide Management Guidelines on Highly Hazardous Pesticides (2016) https://www.fao.org/3/i5566e/i5566e.pdf and GHS Classification https://pubchem.ncbi.nlm.nih.gov/
[39] Stockholm Convention: Proposed Chemical http://chm.pops.int/TheConvention/ThePOPs/ChemicalsProposedforListing/tabid/2510/Default.aspx
[40] Rotterdam Convention: Notifications of Final Regulatory Action http://www.pic.int/Procedures/NotificationsofFinalRegulatoryActions/tabid/1172/language/en-US/Default.aspx
[41] Rainforest Alliance, Annex Chapter 4: Farming, Document SA-S-SD-22 (2022) https://www.rainforest-alliance.org/resource-item/annex-chapter-4-farming/
[42] Fairtrade International https://files.fairtrade.net/standards/Hazardous_Materials_List_EN.pdf
[43] IRAC https://irac-online.org/
[44] FRAC https://www.frac.info/
[45] HRAC https://www.hracglobal.com/

Orange oil	Insecticide	Missing data	Not listed	No	No	✗		✓	✓	✓	**UNE**
Profenofos	Insecticide	Warning	II	No	**Yes**	✓	1 (G3)	RM (HL+AR+WR+PR+BR)	✓ HES	✗	**1B**
Pymetrozine	Insecticide	Warning	III	No	**Yes**	✓	1 (G2)	✓	✓ LT-CE	✗	**9B**
Pyrethrins, pyrethrum	Insecticide	Warning	II	No	No	✓	1 (G3)	RM (HL+PR)	✓	✓	**3A**
Pyriproxyfen	Insecticide	Warning	U	No	No	✗		✓	✓	✓	**7C**
Spinetoram	Insecticide	Warning	U	No	No	✓	1 (G3)	RM (PR)	✓ HES	✓	**5**
Spirotetramat	Insecticide	Warning	III	No	No	✗		✓	✓	✓	**23**
Sulfoxaflor (isoclast)	Insecticide	Warning	II	No	No	✓	1 (G3)	✓	✓ HES	✓	**4C**
Teflubenzuron	Insecticide	Warning	U	No	No	✗		RM (AR)	✓	✗	**15**
Thiacloprid	Insecticide	HHP	II	No	No	✓	1 (G2)	✗	✓ LT-CE	✗	**4A**
Thiamethoxam	Insecticide	Warning	II	No	**Yes**	✓	1 (G3)	✗	✗ HES	✗	**4A**
Ametoctradin	Fungicide	Warning	III	No	No	✗		✓	✓	✓	**45**
Bacillus amyloliquefaciens is.QST713	Fungicide	Missing data	Not listed	No	No	✗		✓	✓	✓	**BM02**
Bacillus subtilis is.IAB/BS03	Fungicide	Missing data	Not listed	No	No	✗		✓	✓	✓	**BM02**
Benalaxyl-M	Fungicide	Missing Data	Not listed	No	No	✗		✓	✓	✓	**4**
Clove oil (Eugenol)	Fungicide	Warning	Not listed	No	No	✗		✓	✓	✓	**BM01**
Copper hydroxide	Fungicide	Danger	II	No	No	✓	1 (G1+G3)	RM (HL+WR)	✓ EC	✓	**M01**
Copper oxide	Fungicide	Warning	II	No	No	✗		RM (PR)	✓	✓	**M01**
Copper oxychloride	Fungicide	Warning	II	No	No	✗		RM (HL+PR)	✓	✓	**M01**
Copper sulphate	Fungicide	Warning	III	No	No	✗		RM (HL+AR+WR+PR)	✓	✓	**M01**
Cymoxanil	Fungicide	Warning	II	No	No	✗		✓	✓	✓	**27**
Dimethomorph	Fungicide	HHP	III	No	No	✗		✗	✓	✓	**40**
Equisetum arvense - horsetail extract	Fungicide	Missing data	Not listed	No	No	MD		Not listed	✓	✓	**Not listed**
Fluazinam	Fungicide	Danger	Not listed	No	**Yes**	✓	1 (G1)	RM (HL+PR+BR)	✓	✓	**29**
Flumorph	Fungicide	Missing data	Not listed	No	No	✗		✓	✓	Not listed	40
Fluoxastrobin	Fungicide	Warning	Not listed	No	No	✗		✓	✓	✓	**11**

Mancozeb	Fungicide	HHP	U	No	Yes	✓	1 (G2)	✗	✓ LT-CE	✗	**M03**
Mandipropamid	Fungicide	Warning	U	No	No	✗		✓	✓	✓	**40**
Metalaxyl-M	Fungicide	Danger	Not listed	No	No	✗		✓	✓	✓	**4**
Potassium phosphonate	Fungicide	Missing data	Not listed	No	No	✗		✓	✓	✓	**Not listed**
Propamocarb	Fungicide	Warning	U	No	No	✗		RM (HL+PR)	✓	✓	**28**
Pyraclostrobin	Fungicide	Danger	Not listed	No	No	✗		RM (HL+AR)	✓	✓	**11**
Pyrimethanil	Fungicide	Low hazard	III	No	No	✗		✓	✓ LT-CE	✓	**9**
Tea tree extract	Fungicide	Missing data	Not listed	No	No	✗		✓	✓	✓	**BM01**
Glyphosate (ammonium salt)	Herbicide	Danger	III	No	No	✓	1 (G2)	✓	✗ LT-CE	✓	**9**
Metsulfuron-methyl	Herbicide	Warning	U	No	No	✗		✓	✓	✓	**2**

Highlighted green=biopesticide

WHO acute toxicity Ib = Highly hazardous; II = Moderately hazardous; III = Slightly hazardous; U = Unlikely to present acute hazard in normal use; FM = Fumigant

PAN score indicates the number of groups the AI falls under. Group 1=Acute toxicity; Group 2=Long term effects; Group 3=Environmental toxicity; Group 4=Conventions

Rainforest Alliance: RM = risk mitigation: HR = higher level; AR = aquatic risk; WR = wildlife risk; PR = pollinator risk; BR = bystander risk

Fairtrade International: Red list – prohibited for use on FTI products; Orange list – restricted use/used under specific conditions. All chemicals on the list are monitored and due to be phased out or moved to the red list. Operators are encouraged to abandon their use; Yellow list – all chemicals are 'flagged' as being hazardous or use with extreme caution – monitored and operators encouraged to abandon use. AT = High Acute Toxicity; EC = Environmental Concern (two of the following effects on the environment i) very persistent ii) very bioaccumulative iii) very toxic to aquatic organisms; HES = Hazard to ecosystem services (toxic to bees); LT-CE= Long term toxic effect (carcinogenic, reproductive toxin, mutagenic, endocrine disruptor)

Mode of Action: UN = compounds of unknown or uncertain MOA; UNE=botanical essence including synthetic, extracts and unrefined oils with unknown or uncertain MOA

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