

Research Article

Consequences of Cultural Practices on the Production and Black Rot of Cocoa Beans in the Agneby-Tiassa Region of Ivory Coast

Fofana Balakissa^{1,*} , Sanogo Souleymane¹ , Amari Ler-N'ogn Dad é Georges Elis é¹ ,
Guinagui N'Doua Bertrand¹ , Silu é Nakpalo³ , Zouzou Michel¹, Kone Daouda^{1,2} 

¹Plant Physiology and Pathology Teaching and Research Unit, University of Félix Houphouët-boigny, Abidjan, Ivory Coast

²Biodiversity and Sustainable Agriculture (Wascal/CEA-CCBAD), Wascal/African Center of Excellence on Climate Change, Abidjan, Ivory Coast

³Agriculture, Allieutic Resources and Agro-Industries, University of San-Pedro, San-Pedro, Ivory Coast

Abstract

Côte d'Ivoire's economy is based on agricultural production, primarily cocoa cultivation. This sector plays a dominant role in the country's development, accounting for nearly 20% of GDP. However, as the world's leading producer of cocoa beans, Côte d'Ivoire faces several challenges, including aging plantations, heavy pest and disease pressure, fluctuating international bean prices, labor shortages, pod brown rot, and plot maintenance. This study aims to evaluate farming practices on village plantations to identify major issues and help farmers find sustainable solutions for cocoa production. To this end, a survey was conducted in 70 localities using a questionnaire to assess farmers' knowledge of brown rot and other pests, biofungicides, chemical pesticides, mineral and organic fertilizers, and their plots' annual production and cleaning. A principal component analysis revealed a strong positive correlation between the survey parameters and the localities. An ascending hierarchical classification was performed on the PCA results. This analysis grouped the plots into three categories: The first group contains plots with low production, the second with average production, and the third with fairly high production. This diagnostic study revealed that black rot of cocoa pods is the primary challenge for farmers. This is due to poor plot management. Therefore, regular field maintenance measures are necessary.

Keywords

Farming Practices, Black Pod Rot, Production, Cocoa Fields

1. Introduction

The cacao tree (*Theobroma cacao* L.), belonging to the Malvaceae family, is one of the most important plants in

tropical agroforestry systems [1]. Since 1977, Côte d'Ivoire has been the world's leading producer of cocoa beans, pro-

*Corresponding author: balakisfof@yahoo.fr (Fofana Balakissa)

Received: 5 August 2025; **Accepted:** 10 September 2025; **Published:** 25 September 2025



Copyright: © The Author(s), 2025. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

ducing over 2.23 million tons in 2023, according to STATISTA [2]. However, several factors pose a real threat to Côte d'Ivoire's ability to maintain its position as the world's leading producer. Côte d'Ivoire's orchards are under severe pressure from pests and diseases, such as swollen shoot and black pod rot. The latter is caused by *Phytophthora* spp. According to Coulibaly *et al.*, et Kébé *et al.*, it could lead to a loss of cocoa production ranging from 25 to 60% if no phytosanitary measures are taken [3, 4]. Poor farming practices and a lack of regular plot maintenance add to this threat. Additionally, farms tend to be small, often inherited, and managed by family producers [5]. Despite cocoa's economic importance, farming systems are still largely characterized by aging orchards, low planting density, and low plant diversity. This directly impacts their productivity and sustainability [6].

Several methods are used to combat this pest, including regularly cleaning plots and removing infected pods from fields [7]. However, these control methods are insufficient, and the use of synthetic fungicides against this oomycete poses a threat to the environment and biodiversity, resulting in the defaunation of certain surrounding species, as well as to human health. To ensure the sustainability of cocoa production in Côte d'Ivoire, the effectiveness of pesticides should be evaluated based not only on their ability to control pests, but also on their environmental impact and effect on biodiversity. In this context, where solutions must improve production, the quality of life of farmers, and environmental protection, isn't it desirable to seek integrated pest management methods as an alternative? This is why a diagnostic study is necessary. This study aims to evaluate village plantations to identify significant issues and assist farmers in finding sustainable cocoa production solutions.

2. Materials and Methods

2.1. Experimental Site

This study was conducted in seven sub-prefectures in Côte d'Ivoire's Agnôby-Tiassa region: Azaguié Agboville, Cêchi, Grand-Morié Loviguié Oress-Krobou, and Rubino. The Agnôby-Tiassa region is located in the southern forest region of Côte d'Ivoire (6°N - 4°W) and covers an area of 9,080 km². It is located in the southeast of the country and belongs to agroecological zone I, as defined by Halle, B. & Bruzon V [8]. It is a humid forest zone with an altitude ranging from 0 to 200 meters, an annual rainfall between 1,400 and 2,500 millimeters, and an average temperature of 29 °C. The soil is clayey and weakly desaturated ferrallitic. The aging plantations are characterized by high pressure from black pod rot [9].

2.2. Survey

A preliminary survey was conducted in 2017 among cocoa producers to address their main concerns and provide sustainable solutions for managing black pod rot. A question-

naire was developed using Sphinx software to assess farmers' knowledge of black pod rot and other pests, as well as their use of biofungicides, chemical pesticides, mineral fertilizers, and organic fertilizers. The questionnaire also asked about the farmers' annual production, previous crops, the area, density, and age of their plantations, whether or not they maintained their plots, and the quantity and cost of their inputs. In each locality, ten farmers were selected based on the accessibility of their plantations and the availability of agents from the National Agency for Rural Development Support (ANADER). A total of 70 growers were interviewed.

2.3. Statistical Analysis

We used principal component analysis (PCA) to characterize and group the orchards according to the survey parameters. Then, an ascending hierarchical classification was performed on the PCA results.

3. Results

3.1. Correlation Between Survey Parameters and Surveyed Plots

3.1.1. Distribution of Inertia and Eigenvalue

The first two components (with eigenvalues greater than 1) explain 21.3% and 12.6% of the total variability between parameters, respectively. The six variables that contributed most to the formation of axis 1 are PROD (cocoa bean production per hectare for each plot), PBP (the price at which producers would like to buy biopesticides), NET (plot cleaning), FREQ (plot cleaning frequency), FONG (fungicide application), and INS (insecticides to control cocoa tree pests). The formation of axis 2 was influenced by seven characteristics: AVG (age of each cocoa orchard), ALT (altitude of the plots), ACT (additional activities carried out by farmers), CIA (annual input costs), NET (plot cleaning), FREQ (frequency of plot cleaning), and VAR (cocoa varieties present in the fields). The variables that contributed to the formation of axis 3 are ENCH (chemical fertilizers), ENOR (organic fertilizers), FONG (fungicides), CIA (annual input cost), DIF (major difficulties encountered by cocoa producers), SYMP (symptoms of diseases other than brown rot), CASS (crops associated with cocoa trees), and VAR (cocoa tree varieties present in the fields). Axis 4 is characterized by the following variables: AGP (age of the producer), CIA (annual input cost), PBP (price of the proposed biopesticide), DIF (difficulties encountered by farmers), and SYMP (symptoms of other present diseases in the fields). Axis 5 (Table 1), however, is characterized by AGP (age of the producer), SCOL (level of education of farmers), ENCH (use of chemical fertilizers), CASS (crops associated with cocoa), and Pour (presence of black pod rot in fields).

Table 1. Matrix of Eigenvalues and Contributions (%) of Variables in the Formation of Principal Axes After PCA.

	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5
Eigenvalue	4,26	2,52	1,82	1,40	1,26
% total variance	21,31	12,59	9,11	6,99	6,29
% total accumulated variance	21,31	33,90	43,00	50,00	56,39
AGV	3,44	15,71	0,41	0,02	5,73
ALT	6,62	13,78	0,25	0,26	3,16
PC	3,72	0,07	2,52	2,38	5,26
AGP	1,42	0,54	1,13	6,24	14,61
SCOL	4,29	0,55	5,53	3,63	8,60
ACT	4,96	10,50	0,53	0,41	0,28
PROD	10,28	0,1	1,70	5,31	0,04
CIA	2,55	9,45	8,13	6,81	1,91
PBP	9,45	2,94	0,47	12,27	0,02
NET	9,50	10,24	0,12	2,91	0,23
FREQ	9,90	11,4	0,03	1,08	4,27
ENCH	3,69	3,82	6,45	3,56	15,34
ENOR	0,64	4,42	16,72	1,12	0,01
FONG	8,89	0,2	7,17	2,74	2,05
INS	9,01	0,40	0,11	4,12	4,09
DIF	2,13	3,07	15,57	22,87	0,80
SYMP	3,64	1,43	8,57	12,61	1,74
CASS	4,81	0,33	7,98	4,52	8,81
VAR	0,86	10,60	11,09	0,87	3,87
POUR	0,18	0,46	5,54	6,26	19,15

3.1.2. Description of Dimensions

Dimensions 1 and 2, with inertia rates of 21.3% and 12.6%, respectively, contain the maximum amount of information necessary to explain variations. Overall, 33.90% of the total variability of the data set is represented in the plane.

Furthermore, the colors of the variables indicate their level of contribution to the construction of the components. For example, we can see that the variables NET (field cleaning), FREQ (frequency of cocoa field cleaning), and ALT (plot altitude) significantly contributed to the formation of the factorial axes. Following these are CIA (annual input cost), FONG (fungicide), PROD (cocoa bean production per hectare for each plot), INS (insecticide), AGV (age of the orchard), PBP (proposed biopesticide price), and ACT (additional

activities carried out by the farmer). Conversely, the lowest contributions were obtained with Pour (black rot) and Agp (age of the producer). This means that the variables with the highest contributions better characterize the fields in the localities (Figure 1).

Positive correlations were observed among the following variables on the first component (Dim 1): INS (insecticide), PBP (proposed biopesticide price), ACT (additional activities carried out by farmers), ALT (plot altitude), SYMP (symptoms of diseases other than brown rot), and CIA (annual input cost).

The aforementioned variables showed negative correlations with AGV (age of the orchard), VAR (number of cocoa varieties in the fields), and SCOL (farmer's level of education).

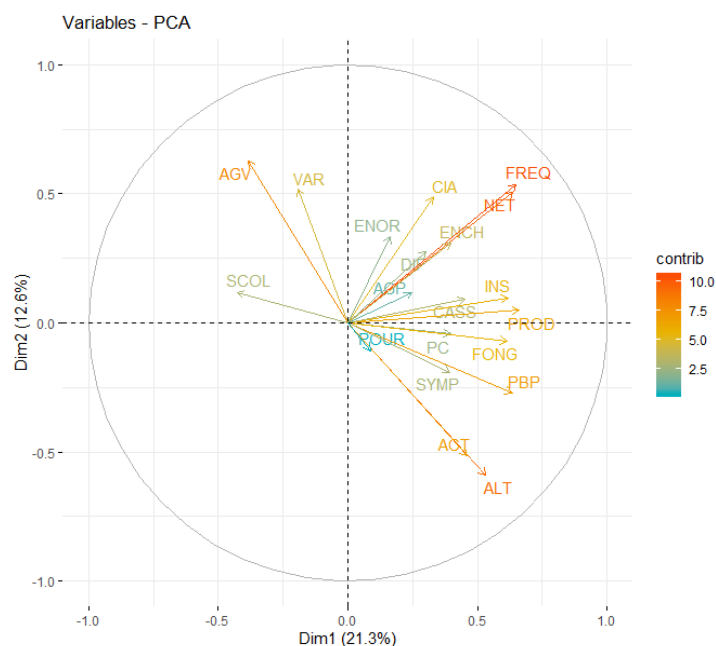


Figure 1. Correlation circle of survey variables after PCA of collected data.

The colors indicate the level of contributions (contrib) of the variables.

PROD: cocoa bean production per hectare per year, PBP: price of biopesticide proposed by farmers, NET: plot cleaning, FREQ: frequency of plot cleaning, FONG: application of fungicides, INS: use of insecticides, AGV: age of cocoa orchard, ALT: altitude of plot, ACT: additional activity of farmer, CIA: annual input cost, VAR: cocoa varieties, ENCH: chemical fertilizer, ENOR: organic fertilizer, DIF: difficulties faced by farmers, SYMP: symptoms of other diseases, CASS: crops associated with cocoa trees, AGP: age of the producer, SCOL: level of education of the farmer, and POUR: presence of black rot in cocoa fields.

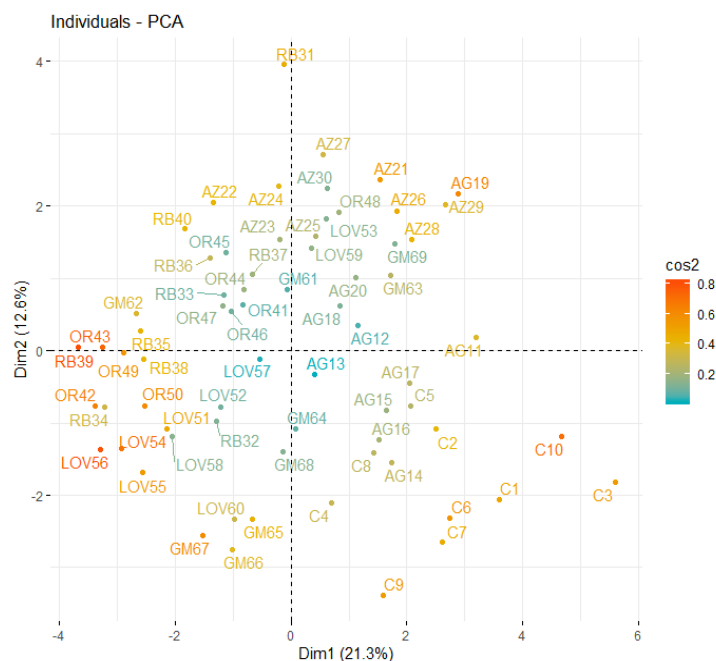


Figure 2. Dispersion of cocoa orchards after PCA of the collected data.

The colors indicate the quality of representation (Cos θ) of the different plots:

C: C échi, LOV: Lovigui é GM: Grand-Mori é OR: Oress-krobou, AG: Agboville, RB: Rubino et AZ: Azagui é

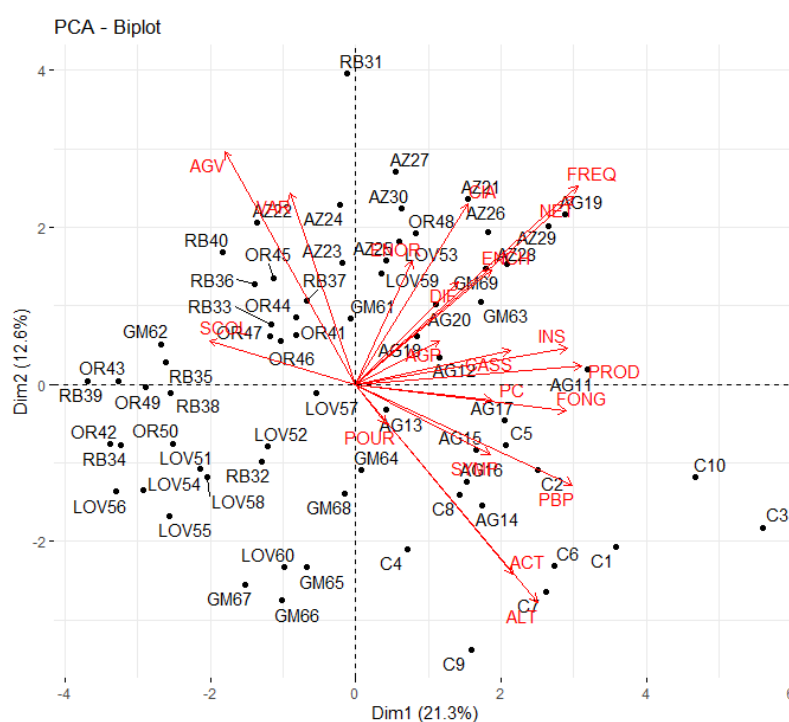
Strong positive correlations were also observed on the second component (Dim 2) between FREQ (frequency of

cleaning cocoa fields), NET (cleaning of plots), VAR (number of cocoa varieties in the fields), AGV (age of the orchard), and CIA (annual input cost). There is a positive, albeit relatively weak, correlation between SCOL (educational level of the farmer) and the variables FREQ (frequency of cleaning cocoa fields), NET (cleaning of plots), and CIA (annual input cost).

Similar to variables, the individuals representing cocoa orchards are characterized by colors (Figure 2). The bright orange points or plots are the ones that are best represented in the factorial plan. These are the ones best interpreted by the collected variables. Thus, the most discriminating cocoa fields are RB31, LOV56, RB39, C10, and OR42. Next are AG19, OR50, LOV54, C3, LOV55, AZ27, AZ21, AZ26, AZ29, AZ28, C1, C3, C6, C9, C2, and LOV51. However, plots GM61, AG12, LOV57, GM68, GM64, OR41, and AG13 do not provide precise information because they are relatively close to the center of the factorial design.

Superimposition of variables was performed on individuals (cocoa orchards). These orchards are characterized by the

following variables: PROD, FONG, INS, PBP, NET, FREQ, PC, ACT, ENCH, ENOR, and CIA. In cocoa fields AZ27, AZ21, AG19, AZ26, AZ29, AZ28, AG11, C10, C2, C1, C3, C4, C5, C6, C10, C7, and C9, producers with high yields ranging from 500 to 1,000 kg/ha use fungicides, insecticides, and chemical and organic fertilizers and clean their plots frequently. These orchards also grow food crops such as yams, plantains, cassava, citrus fruits, coconuts, avocados, and cola nuts. Furthermore, it is important to note that cocoa farmers would like to purchase biofungicides at fairly affordable prices ranging from 500 to 35,000 CFA francs depending on the size of their cocoa plantation. At the same time, the OR43, RB31, AZ24, AZ22, RB40, RB39, RB35, RB38, OR50, LOV54, LOV56, GM67, GM66, GM65, and OR50 have a production of less than 400 kg/ha, do not use inputs, and poorly maintain their cocoa plots. These locations are characterized by aging orchards located at a lower altitude than the plots mentioned above. The variable POUR (black pod rot) located in the center of the circle is not discriminatory ([Figure 3](#)).



Black and red indicate the plots and the data collected, respectively.

Figure 3. Relationship between the plots in the study areas and the variables collected in the factorial design.

3.2. Classification of Locations According to Variables

An ascending hierarchical classification was created based on the results of the principal component analysis (PCA). This analysis grouped the plots according to their characteristics.

Three main groups emerged (Figure 4). The first group (blue) consists of GM66, LOV60, GM68, GM64, LOV52, LOV57, GM67, GM65, LOV55, RB32, RB34, LOV58, LOV54, OR42, LOV56, OR50, LOV51, OR49, GM62, RB39, OR43, RB35, RB38, RB36, RB37, RB40, OR41, AZ22, AZ23, OR46, and OR44. Most of the plots in this group are in Rubino, Oreskrobou, Grand Mori é Lovigi é and Azagui é

They have an average production of 501 to 563 kg/ha/year. These plots are located at altitudes ranging from 9 to 108 meters and the producers do not employ good agricultural practices. They do not use chemical pesticides, clean their fields, or show interest in purchasing biofungicides. They would prefer that the State of Côte d'Ivoire provide them with free inputs in general. Unlike the first group, producers in the second group (yellow) use fungicides and insecticides and maintain their fields. They have fairly high yields. Their plots are located at a high altitude. The farmers engage in other income-generating activities and are willing to purchase biopesticides at prices ranging from 500 to 35,000 CFA francs. This group includes plots AG11, AG12, AG15, AG13, OR48, C3, C1, C10, C9, C7, C4, C5, C2, C6, AG16, AG14, C8, and AG17. The farmers are mainly from the localities of Agboville and C'échi.

The third group (gray color) consists of plots GM69, AZ29, RB31, LOV53, AZ27, AZ21, AG18, AZ24, AZ25, AG20, GM63, AZ28, AZ26, AG19, AZ30, GM61, LOV59, RB33,

and OR45. Most of these plots are in Grand-Morié and Azaguié. These plots are located at an altitude between 8 and 102 meters.

The plots in the Azaguié and Agboville sub-prefectures recorded an average production of 986 and 1,130 kilograms per hectare, respectively. Producers use chemical and organic fertilizers, as well as fungicides and insecticides, on these plots.

The third group (gray color) consists of plots GM69, AZ29, RB31, LOV53, AZ27, AZ21, AG18, AZ24, AZ25, AG20, GM63, AZ28, AZ26, AG19, AZ30, GM61, LOV59, RB33, and OR45. Most of these plots are in Grand-Morié and Azaguié. These plots are located at an altitude between 8 and 102 meters.

The plots in the Azaguié and Agboville sub-prefectures recorded an average production of 986 and 1,130 kilograms per hectare, respectively. Producers use chemical and organic fertilizers, as well as fungicides and insecticides, on these plots.

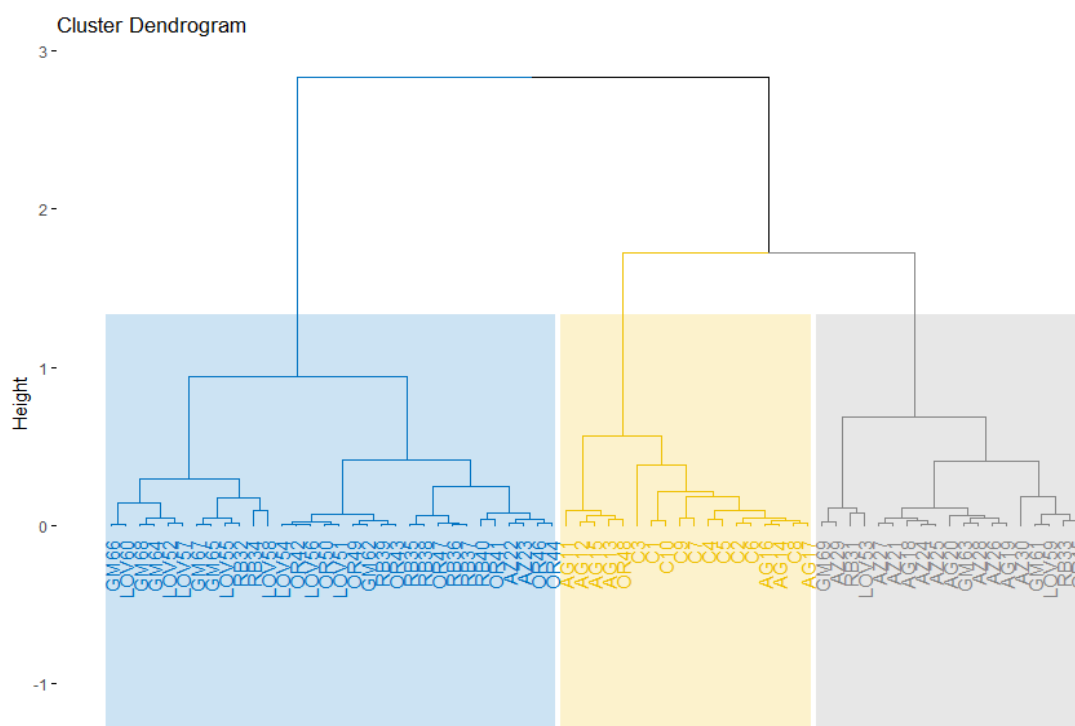


Figure 4. Dendrogram of plots characterized in the localities.

The three different colors indicate the groups of cocoa tree plots:

GM: Grand-Morié LOV: Loviguié RB: Rubino, OR: Oress-krobou, AZ: Azaguié AG: Agboville, C: C'échi, bleu: Groupe 1, l'orange: Groupe 2, Violet: Groupe 3

4. Discussion

The results of the survey conducted in seventy fields spread across seven localities in Agn'èy-Tiassa allowed the localities to be grouped into three categories. The first group includes

plots mainly belonging to Loviguié, Rubino, Oress-Krobou, and Grand-Morié. These areas are characterized by low production due to the lack of use of fungicides, insecticides, chemical fertilizers, and organic fertilizers. Unlike the first group, the second group uses fungicides and insecticides and maintains its fields. They have fairly high production. Most of

these plots are in Agboville and C'échi. The third group consisted of plots from Azaguié, Rubino, Agboville, Oress-Krobou, and Grand-Morié. Thanks to the use of chemical fungicides, mineral or organic fertilizers, and field cleaning, these plots are characterized by relatively high yields. It should be noted that the low productivity of the cocoa trees in this group is linked to the age of the plots and the cocoa tree varieties present in the fields.

Therefore, producers have a good understanding of black pod rot and other cocoa tree pests. In the Agn'ôly-Tiassa region, where most plantations are aging, sanitary harvesting remains the most widely used control method. These plantations range in age from 2 to 20 years, 20 to 60 years, and 60 to 100 years. The high incidence of black pod rot and the widespread aging of plantations can be explained by the fact that few producers carry out phytosanitary treatments and by the lack of regeneration of the old plantations they inherited from their parents. In this regard, our results are consistent with those of Poh'é *et al.* [10] and Kouassi *et al.* [11]. These authors demonstrated the prevalence of black pod rot in Al'p'é Aboisso, and Abengourou. Coulibaly *et al.* [12] and Yao *et al.* [7] also showed the high prevalence of this disease in Côte d'Ivoire. These authors identified *P. palmivora* as the most widespread pathogen in large cocoa-producing areas. Assiri *et al.* [9], Konaté *et al.* [5] and Pana *et al.* [13] highlighted the aging of cocoa orchards, the type of plant material used, planting density, previous crops, production, and the limited use of inputs in plantations in southeastern Côte d'Ivoire. These researchers showed that weeding and phytosanitary treatments are limited to two or three cleanings and one or two insecticide applications per year. According to them, fertilizer is rarely used. All of this results in low productivity. Their average yields range from 260 to 1,000 kg/ha/year [14].

Producers' use of fungicides, chemical insecticides, and chemical and organic fertilizers in the fight against brown pod rot reduces the rate of diseased pods and increases production. The effectiveness of chemical fungicides and insecticides has been repeatedly demonstrated by many authors in the field. Poh'é *et al.* [8, 10], for example, demonstrated the effectiveness of copper oxide and metalaxyl against black pod rot caused by *Phytophthora* spp. Additionally, Coulibaly *et al.* [3] and Oro *et al.* [15] demonstrated the importance of using chemical fungicides to control diseases caused by *Phytophthora* spp. in cocoa cultivation through a technical data sheet. They recommended that farmers use fungicides containing copper oxide, copper oxychloride, copper hydroxide, a combination of copper oxide and metalaxyl, or a combination of mefenoxam and copper hydroxide. According to these authors, choosing the right plant material and adhering to the proper density (1333/ha) before planting are important.

The results of this survey enabled us to identify producers who do not use chemical pesticides or fertilizers, whether organic or inorganic. This explains the low production in this area. Previous studies have shown that cocoa plantation productivity depends on maintenance activities and soil fer-

tility. Producers must be able to assess soil fertility and replenish lost mineral and organic elements through rational practices.

5. Conclusion

This diagnostic study of cocoa orchards in the Agn'ôly-Tiassa region reveals that brown rot of cocoa pods is the primary concern for farmers. This is why this parameter is not discriminatory in the PCA. Other problems include pests (e.g., stink bugs, ants, and loranthus), inputs (e.g., fungicides, insecticides, and fertilizers), technical equipment (e.g., atomizers and sprayers), and labor. Most of these farmers do not use synthetic fungicides or fertilizers on their plantations. This explains the low production in these areas. Those few producers who maintain their fields have seen their production increase.

Abbreviations

C	C'échi
LOV	Loviguié
GM	Grand-Morié
OR	Oress-krobou
AG	Agboville
RB	Rubino

Acknowledgments

The World Bank for funding this work. We would like to thank ANADER for their contribution to this work. We would also like to thank Mr. N'koh Ambroise and the members of the cooperative for making their cocoa field available to us.

Author Contributions

Fofana Balakissa: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Validation, Writing – original draft, Writing – review & editing

Sanogo Souleymane: Methodology, Visualization

Amari Ler-N'ogn Dadé Georges Elisée: Methodology, Visualization

Guinagui N'Doua Bertrand: Formal Analysis, Methodology

Silué Napkalo: Data Curation

Zouzou Michel: Conceptualization, Validation

Koné Daouda: Conceptualization, Methodology, Project administration, Supervision, Validation

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Motamayor, J C., Risterucci, A. M., Lopez, P A., Ortiz, C. F., Moreno A. & Lanaud C. Cacao domestication. In: The origin of the cacao cultivated by the Mayas. *Heredity*. 2002, 89: 308-403. <https://doi.org/10.1038/sj.hdy.6800156>
- [2] Statista, 2023. <https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url>
- [3] Coulibaly, K., Kébé B. I., Aka, A. R., Kouakou, K., N'Guessan, W. P., Tahi, G. M., Kassim, K. E., Guiraud, S. B., Assi, M. E., Koné B. & N'Guessan, K. F. Bien lutter contre la pourriture brune des cabosses du cacaoyer en Côte d'Ivoire. Fiche technique cacaoyer no 6. *Centre National de Recherche Agronomique*. 2017, 2p. <https://doi.org/10.35759/JABs.183.8>
- [4] Kébé B. I., N'Goran, J. A. K., Tahi, G. M., Paulin, D., Clement, D. & Eskes A. B. Pathology and breeding for resistance to black pod in Côte d'Ivoire. In: Proceedings of the International Workshop on the Contribution of Disease Resistance to Cocoa Variety Improvement, Salvador, Bahia, Brazil, 24-26 November. International Group for Genetic Improvement of Cocoa. 1999. 135-140.
- [5] Konaté Z., Assiri, A. A., Messoum, F. G., SEKOU, A., Camara, M. & Yao-Kouame, A. Antécédents culturels et identification de quelques pratiques paysannes en replantation cacaoyère en Côte d'Ivoire. *Agronomie Africaine*. 2016, 27(3): 301-314. <https://www.researchgate.net/publication/294722822>
- [6] Konaté Z., Assiri, A. A., Messoum, F. G., Sékou, A., Camara, M. & Yao-Kouamé A. Identification de quelques contraintes paysannes en replantation cacaoyère en Côte d'Ivoire. *Science de la vie, de la terre et agronomie*. 2016, 04(02): 51-57. ISSN 2424-7235.
- [7] YAO, J. W., SÉKA, K., KOFFI, A. L. F. H. & KOUAMÉ, C. A. Diversity of *Phytophthora palmivora* and *Trichoderma* sp. strains in cocoa orchards in 3 regions of Côte d'Ivoire. *Afrique SCIENCE*. 2024, 24(5): 69-79. ISSN 1813-548X, <http://www.afriquescience.net>
- [8] Halle, B. & Bruzon V. Profil Environnemental de la Côte d'Ivoire. Rapport final. Commission Européenne, offre de service dans le secteur de la coopération relatif au: Contrat Cadre EuropeAid/119860/C/SV/Multi Lot 6: Environnement Pays Bénéficiaire: Côte d'Ivoire *Lettre de Contrat*. 2006, No 2006/119741/1.
- [9] Assiri, A. A., Yoro, G. R., Deheuvels, O., Kebe, B. I., Keli, Z. J., Adiko, A. & Assa A. Les caractéristiques agronomiques des vergers de cacaoyer (*Theobroma cacao* L.) en Côte d'Ivoire. *Journal of Animal & Plant Sciences*. 2009, 2(1): 55-66. <http://www.biosciences.elewa.org/JAPS>
- [10] Pohé J., Koula, J., Rabe, G. R. & Dezai, L. R. Aggravation de la pourriture brune des cabosses de cacaoyer dans le sud-est de la Côte d'Ivoire. *Journal of Animal & Plant Sciences*. 2013, 20(2): 3126-3136. <http://www.m.elewa.org/JAPS>
- [11] Kouassi, K. M. Menaces pour la Durabilité du Cacao Ivoirien: La Boucle de Mégué à l'Épreuve d'une Pression Anthropique et d'un Système Agricole Alternatif. *European Scientific Journal*, ESJ. 2023, 19(19): 48-67. <https://doi.org/10.19044/esj.2023.v19n19p48>
- [12] Coulibaly, K., Kebe, B. I., Koffi, K. N., Mpika, J. & Kone D. Caractérisation des isolats de *Phytophthora* spp du verger cacaoyers de Côte d'Ivoire. *Journal of Applied Biosciences*. 2013, 70: 5567-5579. www.m.elewa.org
- [13] Pana, K., Atti, T., Adigninou, A. K., Exonam A. K. & Moubarak, K. Caractéristiques Agronomiques et Identification des Facteurs Déterminant la Faible Productivité des Agroforêts à Cacaoyers (*Theobroma Cacao* L.) au Togo. *European Scientific Journal*, ESJ. 2022, 18(36): 224-245. <https://doi.org/10.19044/esj.2022.v18n36p224>
- [14] Ballo, Z., Kouayé O. D & Vroh, B. T. A. Caractéristiques des cacaoyères post-forestières dans la Sous-préfecture d'Azaguié (Sud-Est de la Côte d'Ivoire): pratiques paysannes, flore et végétation. *International Journal of Biological and Chemical Sciences*. 2022 16(5): 2088-2101. ISSN 1997-342X (Online).
- [15] Oro, Z. F., Lallié H-D, Kouamé G. K., Sanouidi, D. & Diallo, H. A. Evaluation of the Biostimulant Banzai's Effect and the Previous Fertilizer on the Control of Cocoa Black Cherries Disease in N'Gouaminkro, in the Department of Toumodi, Côte d'Ivoire. *World Journal of Agricultural Research*. 2020, 8(2): 62-69.