Afropolitan Journals

ISSN: 3027-2637 www.afropolitanjournals.com

Assessing the Economic Burden of Black Pod Disease and Cherelle Wilt on Cocoa Farmers in Nigeria

Agbeniyi Sunday O.; Oladokun Yetunde O. M.; Agulanna Foluso T.; and Oluyole Kayode A.

Cocoa Research Institute of Nigeria, P.M.B 5244, Idi-Ayunre Ibadan. Nigeria.

Corresponding author: yetunde.oladokun@gmail.com

DOI: *https://doi.org/10.62154/ajasfr.2025.018.010621*

Abstract

Cocoa is a highly valuable global crop, but about 20-25% of its yield is lost to pests and diseases. This study evaluated the economic impact of premature pod loss on cocoa production in Ibadan, Nigeria, using a demonstration plot at the Cocoa Research Institute of Nigeria. Data was collected from August to October 2022, focusing on healthy pods, black pods, cherelles, and cherelle wilt. The analysis, conducted with descriptive statistics and cost analysis using STATA 12, revealed that 2595 pods were healthy, and 562 pods were infected within a 481.17m^2 area. The total cost for uninfected pods per hectare was ₦3,625,600, while the cost for infected pods was ₦785,600. Black pod disease caused the loss of 562 pods on the 481.17m^2 plot and 12,266 pods on a one-hectare area, translating to a total loss of ₦785,600 per hectare. This resulted in a 22% loss of cocoa pods, with 82% surviving. It was estimated that 2266 kg of dried cocoa beans would survive per hectare, while 491 kg could be lost to black pod disease. In total, 18% of cocoa beans were expected to be lost due to black pod disease. The study emphasizes the importance of implementing good agricultural practices to reduce the occurrence of black pod disease and minimize its impact on cocoa production.

Keywords: Black Pod Disease, Cherelle Wilt, Cocoa Production, Economic Impact, Yield Loss.

Introduction

One of the most valuable crops in the world is cocoa which is grown on 8.2 million hectares globally (Zakaria, 2018). Cocoa has significant impacts on social and economic well-being of over 5 million households and 25 million people living in impoverished rural areas. The top producing countries of cocoa are Ivory Coast, Ghana, Nigeria, Indonesia, and Brazil (Oduro *et al*., 2020). Cocoa is being cultivated in 58 countries which contribute more than $4 billion annually to the global economy. About 74% of the cocoa produced worldwide is sourced from the African continent alone. Ivory Coast is the greatest producer of cocoa (42% of all African nations), followed by Ghana (20%), Nigeria (6%), and Cameroon (5%). Approximately 70% of the world's production comes from the 6 million hectares of cocoa in West Africa. In recent time, top cocoa-producing nations include Côte d'Ivoire, Ghana, Nigeria, and Cameroon, with production rising from about 2,000,000 tons to almost 3,000,000 tons within ten years (Marius and Quist-Wessel, 2015; Vásquez, 2019). Around

4.3 million tons of cocoa are produced annually around the world, with Cote d'Ivoire, Ghana, Nigeria, and Cameroon producing 56, 29, 8, and 7% of that total, respectively (Marius and Quist-Wessel, 2015; Asanye, 2023).

The average yields, however, continue to be low, and this can be ascribed to a number of things, including pests and diseases, outdated and inactive farms, extensive farming techniques, and more. It has been reported that cocoa production in Nigeria has been increasing steadily. The rise from 165,000 metric tons in 1999–2000 to 250,000 metric tons in 2013–2014 has been attributed to government support through the 2011 Cocoa Transformation Action Plan (Nzeka, 2014; Adeniyi, 2019). Also, 640,000 hectares were estimated to have been completely harvested in Nigeria, with a yield of roughly 400 kg per hectare on average. The most widespread, *Phytophthora* species, can kill 10% of trees and result in yield losses of 20–30% in most cacoa-growing nations worldwide while ripe pod infections decrease the quality of the beans, infected immature pods are rendered unusable. Nzeka (2014) contributed that in particular, those small scale isolated farms throughout West Africa that lack effective control measures, pests and diseases cause significant economic losses in the production of cocoa.

According to estimates, roughly 450,000 metric tons of cocoa productions worldwide are being lost to black pod disease, which is brought on by several species of *Phytophthora* (Bowers *et al*., 2001, Adeniyi and Asogwa, 2023). The biggest production barrier is this disease, which probably accounts for 20–25% of the anticipated crop. It poses a serious threat to the cocoa industry and to producers because it can result in annual crop losses of 30–90% to farmers in Africa. Cocoa productivity is limited by a number of factors, some of which are directly related to farmers' practices. Cocoa can have multiple diseases which tend to result in economic loss as a result of loss of significant amount of money. The main problem with cocoa pods worldwide is black pod disease (Oduro *et al*., 2020). Only two of the four species of *Phytophthora* pathogens namely *Phytophthorapalmivora* and *Phytophthora megakarya*are of economic importance. The microorganisms.cause cocoa to cake. A severe assault of cocoa can cause the pods to completely rot; the damage to the pods may be as high as 50% or even greater (David, 2008). A severe infection of cocoa pods can cause a loss of practically all of the pods (Pokou *et al*., 2008; Adeniyi, 2019). This study therefore sought to assess the economic burden of black pod disease and cherelle wilt on cocoa farmers in Nigeria.

Objectives of the study

The main objective of the study is to assess the economic burden of black pod disease and cherelle wilt on cocoa farmers in Nigeria.

The specific objectives are to:

a. assess the number of healthy and unhealthy pods,
b. estimate the total number of pods that were uninfected per hectare
c. assess the number of pods that were lost to black pod disease and wilted cherelles.
d. determine the percentage of cocoa pods that were lost to the healthy ones and

e. ascertain the proportion of the survived cocoa pods to their larger population on the farm

Literature Review

The study by Koné, Keli, and Kebe (2024) investigates Ivorian cocoa farmers' understanding of black pod disease and the factors influencing their choice of control methods. The research highlights that while farmers are aware of black pod disease, there is variability in their knowledge levels, which significantly affects their management practices. Factors such as access to information, education, and resources play crucial roles in determining the control methods employed by farmers. The study emphasizes the need for tailored extension services and training programs to enhance farmers' knowledge and adoption of effective disease management strategies, thereby improving cocoa yield and quality. Sullivan and White (2020) also conducted a comprehensive review of the interaction between *Phytophthora palmivora*, a hemibiotrophic oomycete, and *Theobroma cacao* (cocoa). The study delved into the pathogen's infection mechanisms, highlighting structures such as the germ tube, appressorium, and haustorium, which facilitate host penetration and disease progression. Additionally, the review examined the molecular exchanges between *P. palmivora* and cocoa, emphasizing the role of plant immunity during infection. Understanding these interactions is crucial for developing effective disease management strategies against black pod rot in cocoa.

Adeniyi 2019 examined the diversity of Cacao pathogens and its impact on yield and global production. The author affirmed that global cocoa production has been rising fairly steadily over the years by increasing production in growing countries like Cote d I'voire, Nigeria, Ghana, with most of the production taking place in areas of high pathogen biodiversity. Therefore, the sustainability of the cocoa economy is under threat as diseases of various statuses now constitute the most serious constraint to production. Most important among these is the black pod disease caused by Phytophthora genus with annual losses of 30–90% of the crop. This economically important pathogen is very diverse in nature and varied across growing countries including species such as palmivora, megakarya, capsici and citrophthora distinguished based on chromosome number, sporangial characteristics and pedicel length. World losses of 20–25% in cacao production are due to black pod disease, an estimate of 700,000 metric tons on global scale reducing global cocoa production. High cacao loss to diseases is a prime factor limiting production; consequently, significant effort is required to deal with problems associated with disease control to ensure a sustainable cacao. The effective and sustainable management of black pod disease requires integrated approach encompassing different control measures.

Methodology

This study was carried out at Zone 1 cocoa plots at the headquarters of Cocoa Research Institute of Nigeria (CRIN), Idi-Ayunre, Ibadan. Data was were collected from August to October 2022, focusing on healthy pods, black pods, cherelles, and cherelle wilt. The plot

was left untreated without any chemical for a whole cropping season. However, regular weeding was being carried out on the plot. This experiment was carried out to determine the survival rate of cocoa pods on CRIN experimental plots. The land area of the experimental plot used was 458.17m^2. At the end of the experimental period, the number of healthy cocoa pods, black pod and pods infected with cherelle wilt were counted. Results obtained in this study were statistically analysed using descriptive statistics and cost analysis using STATA 12. The land area of the experimental plot used was 458.17m^2. Nigeria.

Results and Discussion

Table 1 presents the counts of healthy cocoa pods, black pods, cherelles, and wilted cherelles observed on the demonstration plot. In August, the average recorded numbers were 146 healthy pods, 82 cherelles, and 23 infected pods. In September, the averages changed to 126 healthy pods, 1 infected pod, 70 healthy cherelles, and 31 infected cherelles. For October, the average counts were as follows: 94 healthy pods, 41 black pods, 74 healthy cherelles, and 41 wilted cherelles. Over the entire study period, the total counts of healthy pods, black pods, healthy cherelles, and wilted/infected cherelles were recorded as 1,611, 162, 984, and 400, respectively.

Table 1: Number of healthy and unhealthy pods

Period/Date	Number of Healthy Pod	Number of pods with black Pod disease	Number of cherelles	Number of Pod infected with cherrelle wilt
02/08/2022	150		81	16
09/08/2022	157		73	16
16/08/2022	167		74	16
23/08/2022	130		90	32
30/08/2022	128		91	33
Monthly average	146		82	23
06/09/2022	134		85	33
13/09/2022	134	1	82	26
20/09/2022	134		82	26
27/09/2022	102		31	39
Monthly average	126		70	31
04/10/2022	98	53	75	39
11/10/2022	93	38	75	41
18/10/2022	93	29	70	43
25/10/2022	91	42	75	40
Monthly average	94	41	74	41
Total	1611	162	984	400

Source: Field Survey, 2022

Estimate of total number of pods that were uninfected per hectare:

Number of healthy pods + Number of healthy cherelles

1611 + 984 = 2595

Since land area used was 458.17$m^{2.}$ a total of 2595 pods survived.

(One hectare = 10,000m^2)

Number of pods on one hectare =?

10000 X 2,595 / 458.17 = 56,638.37 per hectare

25 cocoa pods give 1kg of dry cocoa beans, therefore, 56,638 cocoa pods will give 56,638/25 =2,266kg of dry cocoa beans.

Price of 1kg of dry cocoa beans as at March 2023 was #1600.

Therefore, 2266kg = 2266 X 1600 = ₦ 3,625,600

The total number of uninfected pods per hectare is calculated by adding the number of healthy pods to the healthy cherrelles. In a land area of 458.17 m^2, a total of 2,595 pods survived, which equates to 56,638 pods surviving per hectare. The monetary value of the survived pods per hectare is ₦ 3,625,600. The number of uninfected pods per hectare is calculated by adding the number of healthy pods to the healthy cherrelles. In a land area of 458.17 m^2, a total of 2,595 pods survived, which equates to 56,638 pods surviving per hectare. The monetary value of the survived pods per hectare is ₦ 3,625,600.

The number of pods lost due to black pod disease and wilted cherelles:

162 + 400 = 562pods

With a land area of 458.17 m^2, a total of 562 pods were lost due to black pod disease and those infected with cherelle wilt.

458.17m^2= 562pods

1 hectare = 12,266.19 pods

Since 25 pods yield 1 kg of dry cocoa beans, we can calculate that 12,266.19 pods will produce:

12,266.19 pods ÷ 25 pods/kg = 491 kg of dry beans

As of March 2023, the price of 1 kg of dry cocoa beans is ₦1,600.

Therefore, the total value of the dry beans lost due to black pod and cherelle is:

491 kg × ₦1,600 = ₦785,600.

Five hundred and sixty-two pods were lost to black pod and cherelle wilt from 458.17m^2 area of land and 12,266 in one hectare. The amount that would be lost was ₦ 785,600.

Percentage of cocoa pods that were lost to the healthy ones:

12,266 cocoa pods were lost to black pod and cherelle wilt.

56,638 cocoa pods were healthy.

The total number of pods that ought to be produced = 12, 266 + 56,638 = 68,904

12,266 / 68904 X 100 = 17.80%

About eighteen percent of cocoa pods were lost compared to the total pod production.

Proportion of the survived cocoa pods to their larger population on the farm:

The total number of cocoa pods includes healthy pods, black pods, cherelles, and pods affected by cherelle wilt.

Total number of cocoa pods = 1611 + 162 +984 + 400 =3157

Hence, if 3157 cocoa pods were in 458.17m^2, therefore 68,905 cocoa pods will be in one hectare.

Survived cocoa pod = 1611+984 = 2595

If 2595 cocoa pods survived in 458.17 m^2, therefore, 56638 cocoa pods will survive in one hectare

The percentage of the survived cocoa pods from the entire cocoa pods per hectare is:

56638 / 68905 X 100 = 0.82 =82%

A total of 562 cocoa pods were lost to black pod disease and cherelle wilt over an area of 458.17 m², which translates to 12,266 pods lost per hectare. This loss amounts to ₦785,600. Out of the total production: - Lost pods (12,266) - Healthy pods (56,638) The total potential production was 68,904 pods, resulting in a loss percentage of approximately 18% (12,266 / 68,904 × 100). The total cocoa pod population consists of healthy pods, lost pods, and infected pods: 1,611 (healthy) + 162 (black pod) + 984 (cherelle wilt) + 400 (infected) = 3,157 total pods. For area conversion, if 458.17 m² equals 3,157 pods, then for 10,000 m², there would be approximately 68,905 pods per hectare. The number of survived pods is 2,595 (1,611 healthy + 984 infected). We can calculate the number of survived cocoa pods per hectare as 56638.

56638 / 68905 X 100 = 0.82 =82%

The entire cocoa pod produced in the 458.17m^2 area of land was 3,157 and 68,905 pods were produced in one hectare. Two thousand five hundred and ninety-five were uninfected in 458.17m^2 area of land, 56639 in one hectare. Eighty-two percent of the cocoa pods survived compared to the entire cocoa pod produced.

Quantity and amount (₦) of cocoa beans that were likely to survive per hectare.

56,638.37 cocoa pods survived per hectare (sum of healthy pods and cherelle). 25pods make 1kg.

56,638.37/ha = 56638/25 = 2266kg cocoa beans likely to survive. 2266kg of dry beans are likely to survive per hectare.

Price of 1kg of dry cocoa beans as at March 2023 is ₦1600.

2266 X 1600 = ₦ 3,625,600

4.7 Quantity and amount in (₦) of cocoa beans that are likely to be lost per hectare

12, 266.19/ha of cocoa pods likely to be lost

25pods make 1kg

12266/25 =491 kg cocoa beans likely to be lost

491kg of dry cocoa beans are likely to be lost

The price of 1kg of dry cocoa beans as of March 2023 is ₦1600.

= 491 X 1600 = ₦ 785,600

Quantity and amount in (₦) of cocoa beans produced per hectare:

68,904.56 cocoa pods are entirely produced in one hectare.

25 pods make 1kg

= 68905/25 = 2756 kg cocoa beans produced per hectare

Amount (₦) of cocoa beans entirely produced in one hectare:

₦ 2756 X1600 = ₦4,409,600

Conclusion and Recommendation

In the study, it was determined that out of a projected 68,905 cocoa pods, approximately 56,639 were likely to be uninfected. The estimated revenue from the surviving pods would be three million, six hundred twenty-five thousand six hundred naira (₦3,625,600), compared to four million, four hundred nine thousand six hundred naira (₦4,409,600) that could have been generated if all the cocoa pods had survived. About 18% of the total production was lost due to black pod disease and cherelle wilt. To enhance the survival rate of cocoa pods, it is recommended that Good Agricultural Practices (GAP) be implemented on cocoa farms.

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