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Influence of the Impurity Level of Seed Cotton on the Ginning Yield and the Technological Characteristics of the Fiber in Côte d'Ivoire

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Abstract

Background: Cotton growing in Côte d'Ivoire faces a number of constraints, not least climate change, which is having an increasingly visible impact on production. In addition to the drop in cotton production, one of the problems facing the Ivorian cotton industry is the low fibre yield at ginning factories and the poor quality of the fibre sold on the international market. The causes identified include the poor quality of seed cotton purchased on local markets, particularly the level of impurities. This study was therefore carried out to determine the influence of the waste contained in the seed cotton ginned in factories on the fibre yield and the technological characteristics of cotton fibre in Côte d'Ivoire. The work consisted in carrying out ginning trials in ginning factories to assess fibre yield in relation to the level of impurities in the cotton harvested. The fibre samples taken from the bales during the ginning trials were analysed on an HVI 1000/1000 integrated measurement chain. The data collected were used to perform a multivariate analysis (PCA) and simple regressions. **Results:** The results showed that the waste rate increased from 2.96% to 5.33% from the youngest production generations to the oldest. Principal component analysis revealed correlations between parameters collected in factories. The level of impurity was negatively correlated with fifer ginning yield, fibre length ($y = -0.4408x + 28.991$; $R^2 = 0.3956$; $p = 0.005$) and length uniformity ($y = -0.5963x + 81.078$; $R^2 = 0.5185$; $p = 0.001$). It is positively correlated with short fibre content ($y = 1.8376x + 8.8186$; $R^2 = 0.5833$; $p = 0.000$) and trash in baled fibres ($y = 4.8515x + 25.759$; $R^2 = 0.4054$; $p = 0.004$). **Conclusion:** Impurities in seed cotton contribute to reducing the fibre yield at ginning in factories and degrading the fibre characteristics by reducing fibre length and uniformity on the one hand, and by increasing short fibre rates on the other. This contributes to reducing the market value of cotton fibre.

Keywords

Seed Cotton, Quality, Fibre Yield, Technological Characteristics, Fibre, Ginning, Côte d'Ivoire

1. Introduction

In Côte d'Ivoire, cotton growing has been the main source of cash income for farmers in savannah areas for over 30 years [1]. Cotton now accounts for 7% of the country's export earnings and contributes 1.7% of Gross Domestic Product [2]. It is estimated that more than 3.5 million people make their living directly or indirectly from cotton growing [3]. Despite this importance, cotton growing in Côte d'Ivoire faces several constraints, notably climate change, which is having an increasingly visible impact on production. Apart from the fall in cotton production, one of the problems facing the Ivorian cotton sector is the low fibre yield at ginning in the factories and the poor quality of the fibre [4] sold on the international market. This poor quality creates a discount on the price of cotton from Côte d'Ivoire, thus generating economic losses [5]. These problems are common in African cotton-producing countries, whose production systems are very similar, but it is accentuated in Côte d'Ivoire [2] [5]. Among the causes identified is the poor quality of seed cotton purchased on local markets, particularly the level of impurities. Indeed, cotton is harvested manually in Côte d'Ivoire. This implies that it must be clean compared to cotton harvested by machine. Unfortunately, this cotton is often provided with plant impurities (pieces of stems, leaves, carpels, bracts, etc.) and stones from poor storage [6]. This study was therefore conducted to determine the influence of the waste contained in the seed cotton ginned in the factories on the ginning fibre yield and the technological characteristics of cotton fibre in Côte d'Ivoire.

2. Materials and Methods

2.1. Presentation of the Study Sites

The cotton ginning work was carried out in eight factories of the main cotton companies operating in Côte d'Ivoire (COIC, SECO, IVOIRE COTON and CIDT) at a rate of two factories per cotton company (**Figure 1**). These factories are generally equipped with Lummus-type gins with 170 saws.

2.2. Plant Material

The plant material used in this study consisted of seed cotton of *Gossypium hirsutum* L. specie, that is the only one cotton specie grown in Côte d'Ivoire. The seed cotton collected from the fields and sent to the factories from the tree production generations (G3, R1 and R2):

G3: Cotton given by research as created verity;

R1: First cultivation year;

R2: Second cultivation year.

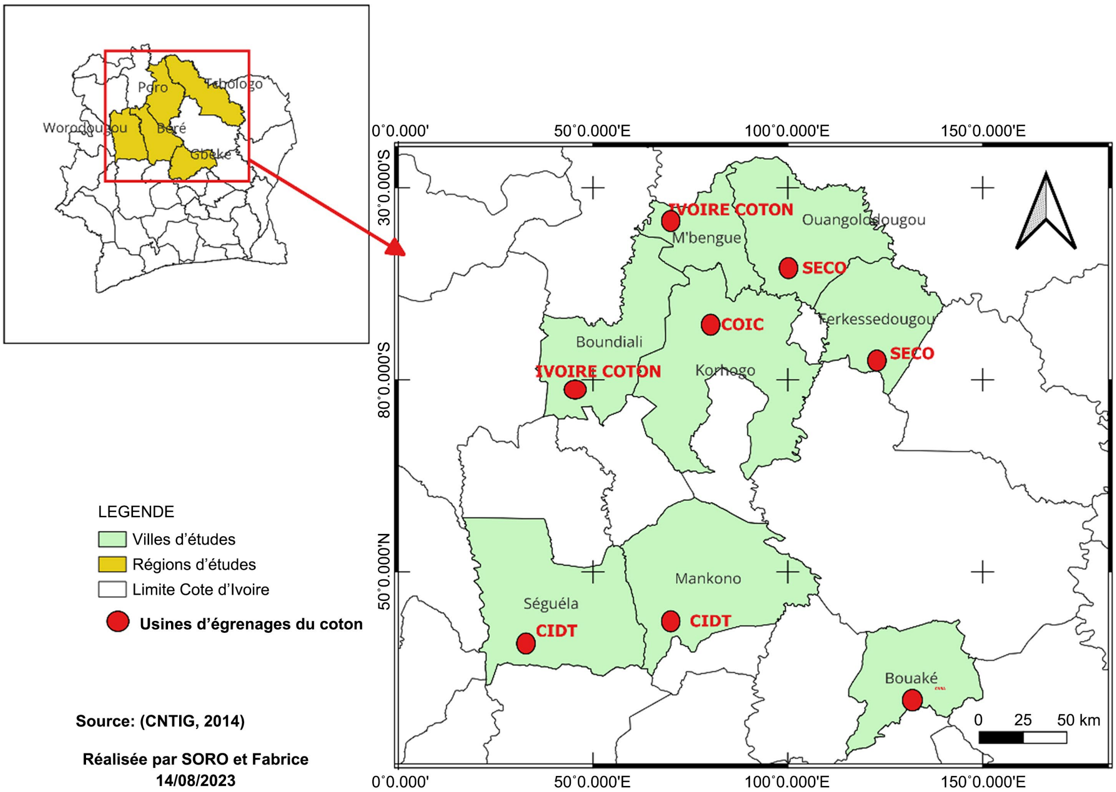

Figure 1. Map of Côte d'Ivoire with study sites.

2.3. Technical Equipment

The technical equipment used in this study consisted of 170-saw gins at the mills (Figure 2(a)) and an HVI 1000/1000 integrated measurement chain (Figure 2(b)) for determining the technological characteristics of the fibres.

2.4. Data Collection in Ginning Factories

The data collected at the factories were made possible by ginning tests [6], carried out on loads of seed cotton arriving in ginning factories, for ginning. During the tests, waste rates and fibre yields were determined according to Formulas (1) and (2) respectively.

Formula (1): $$\text{Fibre content}(\%) = \frac{\text{Fibre weight}(\text{kg})}{\text{Seed cotton weigth}(\text{kg})} \times 100$$

Formula (2): $$\text{Waste rate}(\%) = \frac{\text{Waste weigth}}{\text{Seed cotton weigth}(\text{kg})} \times 100$$

(a)

(b)

Figure 2. Technical equipment used for the study.

2.5. Determination of Fibre Technological Parameters

The fibre samples collected after ginning were analysed on an HVI 1000/1000 integrated measurement chain [6]. This fully automated device has three modules for determining agro-industrial quality from a sample of 100 g of fibre. The main technological characteristics assessed were fibre length (UHML), fibre tenacity, short fibre content and fibre length uniformity.

2.6. Statistical Analysis

In order to assess the impact of waste on the agro-industrial quality of cotton, linear regressions were used to study its relevance by predicting technological characteristics as a function of these impurities.

Principal component analysis (PCA) was used to observe the relevance of the technological parameters studied. All these analyses were carried out using Excel 2016 and STATISTICA version 7.1 software.

3. Results

3.1. Effects of Generations on the Rate of Waste in Seed Cotton

The rate of waste contained in seed cotton increased with the R^2 generation, with a value of 5.33% (**Figure 3**). On the other hand, the lowest rate was obtained with generation G3 (2.96%).

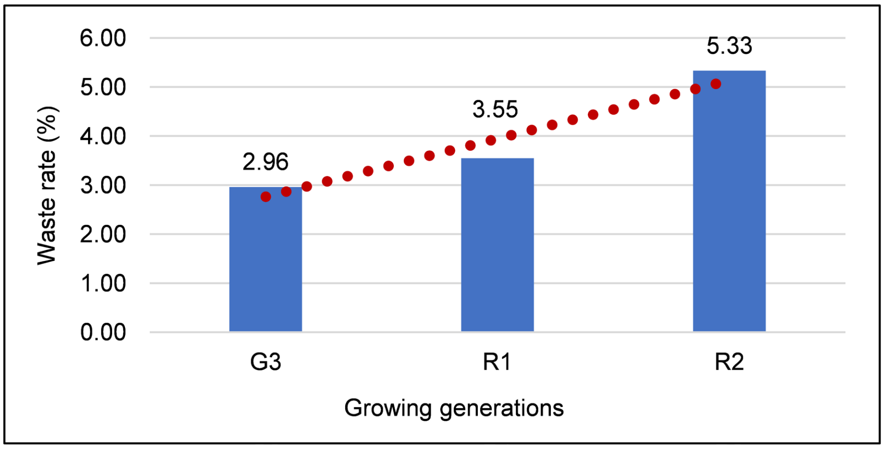

Figure 3. Rate of waste contained in seed cotton according to crop generation.

3.2. Influence of Waste Rate on Fibre Yield at Ginning

Figure 4 shows that a significant prediction (p = 0.002) could also be made between waste rate and cotton fibre yield. The accuracy was approximately 62% (R^2 = 0.6273). The equation of the regression line showed that it is also negative (y = −0.6024x + 45.376).

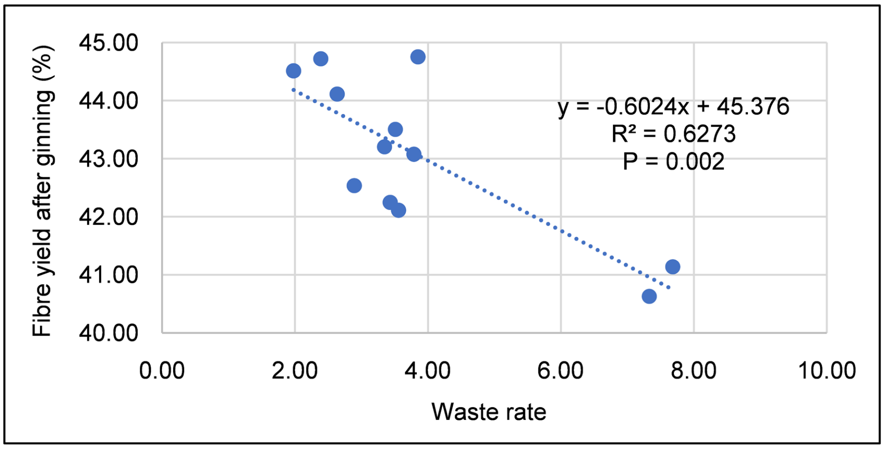

Figure 4. Linear regression of lint yield according to waste content in seed cotton.

3.3. Principal Component Analyses between Plant Parameters

The relevance of the variables studied is shown in **Figure 5**. Most of the information was contained on axes 1 and 2 (84%). On these axes, the most explanatory variables were the quantity of seed cotton (material), the rate of waste (total losses) and the rate of cotton fibre (fibre yield). For these variables, the correlations were negative between the quantity of seed cotton and the rate of cotton fibre on the one hand, and the rate of waste on the other.

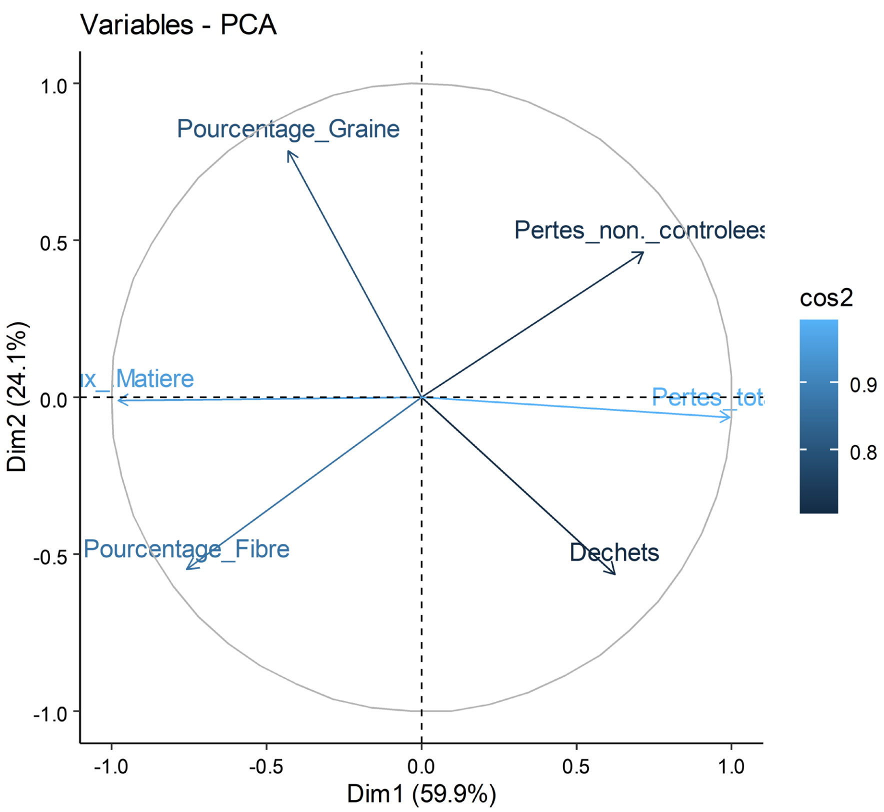

Figure 5. Multivariate analysis of parameters in ginning factories.

3.4. Influence of Seed Cotton Waste on the Technological Characteristics of the Fibre

- **Influence on cotton fibre length**

The regression of cotton fibre length as a function of cotton waste content is shown in Figure 6. The regression was negative ($y = -0.4408x + 28.991$) with a precision of only 39% but was still significant ($p = 0.005$). The more waste, the shorter the cotton fibres.

- **Influence on cotton fibre tenacity**

According to the linear regression of the graph in Figure 7, the level of waste contained in the cotton had no influence ($p = 0.441$) on the tenacity of the cotton fibres.

- **Influence on cotton short fibre content**

The influence of seed cotton waste on short staple fibre content was highly significant ($p = 0.000$) and positive (Figure 8). The coefficient of determination was 0.5833. In fact, the more impurities there are in the seed cotton, the more short fibres are generated by the ginning process in the mass of fibres obtained.

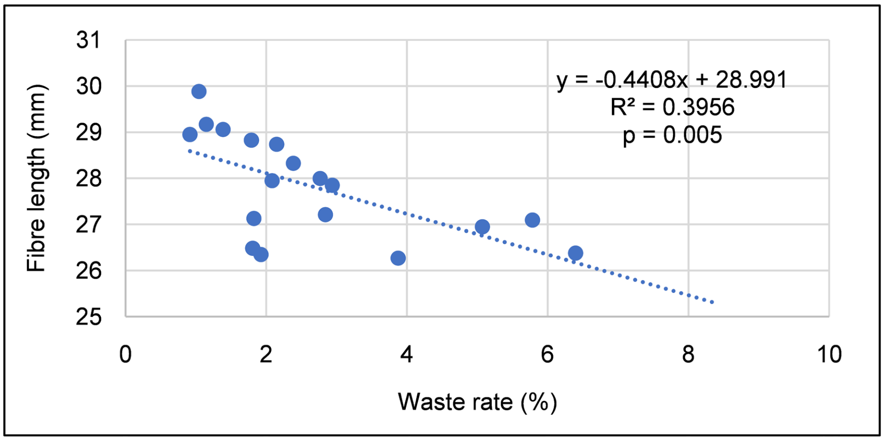

Figure 6. Linear regression of fibre length according to the waste content of seed cotton.

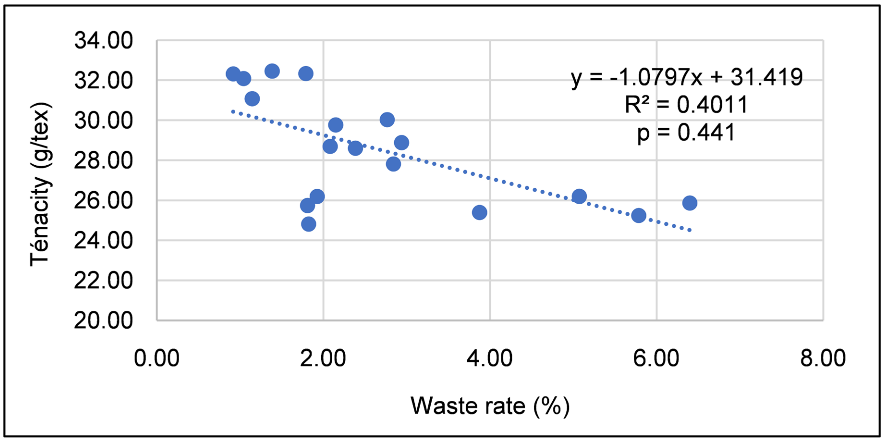

Figure 7. Linear regression of fibre tenacity according to waste content in seed cotton.

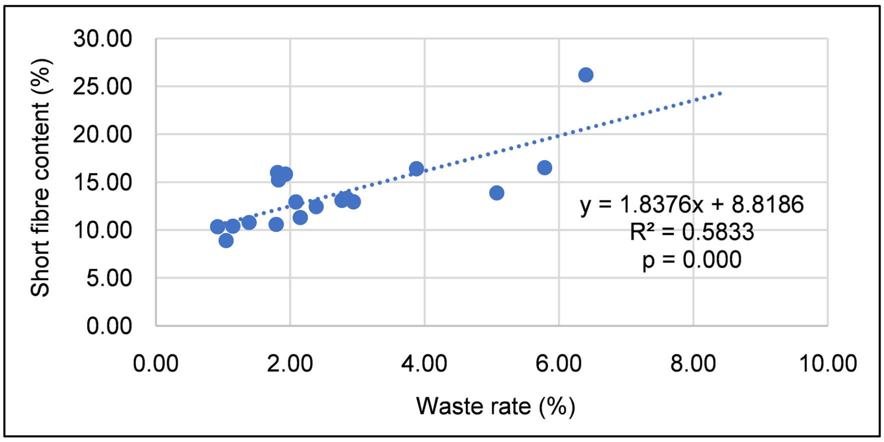

Figure 8. Linear regression of short fibre content according to waste content in seed cotton.

- **Influence on the uniformity rate of cotton fibre length**

A negative influence ($y = -0.5963x + 81.078$), significant ($p = 0.001$) and with a coefficient of determination $R^2 = 0.5185$ was observed (Figure 9). So, the more waste there is in the harvested cotton, the less uniform the fibre lengths will be.

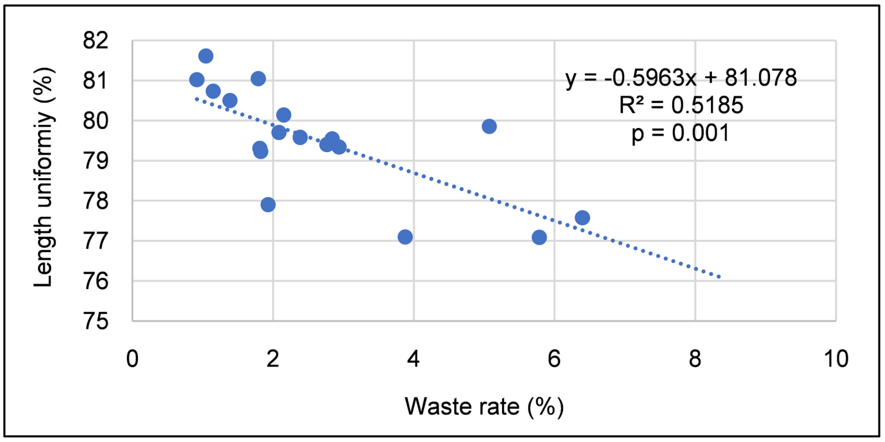

Figure 9. Linear regression of fibre uniformity according to waste content in seed cotton.

4. Discussion

The aim of this study was to assess the influence of the waste contained in the seed cotton ginned in the mills on the ginning fibre yield and the technological characteristics of cotton fibre in Côte d'Ivoire.

The results of the fibre, material and waste rates per generation showed that the rate of crop waste in seed cotton increases as crop generation levels increase. This increase is thought to be due to a lack of care taken with seed cotton during harvesting [7] at levels where there is a low level of supervision of producers [5].

Lint yield at ginning is significantly impacted by the waste contained in the seed cotton. The more waste there is in seed cotton, the less fibre and seed are obtained, as shown [6] in ginning factories in Cameroon.

The study also showed that high levels of waste in seed cotton contribute to a deterioration in fibre quality, particularly in terms of length, tenacity, uniformity and short-staple content. These results are in line with those of [8] and [9], who have shown that seed cotton cleaning operations during the ginning process contribute to reducing the length, tenacity and uniformity of the fibres, while generating a high rate of short fibres.

5. Conclusion

This study has contributed to show that impurities in seed cotton contribute to reducing the fibre yield at ginning in factories and degrading the fibre characteristics by reducing fibre length and uniformity on the one hand, and by increasing short fibre rates on the other. This contributes to reducing the market value of cotton fibre. In order to ensure a good fibre yield at the factory and guarantee the quality of the cotton fibre, farmers should be made aware of harvesting clean cotton and sorting it to remove impurities before sending it to the factories. Cotton companies should reject seed cotton that arrives too dirty in the factories.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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