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Effects of Zone, Cropping System Type, and Previous Crop on the Health Status of Capsules and Seed Cotton Yield of the Gouassou Fus 1 Variety in the Cotton Basin of Cote D'ivoire

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Abstract **Original Research Article**

Seed cotton production in the Ivorian basin is subject to strong variability related to local agroecological factors and farming practices. Indeed, agricultural practices such as cultivation method and previous crop also influence productivity and boll sanitary quality. This study aims to assess the variability of selected production parameters of the Gouassou cotton variety using field data collected and analyzed to compare yields and boll sanitary quality according to zone, cultivation system, and previous crop in the Ivorian cotton basin. The results showed that both yield and sanitary quality varied significantly across zones ($p < 0.001$), with maximal performance at Boron (1492.03 kg/ha) and Kaoura (1156.3 kg/ha), associated with favorable agroecological conditions such as nutrient availability, water management, and climate. The use of animal draft cultivation improved yields through more uniform stand establishment and more vigorous plants, while the peanut cultural precedent increases nitrogen fertility and resistance to pests, leading to a maximum yield of 1144.32 for peanuts compared to crops. These results highlight the importance of integrating local agroecological factors and tailored farming practices to optimize the productivity and sustainability of cotton systems in Côte d'Ivoire.

Keywords: seed cotton yield Gouassou FUS 1, Agroecological adaptation, cropping system, Crop rotation, Capsule health.

INTRODUCTION

Cotton cultivation is the principal driver of development in the northern and central regions of Côte d'Ivoire. The sector involves more than 200,000 farms (mostly smallholders) over nearly 300,000 hectares, with an average yield of about 1,200 kg/ha. Cotton accounts for approximately 20% of the total cotton production of CEDEAO and remains the main source of farm income and employment in these areas (Kouakou *et al.*, 2024). Furthermore, cotton provides nearly 48% of the gross agricultural added value in the North and Center of the country (Tillie *et al.*, 2018), thus confirming its status as a major cash crop. Cotton farming has also fostered the growth of industrial and artisanal units (spinning, weaving, tailoring, ginning, etc.) in these regions (Kouakou *et al.*, 2024).

In the Ivorian savannahs, cotton is traditionally the main crop in yearly rotations. However, increased demographic and land pressure has greatly reduced fallow availability, driving an intensification of cropping systems (Tillie *et al.*, 2018). Consequently, farmers practice rotation and/or association of cotton with food crops (maize, peanut, etc.) or perennial crops (cashew, shea, etc.) to optimize land use and maintain agronomic productivity.

The Gouassou FUS1 variety, created in Côte d'Ivoire, was released in 2018 and has since established itself as one of the main cotton varieties in the Ivorian basin. This variety is valued for its good adaptation to local soil and climate conditions and its high agronomic performance, particularly its tolerance to fusarium wilt and pests (Amangoua *et al.*, 2022).

In an Ivorian cotton basin marked by strong environmental and agricultural practice heterogeneity, are the agronomic performances of the Gouassou FUS 1 variety as recognized by Amangoua *et al.*, 2022 consistent across production zones ? Given the lack of systematic studies on the variety's agronomic potential expression across diverse contexts, it is necessary to assess its behavior with respect to agroecological frameworks and local practices, in order to identify the main determining factors and to formulate technical recommendations tailored to each production area.

The objective of this study is to evaluate the variation in selected production parameters of the Gouassou variety notably plant density, yield, and sanitary parameters according to zone, cropping system type, and previous crop in the Ivorian cotton basin.

MATERIALS AND METHODS

Plant material

The plant material consists of the Gouassou Fus 1 cotton variety of the species Gossypium hirsutum, grown by producers.

METHODS

Sampling sites

Description of the study site

The study was conducted in producers' plots, representing typical small-to-medium scale cotton farms, across 30 locations. This zone was divided into two parts : the northern part, above the 9th parallel, which is characterized by a Sudanian climate with a rainy season (June–September) and a dry season (October–May). The part located below the 9th parallel is characterized by a sub-Sudanian-type climate. It has two rainy seasons (March to July and October to November) and two dry seasons (August to September and December to February). The 9th parallel is recognized as a key agro-ecological boundary in the region, influencing crop calendars and pest dynamics (Kouakou *et al.,* 2021).

Selection of study plots

In each location, 10 producer plots were selected. This number was determined to ensure adequate representation of local variability while remaining logistically feasible for intensive data collection. Two parameters were considered for selection. First, the North-South and East-West axes were considered to ensure representation from all parts of the locality. The second parameter was the cotton sowing period. First, the sowing dates of all producers in the locality were recorded. The dates were grouped by 10-day periods (decades). Next, 10 producers were selected within these sowing decades. Next, 10 producers were selected within these sowing decades. The number of producers per decade was allocated according to the overall proportion of producers who were sowed during that period. In the northern part, most producers sowed between June 1st and June 30th. Thus, seven out of ten 10 producers (70%) were selected during this period. In the southern part, most of the sowing occurs between June 11th and July 10th. This period included eight of the ten producers, or 80% of the sample. Once the numbers were allocated, a random draw was performed.

n each selected plot, a usable area of 0.25 ha was marked off in the center for data collection. This specific area size is commonly used in field trials to ensure a representative sample and placing it in the center helps to mitigate potential edge effects from surrounding non-study areas or different management practices. This allows for monitoring the evolution of the factors studied (e.g., boll damage, pest populations, disease symptoms) in the same portion and makes data collection easier (Table1).

Table 1: Number of plots by location and according to geographic position

Sowing decades	North (above 9th parallel)	South (below 9th parallel)
20-31 may	1	-
01-10 june	2	1
11-20 june	3	3
21-30 june	2	3
01-10 july	1	2
11-20 july	1	1
TOTAL	**10**	**10**

Data collection

Plot and cultivation operation data

For each plot, data recorded included its position (North or South), previous crop, mode of cultivation (manual, draft-animal), etc.

For agronomic operations, the collected data included sowing date, herbicide and insecticide application dates, weeding and fertilizer application dates, as well as any other operations performed by the farmer.

Before harvest, about 100 days after sowing, existing plants were counted on a segment of 10 centraux rows, each 20 m long, per plot. Plant density per hectare was thus determined.

Sanitary data

On each plot, five weekly sanitary assessments of green bolls (conducted at 80, 87, 94, 101, and 108 days after emergence) were performed to evaluate the phytosanitary status of the crop. At each assessment date, a representative sample of 50 greens bolls of the same physiological age was collected from the middle third of the plant, near the main stem (one boll per plant). The four central rows of each plot were excluded from yield estimation to avoid bias.

All collected bolls were individually examined to determine whether they were healthy, i.e., free from any signs of pest attack or rot. This analysis aimed to quantify the incidence and severity of damage caused by pests and diseases, which is essential for assessing crop health and potential yield losses. Each boll was then opened to determine whether internal rot was present or whether damage had been caused by lepidopteran larvae.

Production data

When bolls opened, seed cotton from the four central rows (each 20 meters) was harvested from the middle of each plot. After weighing, the yield was estimated in kg/ha.

Data analysis

The data were first subjected to ANOVA validation requirements. When the assumptions of normality, assessed using QQplots, and homogeneity of variances, evaluated with Levene's test, were not met, non-parametric tests (Kruskal–Wallis and Wilcoxon) were applied. When a significant difference was detected at the 0.05 probability level, the Kruskal–Wallis post-hoc test, based on Fisher's least significant difference criterion and implemented in the agricolae package, was subsequently used to compare factor levels and identify significant differences. All statistical analyses were performed using R software, version 4.1.2 (R Core Team, 2021), with the Hstat package (https://github.com/houphouet/Hstat), which provides a smooth and user-friendly interface.

RESULTS

Average expression of production and health parameters in the cotton-growing region

Table 2 presents the minimum, maximum, and average values of the main agronomic and health parameters of the Gouassou Fus 1 variety. Plant density showed high variability, ranging from 44,045 to 95,182 plants/ha. Seed cotton yield was also highly variable, with values ranging from 667.16 to 1,492.03 kg/ha, averaging 1,079.22 ± 317.97 kg/ha. On the health front, the rate of healthy, non-punctured bolls remained generally high (68.62–98.53%, average: 90.21 ± 7.36%). Conversely, the proportion of punctured bolls was low (0.12–9.59%, average: 1.68 ± 2.32%). Similarly, the incidence of non-punctured rotten bolls remained low, with an average of 1.45 ± 2.80%.

Table 2: Descriptive Statistics of Agronomic and Health Parameters of the GOUASSOU Fus 1 Variety in the Cotton Basin

Parameter	Minimum	Maximum	Mean ± Standard Deviation
Plant Density (plants/ha)	44045.68	95184.27	60503.70 ± 21268
Seed Cotton Yield (kg/ha)	667.12	1492.03	1079.22 ± 373.97
Rate of Healthy bolls (%)	68.62	98.39	90.21 ± 0.73
Rate of punctured bolls (%)	0.05	5.95	1.45 ± 8.56
Rate of bolls with Internal damage (%)	0.11	7.69	6.86 ± 2.28
Rate of non punctured rotten bolls (%)	0.00	9.92	1.45 ± 2.80

Effect of Geographical Position (North vs. South) on Boll Health and Seed Cotton Yield

Table 3 presents the average values of production and health parameters between the North and South regions, based on the non-parametric Wilcoxon test. The results highlight significant differences for several variables. Plant density was significantly higher in the North (65,046.9 plants/ha) compared to the South (53,136.83 plants/ha). Yield was higher in the South (1,126.71 kg/ha) compared to the North (1,049.86 kg/ha). No difference was observed in the rate of healthy bolls between the North and South. However, the rate of punctured bolls was higher in the North (1.53%) compared to the South (1.33%). The rate of bolls with internal damage was higher in the South (8.69%) than in the North (5.74%). No difference was observed between the two regions for the rate of non-punctured rotten bolls.

Table 3: Average values for production and health parameters during the 2021 to 2024 agricultural seasons

Parameters	North	South	W	P-value
Plant Density (plants/ha)	65046.9±22454.86 a	53136.83±16786.38 b	65893	0,0001
Seed Cotton Yield (kg/ha)	1049.86±342 b	1126.71±417.04 a	45131,5	0,01
Rate of Healthy bolls (%)	91.27±6.57 a	88.51±10.85 a	55666	0,05
Rate of punctured bolls (%)	1.53±2.16 a	1.33±2.49 b	55925,5	0,03
Rate of bolls with Internal damage (%)	5.74±5.1 b	8.69±9.23 a	44232	0,001
Rate of non puntured rotten bolls (%)	1.46±2.7 a	1.47±2.97 a	48172,5	0,1

Effect of Cultivation Zone on Boll Health and Seed Cotton Yield

The Kruskal-Wallis test results show significant variation in density, yield, rate of healthy bolls, and rates of punctured, internally damaged, and non-punctured rotten bolls according to the cultivation zone ($p < 0.001$; df = 29). The highest yield was observed in the Boron zone (1,492 kg/ha), associated with a lower density (47,728 plants/ha) and a healthy boll rate above 96%. Conversely, Zuénoula had the lowest yield (667 kg/ha), high density, and the lowest rate of healthy bolls (68.62%), coupled with high rates of punctured and rotten bolls. Other zones (Dianra, Kanoroba, Sarhala, Sinémentialy) stood out with healthy boll rates above 97%.

Table 4: Average values (± standard deviation) of characteristics related to production and health parameters of the Gouassou variety according to zone during the 2021 to 2024 agricultural seasons

Zone	Plant Density (plants/ha)	Seed Cotton Yield (kg/ha)	Rate of Healthy bolls (%)	Rate of punctured bolls (%)	Rate of bolls with Internal damage (%)	Rate of non puntured rotten bolls (%)
Boron	47728.12±2447.15ghi	1492.03±90.8a	96.07±0.78b	0.97±0.39hijk	2.61±0.68ijk	0.34±0.15ghijk
Bouandougou	52449.48±1944.42fgh	1206.54±65.85ab	80.44±1.59kl	1.63±0.28bcd	16.47±1.64ab	1.46±0.28ef
Dianra	54496.31±3403.1fg	964.12±75.52cde	97.13±0.38b	0.52±0.12fghij	0.83±0.19klm	1.52±0.19cde
Dianra village	66577.34±3598.88d	1166.12±60.97bc	89±2.28cd	3.48±1.17cdef	3.77±1.13klijhm	3.75±0.9bcd
Diawala1	73310.04±1556.55b	1012.26±42.98cde	91.99±0.32c	0.55±0.1ghij	6.96±0.26fg	0.5±0.12g
Ferké1	62435.21±2731.33de	926.67±49.6def	89.86±0.67def	4.21±0.4 a	2.91±0.38i	3.02±0.22ab
Goulia	72291.07±4213.69bcd	1094.34±63.34bcd	88.36±0.86fgh	1.68±0.22bc	7.12±0.63fg	2.83±0.37bcd
Kanoroba	45937.75±1659.65hi	1006.03±30.42cde	98.82±0.18a	0.47±0.11hijkl	0.47±0.1lm	0.24±0.08hijkl
Kaouara	95184.27±4126.39a	1156.3±88.7bcd	85.37±2.13fghi	2.24±0.65cde	12.38±1.71de	0±0l
Kasséré	72154.73±5136cd	1150.15±58.73bc	89.23±1ef	1.85±0.56fghi	6.26±0.72gh	2.66±0.59cbd
Korokara	75141.8±3197.99bc	918.96±41.69def	90.3±0.85cde	3.41±0.23a	5.46±0.21h	0.83±0.67d
Koumbala	64812.51±2531.18d	1111.46±67.56bc	87.63±1.16fgh	2.87±0.59b	5.13±0.82h	4.37±1.1de
Kounahiri	54994.75±2064.77ef	1003.13±55.17cde	84.31±0.67jk	2.39±0.5bc	10.72±0.94cd	2.58±0.32abc
Madinani	67186.21±3152.51cd	1251.65±89.77abc	89.19±1.24def	1.21±0.34efgh	6.65±0.85gh	2.94±0.54cde
Mankono	51699.37±4959.46gfh	809.78±107.91def	71.4±2.6l	1.92±0.4bc	25.87±2.34a	0.81±0.25fg
Marandala	55677.34±5601.37efg	1083.12±99.67bcd	77.67±4.27jkl	0.5±0.5lm	21.33±4.42ab	0.5±0.5hijkl
Morondo	4946.93±626.96j	1309.1±186.95abc	85.66±1.73ghij	0.22±0.14lm	12.34±1.61bcd	1.78±1.04fg
Niellé	84886.88±7194.06bcd	1103.96±70.95bcd	87.96±0.77fghi	0.12±0.07m	11.89±0.77bcd	0.03±0.02kl
Odienné	46630.71±2823.82ghi	791.47±82.19ef	86.45±0.64hij	1.46±0.25bc	7.69±0.3ef	4.39±0.49a
Sarhala	61209.66±1271.39de	1190.23±53.56ab	99.12±0.2a	0.05±0.04m	0.37±0.08lm	0.46±0.15ghij
Sinémentialy	51080.36±1556.21fgh	1001.43±20.53cde	99.39±0.12a	0.17±0.05lm	0.11±0.05m	0.33±0.09ghi
Sirasso	50615.62±3302.44fg	958.11±28.67def	96.77±0.27b	0.27±0.11ijklm	2.88±0.27i	0.08±0.05ijkl
Sordi	71973.21±5008.75bcd	944.71±111.72cdef	96.64±0.97b	2.2±0.61bc	1.16±0.46jklm	0±0l
Tehini	51991.53±3855.4fg	1085.21±96.8bcd	92.44±0.25c	1.58±0.2bc	5.99±0.15gh	0±0l
Tengréla	69829.16±4073.22bcd	1245±95.68ab	85.14±1.25ijk	0.31±0.14jklm	11.73±1.38bcd	2.81±0.5bcd
Tienko	46246.53±1331.9hi	918.28±108.2cde	95.02±1.82b	2.65±0.92defgh	2.17±0.93jkl	0.16±0.11ijkl
Tieningboué	61676.62±2190.63de	1019.17±96.42cde	83.59±1.27jk	1.23±0.18cde	13.94±1.07bc	1.23±0.23e
Tortiya	44045.68±1751.37i	1086±71.89bcd	96.74±0.32b	0.79±0.08cdefg	2.37±0.26ij	0.1±0.06jkl
Vavoua	51161.05±2006.2fgh	1172.91±87.28bc	89.02±0.88efg	0.28±0.13klm	10.11±0.78de	0.59±0.16gh
Zuénoula	65640.63±582.33bcd	667.12±53.72f	68.62±3.17l	5.95±1.08a	15.51±1.31ab	9.92±3.33abcd
ddl	29	29	29	29	29	29
P	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Kruskal-Walllis	305.26	94.79	451.81	282.48	471.45	320.07

Effect of Cultivation Type on Boll Health and Seed Cotton Yield

The Kruskal-Wallis test results (Table 5a) showed that only yield and the rate of punctured bolls were significantly influenced by the cultivation type ($p < 0.001$ for yield and $p = 0.01$ for punctured bolls). The average yield with animal draft cultivation was estimated at 1,192.61 kg/ha with a density of 61,228 plants/ha, while manual cultivation yielded 884 kg/ha with a density of 59,258.62 plants/ha. The rate of punctured bolls was higher in mechanized cultivation (1.57%) compared to manual cultivation (1.26%).

Effect of Previous Crop on Boll Health and Seed Cotton Yield

The results show that the previous crop significantly affected all studied agronomic parameters ($p < 0.05$). Plots with peanuts as the previous crop had the highest densities (68,025.84 ± 4,701.28 plants/ha) and the highest yield (1,144.32 ± 76.1 kg/ha). The rate of healthy bolls ranged from 89.6% (no previous crop) to 92.51% (rice). The lowest rate of punctured bolls was observed with rice as the previous crop (0.92 ± 0.22%), while maize recorded the highest (1.78 ± 0.16%). Bolls with internal damage ranged from 5.73 ± 1.01% (rice) to

7.28 ± 0.5% (cotton). Finally, the frequency of non-punctured rotten bolls was lowest with rice (0.84 ± 0.2%) and highest with peanuts (2.11 ± 0.43%).

Table 5: Average values (± standard deviation) of production and health parameters for the Gouassou variety according to crop type during the 2021 to 2024 agricultural Campaigns

Type of crops	Plant Density (plants/ha)	Seed Cotton Yield (kg/ha)	Rate of Healthy bolls (%)	Rate of punctured bolls (%)	Rate of bolls with Internal damage (%)	Rate of non 1578uncture d rotten bolls (%)
Harnessed	61213.19±995.32[a]	1192.82±16.98[a]	90.08±0.42[a]	1.57±0.11[a]	6.95±0.36[a]	1.39±0.14[a]
Manual	59258.62±1476.68[a]	884.17±21.65[b]	90.47±0.55[a]	1.26±0.16[b]	6.7±0.44[a]	1.57±0.18[a]
ddl	1	1	1	1	1	1
P	0.20	<.0001	0.47	0.01	0.97	0.35
Kruskal-Wallis	1,62	125,74	0,46	6,47	0,001	0,96

Table 6: Average values for production and health parameters for the Gouassou variety based on previous crops during the 2021 to 2024 agricultural seasons

Previous crop	Plant Density (plants/ha)	Seed Cotton Yield (kg/ha)	Rate of Healthy bolls (%)	Rate of punctured bolls (%)	Rate of bolls with Internal damage (%)	Rate of non puntured rotten bolls (%)
Peanuts	68025.84±4701.28[a]	1144.32±76.1[a]	89.86±1[b]	0.96±0.26[bc]	7.07±0.95[a]	2.11±0.43[a]
Cotton	56729.91±1136.02[b]	1132.4±24.24[ab]	89.94±0.58[b]	1.25±0.13[b]	7.28±0.5[a]	1.52±0.18[bc]
Corn	67236.17±1548.65[a]	1053.67±21.7[b]	90.08±0.51[b]	1.78±0.16[a]	6.72±0.41[a]	1.41±0.19[cd]
None	54183.36±1987.49[b]	911.27±40.92[c]	89.6±1.11[b]	1.82±0.32[ab]	6.86±0.75[a]	1.72±0.38[ab]
Rice	53615.65±2090.21[b]	1116.05±50.94[ab]	92.51±1.09[a]	0.92±0.22[c]	5.73±1.01[b]	0.84±0.2[d]
ddl	4	4	4	4	4	4
P	<.0001	0.0003	0.01	0.006	0.02	0.001
Kruskal-Wallis	34.52	20.77	12.15	14.26	10.71	17.62

DISCUSSION

This study highlighted the variability of production parameters for the Gouassou variety depending on the growing area, cultivation method, and previous crop in the Ivorian cotton-growing region. These results underscore the importance of agroecological factors in cotton crop performance, confirming the hypothesis that the adaptability of varieties to the local context is a key factor in yield.

Analysis of the results highlights a significant influence of the growing area on the yield, density, and health parameters of the Gouassou variety. Areas with excessively high densities recorded the lowest yields and increased rates of capsules with holes and rot. These results show that excessively high densities promote intraspecific competition, reduce light exposure at the fruiting site, and increase humidity, which contributes to capsule rot. This also creates a microclimate conducive to pest development. Yields also varied significantly from one area to another, suggesting that environmental and agronomic factors specific to each environment play a role. Part of these differences could be explained by cropping history, as the results show that previous crops directly influence yield. Some previous crops may have depleted the soil of nutrients essential to cotton, thereby reducing its productivity, while others, such as peanuts, contribute to soil enrichment through biological nitrogen fixation, thereby improving fertility and nutrient availability (N'Goran Kouadio *et al.*, 2021). Furthermore, the variability of climatic conditions between regions is another determining factor, as differences in rainfall, temperature, and water regimes can influence both cotton growth and yield potential (Dekoula *et al.*, 2018).

The yield gaps observed between the southern and northern zones of the cotton basin could be explained by a more regular and quantitatively higher rainfall in the southern zones, compared to the more limited rainfall conditions that characterize the northern basin (Koné *et al.*, 2017; Kouadio *et al.*, 2024).

In animal-drawn cultivation, the high yield highlights the structuring effect of mechanization on planting uniformity, rational use of cultivated space, and increased cotton productivity. This aligns with the observations of Sinan et al. (2020), who note that mechanized tillage systems, whether animal-drawn or motorized, achieve significantly higher yields than manual methods, primarily due to consistent seedbed preparation and reduced soil compaction. Furthermore, Abdellaoui *et al.*, (2010) emphasize that mechanization promotes deep and uniform soil loosening, improves water infiltration and retention, optimizes nutrient uptake, and reduces the labor intensity of operations, contributing to the sustainable intensification of cotton systems and the spatial stability of farms.

Regarding the effect of the previous crop, the high seed cotton yield observed after peanuts, compared to other previous crops, underscores the importance of this legume in cotton production systems (N'Goran *et al.*, 2011). Peanuts enhance soil nitrogen availability through symbiotic fixation, promoting the growth of subsequent crops and contributing to yield increases (Kouakou *et al.*, 2020). Similarly, Kouakou *et al*. (2021) report that a peanut previous crop can increase seed cotton yield by 19.67%. Moreover, N'Goran Kouadio *et al*. (2021) highlight that combining a peanut previous crop with even partial mineral fertilization significantly improves cotton biomass and boll numbers, leading to yield gains ranging from 3 to 58%.

Plots with peanuts and rice as previous crops had higher proportions of healthy pods, indicating good resilience to pests. This could be attributed to the positive effects of legume and cereal residues left on the soil, which help reduce pest and disease pressure (Koné *et al.*, 2009; Badou *et al.*, 2013). Conversely, the absence of crops (fallow land) and cotton as a previous crop showed higher rates of pods with holes and pods with internal damage, suggesting greater vulnerability to attacks. Indeed, cotton as a previous crop may have left residues that favor the development of certain pests specific to each region.

Regarding the rate of non-punctured rotten bolls, rice as a previous crop recorded the lowest value, while peanuts and no previous crop showed higher rates. This could be explained by better aeration and moisture management in plots previously cultivated with rice, a crop adapted to wet but drained soils, which limits the spread of fungal pathogens responsible for boll rot (Hou *et al.*, 2018). Thus, the differences observed among previous crops may be linked, on one hand, to the nature of crop residues, which influence soil fertility and pest dynamics, and on the other hand, to management practices (rotation, integrated pest management) that optimize yield expression and the health quality of harvested bolls.

CONCLUSION

This study shows that the variability in agronomic and health performance of the Gouassou variety in the Ivorian cotton-growing region is the result of complex interactions between the growing zone, cultivation methods, and crop rotation. The results highlight the importance of adapting varieties and agronomic practices to the local agroecological context in order to optimize yields and crop quality. The integration of legumes, such as peanuts, into crop rotation appears to be particularly beneficial for soil fertility and crop resilience, through nitrogen restoration and improved health parameters. In addition, mechanization, particularly in the form of trailed cultivation, promotes uniform planting and efficient use of space, thereby contributing to sustainable intensification and a significant increase in productivity. Finally, analysis of previous crops and health statistics highlights the need for rational management of crop rotations and phytosanitary monitoring to limit losses due to pests and diseases. These findings support the shift cotton systems towards innovative, integrated, and ecologically adapted practices, ensuring sustained and sustainable production in the face of contemporary climatic and economic challenges.

Conflict of Interest

The authors declare that they have no conflict of interest with respect to this article.

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