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Morphological and Physical Characterization of Soils for Cotton Suitability Assessment in the Mankono District (Central-West Côte d'Ivoire)

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Authors' contributions

This work was carried out in collaboration among all authors. Author NBJC designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author OBM managed the mapping and contributed to the improvement of the manuscript. Author NKE contributed to the improvement of the manuscript. Author YGF supervised the work. Authors ATJEA, KKC, KBJ and KM contributed to the improvement of the manuscript. All authors read and approved the final manuscript.

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Abstract

Background and Aims: In Côte d'Ivoire, cotton farming plays a vital role in the livelihoods of local communities in the savanna region. However, it faces several challenges, including declining soil fertility caused by land-use pressure and climate variability, which limit yields and farmers' incomes. Sustainable soil management therefore requires the adoption of resilient agricultural practices. To achieve this, knowledge of soil properties is necessary to align soil use more effectively with crop requirements. In this context, the overall objective of this study was to update morpho-physical data in order to map the agricultural suitability of soils in the Mankono district. The study was intended, first, to provide a key tool for optimising land use and improving seed cotton yields by aligning the requirements of the cotton plant with the current characteristics of the soil. Second, through crop suitability mapping, it informs stakeholders about areas that remain suitable for cotton cultivation.
Place and Duration of Study: The study lasted two months and was conducted in the Mankono square degree in the Central-Western region of Côte d'Ivoire.
Methodology: To achieve the objective of this study, a soil survey combining toposequence and soil landscape methods was conducted, soil samples were collected, and cartographic and statistical analyses were performed.
Results: The results show that the soils in the Mankono district have sandy-clay to sandy-clay-loam textures. The soils are generally gravelly, with fairly variable depths (33 to 120 cm), but are suitable for cotton cultivation. The depth at which internal drainage problems occur is generally favourable (≥ 30 cm). Thus, 96.08% of the soils are suitable for cotton cultivation.
Conclusion: The morphological and pedological characteristics of the soils have been updated. These parameters indicate that the soils in the Mankono district remain suitable for cotton cultivation; however, over the long term, these soils may become susceptible to erosion and crusting. Regarding agricultural suitability, 96.08% of the soils are suitable for cotton cultivation, with a good agricultural suitability rating. Nevertheless, chemical analyses are necessary to optimise fertilisation and improve yields.

Keywords: Cotton suitability; soil morphology; morpho-physical characterisation; soil depth; coarse fragments; internal drainage; soil texture; toposequence; pedolandscape; Mankono district; Côte d'Ivoire.

1. Introduction

Cotton cultivation is the economic backbone and the driving force behind rural development in the savanna regions of West and Central Africa (WCA) (Soumaré et al., 2020). In Côte d'Ivoire, it is the driving force behind socio-economic development in the northern and central regions. It employs more than 150,000 producers and improves the living conditions of nearly 3.5 million people (Paul-Alfred, 2018). However, yields are declining. National production over the last twenty years has fluctuated between 1,000 and 1,200 kg/ha, with an average yield of 1.2 t/ha (Intercoton, 2021; APROCOT-CI, 2021), whereas in the past, yields reached up to 1.4 t/ha (Kouakou et al., 2021). Indeed, soils are subject to a continuous decline in fertility (Ettien et al., 2022). One of the main causes of this decline is demographic growth, which increases land pressure and, consequently, the demand for land. As a result, arable land is shrinking, while human needs (energy, food, services, etc.) are increasing. Thus, in the hope of increasing yields, farmers are forced to make the most of the available land. This has led to the disappearance of long-term fallow periods, the overexploitation of land, and poor farming practices, compounded by climate variability and pest pressure, all of which contribute to soil acidification and declining yields. This is the case for soils in Côte d'Ivoire's cotton-growing region, which are steadily becoming depleted, degraded, and losing their natural fertility. In recent years, several studies have been conducted in the Ivorian cotton-growing region with the aim of addressing these issues. Kouadio et al. (2018) conducted studies on soil fertility in the cotton-growing region. These studies focused on the chemical characteristics of the soils, and particle size analysis of the topsoil was performed. A more recent study conducted by Koné et al. (2022) in the Ivorian cotton-growing region provided information on soil fertility levels, but no morpho-pedological studies were conducted. Although this research revealed nutrient deficiencies in cotton-growing soils, it did not provide information on the morpho-physical condition of these soils in relation to the requirements of the cotton plant. However, following fertility assessments, the lack of precise mapping of soil physical and chemical properties may limit the implementation of soil amendment recommendations. It is therefore important to update the morphological and physical data of soils in the cotton-growing region in order to assess their suitability for cultivation and to identify areas that remain suitable for cotton farming. This approach will help cotton producers and decision-makers maximise yields by adopting sustainable soil management practices. In addition, the results of such a study will make it possible to better align the specific needs of the crop with actual soil characteristics, optimise soil use, and take natural constraints into account in order to guide agricultural decisions more effectively. Consequently, a gap remains in spatially explicit morpho-physical information needed to evaluate current cotton suitability in the Mankono district. The purpose of this study is therefore to characterise the morpho-physical properties of the soils in the Mankono district in order to map their suitability for cotton cultivation using a combined toposequence-pedolandscape approach.

2. Material and Methods

2.1 Study Area

The study was conducted in the square degree (SD) of Mankono, which covers an area of 12,100 km² and is located in the Central-West of Côte d'Ivoire. It is bounded by the 7th and 8th degrees of north latitude and the 6th and 7th degrees of west longitude (Fig. 1). The flora of this zone is dominated by savanna vegetation (Koné, 2012). Ferralsols, Lixisols, and Gleysols are found on granitic and schistose formations (Guibert, 2015). The climate is Sudanian, characterised by two seasons: a rainy season from March to October and a dry season from November to February. The average annual rainfall is 1331.81 mm. The average annual temperature is 25.80 °C.

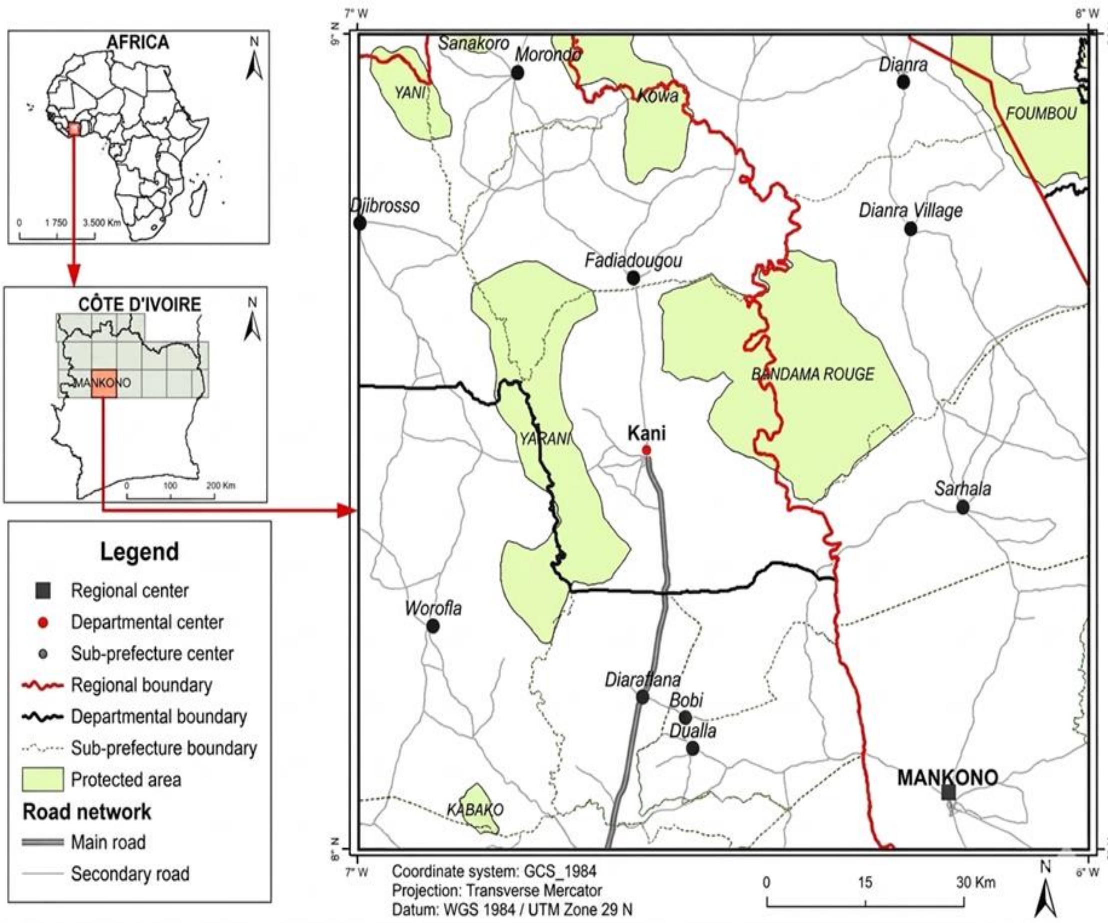

Fig. 1. Map showing the study area

2.2 Study Data

The data used in this study were those used to create the pedolandscape maps. These include maps of slope, topography, land cover, and geology for the study area. Landsat satellite images (scenes: 195-55, 195-56, 196-55, 196-56, 197-55, 197-56, 197-57, 198-55, 198-56, 198-57) were used to map land cover, and SRTM (Shuttle

Radar Topography Mission) satellite images were used to map the topography, slopes, and geology of the study area.

2.3 Morpho-physical Characterization of Soils

Major morpho-physical soil data were collected in the field by combining toposequence and pedolandscape methods (Rossiter & Poggio, 2025; Alves et al., 2024). The pedolandscape map was produced using Geographic Information Systems (GIS) combined with base map data, namely slope, geology, relief, and land cover maps (Fig. 2). Nine (9) toposequences were established across it to intersect as many cartographic units as possible in order to form a representative grid at the square degree scale. Observation points were systematically positioned at 500-metre intervals and georeferenced. Once prepared, the soil survey maps were printed, and all related GPX (GPS eXchange format) data were imported into GPS (Global Positioning System) units for tracking during field soil surveys (Fig. 3).

In the field, using these GPS units, paths were cleared with machetes along the different toposequences. Observation points were identified and marked with stakes, and soil pits were excavated at these points. In total, 531 observation points were described across 9 toposequences, representing an average density of about 1 profile per 23 km². The viewing face of each profile was oriented in the east-west direction to ensure better lighting for description. These pits had a depth of 1 m, unless natural obstacles prevented this, with a length of 1 m and a width of 0.90 m. Soil profiles were described according to the ORSTOM soil glossary (Van den Driessche, 1969), considering general location data (date, location, profile code, and geographical coordinates). Data regarding the physical environment of the pit (general shape of the relief, topographic position, and land cover type) and the horizons to be described (depth, moisture, organic matter, general structure/cohesion, texture, coarse fragments, general porosity, rooting, drainage class, and transition) were collected.

The coarse fragment content was determined for samples taken from each profile at the Central Soil, Water, and Plant Laboratory of the National Center for Agronomic Research (NCAR). After air-drying in trays, the samples were weighed and crushed to detach the coarse fragments from the soil clumps. Sieving was performed with a 2 mm square-mesh sieve column. The material retained on the sieve, which constitutes the coarse fragments, was weighed. The ratio of the weight of the sieve residue to the weight before sieving indicates the coarse fragment rate, expressed as a percentage (Equation 1).

$$\text{Coarse fragment content (\%)} = \frac{\text{Mass of sieve residue}}{\text{Mass of air−dried soil simple}} \text{x } 100 \qquad \text{(Eq. 1)}$$

2.4 Determination of Soil Suitability for Cotton Cultivation

Based on the requirements of cotton cultivation, five parameters were selected in order of priority for the optimal development of the cotton plant. These parameters are soil depth, coarse fragment content, depth of appearance of coarse fragments, texture, and drainage. These parameters were codified according to the evaluation classes developed by the research team of the NCAR (Table 1). Each profile therefore received a five-digit code corresponding to the five parameters. The assignment of agricultural suitability levels was based on the cultivation suitability classes developed by Boyer (1971). A five-level agricultural suitability scale was chosen (1: very good suitability, 2: good suitability, 3: fairly good suitability, 4: passable suitability, and 5: poor suitability). The very good class is assigned when there is no limiting factor. The good class is assigned when there is a single minor limiting factor. The fairly good class is assigned when there are two (2) minor limiting factors or one (1) major limiting factor, or when there is one (1) major limiting factor and one (1) minor limiting factor. The passable class is assigned for two (2) major limiting factors (excluding depth). The poor class is assigned for more than two (2) major limiting factors. For the cotton plant, soil depth is considered the primary major limiting factor, and the depth at which coarse fragments appear is considered the second. When the coarse fragment rate carries the number 2, which corresponds to an unfavourable rate (≥ 30%), it becomes a major limiting factor if it appears at an unfavourable depth (< 20 cm). This codification resulted in a matrix showing the different possibilities of five-digit combinations, the codes assigned according to the scale, and the corresponding suitability classes (Table 2). The cartographic restitution of the results was essentially based on the implementation of GIS between the various previously spatialised information layers (Fig. 4). It consisted of converting the Excel matrix obtained after codification into a CSV and then an SHP file. Then, a Spline with

Barriers interpolation was performed for each parameter (depth, coarse fragment content, depth of appearance of coarse fragments, texture, and internal drainage) to respect the boundaries of the pedolandscapes.

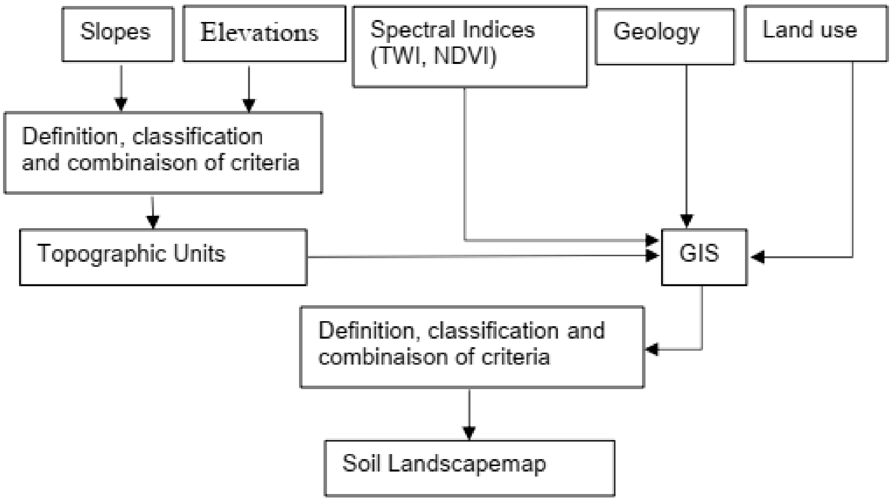

Fig. 2. Processing chain for the development of the soil landscape map

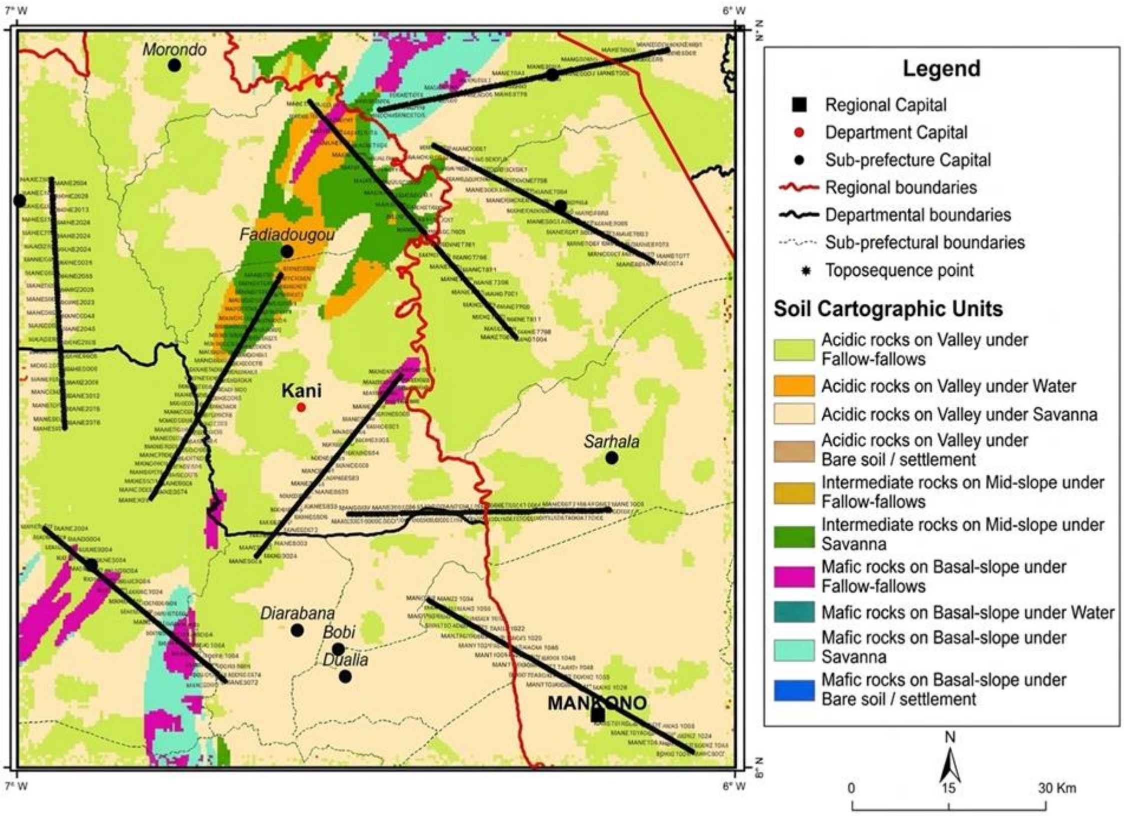

Fig. 3. Location of toposequences and observation points in the soil landscapes of the Mankono square degree

The codification data for these parameters allowed the production of suitability sub-maps or thematic maps. The resulting thematic maps were overlaid to obtain the comprehensive suitability map, which corresponds to the agricultural suitability map. For this purpose, the weighted overlay method was used.

Table 1. Assessment of morphological and physical characteristics in accordance with cotton-growing requirements

Physical parameters	Critères d'appréciation	Modalités et classes d'appréciation pour le coton		
		God : 1	**average : 2**	**Bad : 3**
Effective soil depth (cm)	Limitation par une roche, cuirasse ou autre	≥40	[20-40]	<20
Coarse soil particles (CP)		**God :1**		**Bad : 2**
	Coarse Particule percentage (%)	<30		≥30
	Depth at which CP appears (cm)	≥20		<20
Texture	Sandy (S) Clayey (C) Silty (S)	A texture other than light or heavy		Light or heavy texture
Internal drainage	Depth at which signs of hydromorphism appear (cm)	≥30		<30

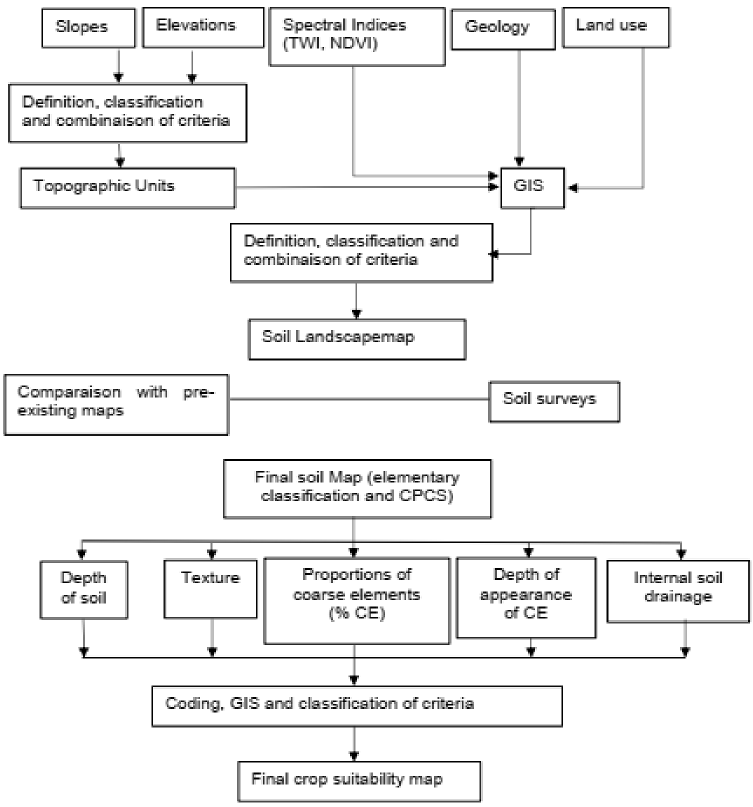

Fig. 4. Processing chain for the development of the crop suitability map

Table 2. Agricultural skills classes in the Mankono square degree

Five-digit combination	Codes	Crop-specific classes
11111	1	Very good
12111	2	Good
11221	3	Fairly good
11121	3	Fairly good
12112	3	Fairly good
12211	4	Passable
12212	4	Passable
22211	5	Poor

2.5 Data Processing and Analysis

The data were entered and coded using Excel. The entire dataset was subjected to descriptive statistical analyses to summarise it into key statistics (mean, median, standard deviation, etc.) for easier visualisation in tables. ArcGIS software was used for mapping.

3. Results and Discussion

3.1 Results

3.1.1 Morpho-physical Characteristics of Soils

3.1.1.1 Soil Depth

Table 3 presents soil depths in the departments of the Mankono square degree. The effective depth of soils in the Mankono square degree is generally good to very good for cotton cultivation. Departmental averages vary from 85.25 cm in Kani to 97.80 cm in Mankono, with a zonal average of approximately 90 cm, placing the entire area in the "Good (1)" class according to the cotton evaluation criteria (≥ 40 cm). Percentile analysis confirms this favourable trend: P25 values (72 to 82 cm) indicate that even the shallowest quarter of the soils remains acceptable, while medians (P50) reach or exceed 88 to 100 cm, and P75 values reach 100 to 120 cm. Only a few isolated points, mainly in Dianra (minimum 33 cm), show a depth below 40 cm.

Standard deviations, ranging from 16.22 to 20.29 cm, reflect moderate to high variability depending on the department, particularly in Mankono, highlighting spatial heterogeneity that should be considered in crop management.

Table 3. Soil depth in the departments of the Mankono square degree

Departments	Headcount	Min (cm)	P25	P50	P75	Max (cm)	Moy (cm)	Stand dev
Kani	177	40	72	88	100	100	85,25	16,47
Seguela	147	40	82	100	100	120	92,85	17,731
Dianra	63	33	77	90	100	100	86,03	16,22
Mankono	144	66	78	100	120	120	97,80	20,29

Minimum: min
Maximum: max
Stand deviation: stand dev

3.1.1.2 Coarse Fragment Content

The coarse fragment content of the soils in the Mankono square degree is generally moderate to high, with a zonal average of about 36%. According to the evaluation criteria for cotton, three out of four departments (Seguela, Dianra, and Mankono) present averages above the 30% threshold, classifying them in the "Poor" category. The Dianra department is the most unfavourable, with an average of 53.45% and a median of 48.05%, indicating that the majority of soils there are heavily loaded with stones and gravel. Kani is the exception, with an average of 24.55%, remaining in the "Good" class. Percentile analysis reveals that P25 ranges from 2.63% to 45.33% and that P75 often exceeds 60%, while standard deviations (16 to 36%) reflect strong spatial variability, particularly in Mankono (Table 4).

Table 4. Coarse-textured material content of soils in the square-degree departments of Mankono

Departments	Head count	Min (%)	P25	P50	P75	Max (%)	Moy (%)	Stand dev
Kani	177	0,45	6,12	10,60	46,87	65	24,55	21,58
Seguela	147	0,25	5,37	36,69	61	93,33	34,05	27,63
Dianra	63	29,06	45,33	48,05	62,22	85,41	53,45	15,51
Mankono	144	0,32	2,63	34,48	74,02	93,33	39,39	35,71

Minimum: min
Maximum: max
Stand deviation: stand dev

3.1.1.3 Depth of Appearance of Coarse Fragments

The depth of appearance of coarse fragments in the soils of the Mankono square degree indicates an overall moderate situation, with a zonal average of about 48 cm. According to the evaluation criteria for cotton, departmental averages all remain above the 20 cm threshold (Good class). However, percentile analysis qualifies this finding: P25 values vary from 16 cm in Mankono to 23 cm in Dianra, indicating that 25% of the soils, particularly in the Mankono and Dianra departments, exhibit coarse fragments at depths below 20 cm or at very shallow depths. Medians (P50) range from 33 cm (Mankono) to 69 cm (Kani), while P75 values reach 40 to 73 cm. Standard deviations, ranging from 15.89 to 22.86 cm, reveal moderate to high variability across departments (Table 5).

Table 5. Depth at which coarse particles appear in the soils of the departments within the Mankono square degree

Departments	Head count	Min (cm)	P25	P50	P75	Max (cm)	Moy (cm)	Stand dev
Kani	177	18	40	69	73	88	58,89	20,34
Seguela	147	9	47	68	70	79	60,40	15,89
Dianra	63	10	23	51	67	74	44,03	22,86
Mankono	144	9	16	33	40	83	32,23	18,72

Minimum: min
Maximum: max
Stand deviation: stand dev

3.1.1.4 Soil Texture

The soil texture of the Mankono square degree is generally highly favourable for cotton cultivation. The dominant textures (sandy-clay, sandy-clay-loam, and clay-sandy) are balanced and correspond to the "Good" class according to the evaluation criteria. Of the 531 points observed, 512 soils (96.4%) are suitable, while only 19 soils (3.6%) are unsuitable. The departments of Seguela and Dianra present 100% favourable soil textures. Kani shows an excellent suitability rate (96.6%), while Mankono records a slightly higher rate of unsuitable soils (9%) (Table 6).

Table 6. Soil texture in the departments of the Mankono square degree

Departments	Headcount	Texture type	Recommended textures	Soil types suitable	Number of Unsuitable Soils
Kani	177	Sandy-clay	Other than light /	171	6
Seguela	147	Sandy-clay-loamy	coarse	147	0
Dianra	63	Clay-sand soil		63	0
Mankono	144	Sandy-clay		131	13

3.1.1.5 Internal Drainage

The majority of the studied soils showed good internal drainage. Percentile analysis reveals that P25, P50, and P75 are all equal to 0 cm in the four departments, indicating that more than 75% of the observed profiles do not show signs of hydromorphy. Internal drainage problems do not affect the cotton plant when they occur at depths greater than 30 cm. Soils that presented drainage issues showed signs of hydromorphy at maximum depths of 76 cm in Kani, 37 cm in Seguela, and 67 cm in Dianra. Departmental averages vary from 1.24 cm in Seguela to 5.35 cm in Dianra, with maximum values not exceeding 76 cm. This situation reflects susceptibility to temporary waterlogging at depth during the rainy period for some soils in these areas. In the Seguela department, some soils should be monitored because a maximum depth of hydromorphy-sign appearance at 37 cm can limit soil aeration. Mankono soils showed no signs of hydromorphy (Table 7).

Table 7. Depth at which hydromorphism occurs in soils in the departments of the Mankono square district

Departments	Headcount	Min (cm)	P25	P50	P75	Max (cm)	Moy (cm)	Stand dev
Kani	177	0	0	0	0	76	3,26	13,43
Seguela	147	0	0	0	0	37	1,24	6,621
Dianra	63	0	0	0	0	67	5,35	15,69
Mankono	144	0	0	0	0	-	-	-

Minimum: min
Maximum: max
Stand deviation: stand dev

3.1.2 Proportion and Spatial Representation of Agricultural Suitability of Soils

Cartographic processing of survey data allowed the spatial distribution of morpho-pedological parameters to be presented on maps. These treatments identified zones and areas favourable for cotton cultivation.

In terms of proportions, the soils of the Mankono SD are 96.08% favourable for cotton cultivation. The good suitability class is predominantly represented over 6030.27 km² of the total area, or 49.61%. The very good suitability class follows the previous class, with a proportion of 32.33% over an area of 3929.42 km². The fairly good suitability class represents 14.14% over an area of 1719.04 km². The lowest class in terms of proportion is the passable class, represented over 475.27 km² out of a total area of 12,154 km², or 3.91% (Table 8).

Table 8. Areas and relative proportions of soil suitability classes for cotton in the Mankono square district

Classes	Lands aeria (km^2)	Proportions (%)
Very good	3929,42	32,33
Good	6030,27	49,61
Fairly good	1719,04	14,14
passable	475,27	3,91
Total	12154	100

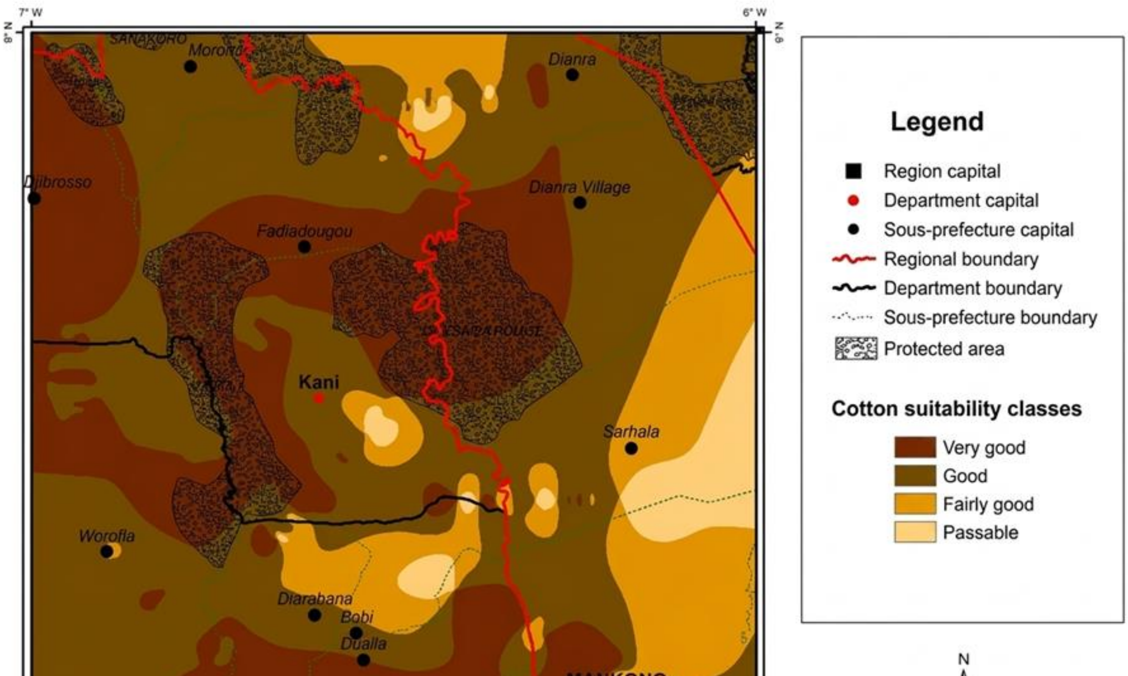

Fig. 5. Spatial Representation of Soil Suitability for Cultivation in the Mankono Degree Square

The spatial map shows that the soils in the Mankono SD have four (4) classes of agricultural suitability. Very good agricultural suitability classes are located in the centre in the sub-prefecture of Fadiadougou, in the north-west at Djibrosso, and in the south in the sub-prefecture of Dualla. Good agricultural suitability classes are distributed in the north in the sub-prefectures of Dianra, Morondo, and Dianra village, in the centre at Kani, and in the south at Worofla and Diarabana. The fairly good and passable agricultural suitability classes are distributed in the eastern part of the SD at Sarhala, in the south at Mankono, and partly in the centre and the north. The poor class is very low in proportion and occupies a very small area; therefore, it does not appear at the spatialisation scale (Fig. 5).

3.2 Discussion

The results show that the soils generally had depths adequate for cotton cultivation. The observed soil depths are mostly greater than 40 cm. In fact, most of the root biomass and the nutritional activity of the cotton plant's taproot are concentrated in the 40-60 cm depth range of the soil (Meshram et al., 2021; Guo et al., 2023). According to the FAO (2014a), the cotton plant prefers deep soils where its taproot can penetrate deeply to ensure not only the stability of its above-ground parts but also its water supply in the event of prolonged drought. The depth ranges observed in this study (30 to 120 cm) may be due to intense geochemical weathering processes occurring in a transitional tropical climate characterised by alternating dry and wet seasons in this area of the Ivorian savanna. Brou (2005) and Kassin et al. (2012) confirm the adequate soil depth based on these bioclimatic parameters and the degree of rock weathering. These results corroborate those of Alves et al. (2024), who showed that soils in the study area are predominantly more than 40 cm deep. Furthermore, in their study conducted in the Ivorian cotton-growing region, Koné et al. (2022) confirm our findings by showing that the soils in Mankono have sufficient depth to support cotton cultivation.

With regard to coarse particles, the results show that the soils studied are fairly gravelly, with the majority having a coarse particle content exceeding 30%, the threshold level for cotton cultivation. The high levels of coarse particles in these areas could be explained by the weathering of the bedrock, which releases iron and aluminium oxides that aggregate into gravel. This abundance of coarse particles reduces the volume of fine soil, decreases water and nutrient retention capacity, and can limit cotton yield potential. However, the presence of coarse particles constitutes a constraint on crop growth only when combined with the occurrence of gravelly soil layers considered unfavourable for these plants (FAO, 1998). In cotton cultivation, coarse particles pose a problem when they occur at depths of less than 20 cm (Ezan et al., 1998; Walke et al., 2012). In the Seguela and Kani departments, coarse particles appear at depths greater than 20 cm, which does not pose a problem for cotton plants. In contrast, in Mankono and Dianra, 25% of the soils contained coarse particles at shallow depths (16 and 23 cm). Koné et al. (2022) confirm these findings, noting in their research the frequent presence of coarse particles in the surface soil layers of these areas of the Ivorian cotton-growing region. This relatively shallow occurrence of coarse particles in a significant portion of the soils reduces the volume of fine soil available to cotton roots, limits water and nutrient reserves, and may increase the risk of water stress. Particular attention should be paid to areas where coarse particles appear at shallow depths, particularly in Mankono and Dianra.

Most of the soils had sandy-clay and sandy-clay-silt textures. According to the FAO (2014b), cotton plants prefer soils that are not too heavy, such as sandy-clay or sandy-loam types. Consequently, the soils studied have the appropriate texture for cotton cultivation. The predominantly sandy texture in these areas could be explained by the soil type (ferric lixisols), which is characterised by a low clay content at the surface in this region. Our results are consistent with those of Kouadio et al. (2018), who show in their study that soils in the Ivorian cotton-growing region have a predominantly sandy texture in the surface horizons. This predominance of well-balanced textures promotes good aeration, adequate water and nutrient retention, and optimal cotton root development. The few areas of unsuitable soil, located mainly in Mankono and Kani, do not pose a major constraint for the region as a whole, but may require specific management measures (application of organic matter and selection of suitable varieties).

In terms of internal drainage, the soils did not exhibit any problems with poor drainage. When signs of waterlogging, whether permanent or temporary, appeared, they occurred at depths greater than 30 cm, which is favourable for cotton plants, as they grow best in light-textured, well-drained soils. This could be explained by the predominance of sand in the upper soil layers, which is characteristic of a light texture and good aeration. Since water does not pool, drainage will consequently be rapid. Our results corroborate those of N'Guessan et al. (2015) and Kouadio et al. (2018), who confirm that the soils of the cotton-growing region of Côte d'Ivoire have light surface textures, ensuring the absence of constraints related to poor internal drainage, which is favourable for cotton cultivation.

In terms of agricultural suitability, 96.08% of the soils studied are still suitable for cotton cultivation and fall into the "good agricultural suitability" class. Of a total area of 12154 km², this class covers 11678.73 km².

Although this study provides important information on the morphological and physical characteristics of the soil and its suitability for cotton cultivation in the Mankono district, certain limitations must be acknowledged. First, the assessment was based primarily on the morphological and physical properties of the soil. To better optimise fertilisation and improve production, future research should incorporate soil chemical parameters. Furthermore, this could provide a more comprehensive assessment of soil fertility. Second, the suitability of soils for cotton cultivation was analysed under current environmental conditions; however, future research should incorporate climate-change projection models to anticipate long-term changes in precipitation and temperature patterns that could affect cotton yields.

4. Conclusion

Although chemical characteristics are also taken into account when assessing soil suitability for cultivation, in this study, the assessment of soil suitability for cotton cultivation was based on morpho-physical properties (depth, texture, percentage of coarse particles, depth at which coarse particles appear, and internal drainage) because, first and foremost, these are stable characteristics that determine soil structure. Second, physical constraints are the most limiting and persistent factors affecting the root system of the cotton plant. In contrast, chemical parameters can be rapidly modified through the application of fertilisers. As a result, this research can guide immediate agricultural planning and sustainable land management in the Mankono district with the aim of optimising yields. This study on the morpho-physical characterisation and evaluation of the suitability of soils in the Mankono district for cotton cultivation has thus provided insight into the current morpho-physical condition of the soils and their suitability for cotton cultivation. The results showed that the soils of the Mankono square degree have a texture that is neither light nor heavy, which is favourable for cotton cultivation. The soils had sufficient depth for cotton roots and good internal drainage. Only the content of coarse particles exceeded the threshold level required for proper crop development. However, the depths at which these coarse particles occur do not pose a constraint for cotton. The physical and morphological characteristics of soils in the study area remain favourable for cotton cultivation. While these characteristics give the area a good agricultural suitability rating, the surface texture and the presence of gravel in the soil can increase susceptibility to erosion and crusting, which may reduce long-term productivity. To optimise soil use, organic matter should be added to the soil. As it decomposes, it will produce humus, which helps stabilise soil structure and prevent erosion. Crop residues or cover crops should be used to maintain soil moisture and prevent crusting. Looking ahead, it will be important to incorporate chemical parameters into future research to determine the soil's ability to supply nutrients to the plant, optimise fertilisation, and improve yields, as the cotton plant is a nutrient-demanding crop.

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Declaration of AI Use

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Competing Interests

Authors have declared that no competing interests exist.

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