POLICY BRIEF

Soil fertility decline: danger for food security

A new study shows of the evolution of soil fertility in the cotton basin of Côte d'Ivoire

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Combating Climate Change. Improving Livelihoods

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Soil fertility management issues are at the centre of debates on the sustainability of agricultural production systems in Africa, particularly in West Africa where farmers are concerned with decline of soil fertility[1]. This decline of soil fertility markedly accounts for the low agricultural productivity and this is perceived to be widespread in the highland soils of the tropics, particularly in west Africa[2].

Figure 1: Soil status

One of the reasons for this low productivity is the extraction of nutrients by continuous cropping with low external nutrient supply, resulting in declining soil fertility[3]. Soil fertility is a function of many soil properties, many of which are interrelated.

However, in most cases, the term 'soil fertility' describes the current state of the soil, which means that soil fertility is a combination of the current soil quality (chemical & physical composition).

Soil fertility decline includes nutrient depletion (more nutrients removed than added), nutrient mining (high nutrient removal and no nutrient addition), acidification (lowering of pH)[4], loss of organic matter. Côte d'Ivoire is facing a continuous decline in soil fertility resulting in stagnant or declining cotton yields[5]. Soil fertility degradation through nutrient depletion, mainly by erosion and/or crop removal, is one of the threats facing agricultural systems in Cote d'Ivoire.

1.Kanté S, van Keulen H, Smaling EMA. Gestion de la fertilité des sols par classe d'exploitation au Mali-sud (2001). Available at: http://edepot.wur.nl/196518.
2. Djurfeldt G. The African food crisis: Lessons from the Asian green revolution. (2005). doi: 10.1079/9780851999982.0000
3. Karltun E, Lemenih M, Tolera M. Comparing farmers' perception of soil fertility change with soil properties and crop performance in beseku, Ethiopia.
4.Land Degradation Dev (2013) 24(3):228–35. doi: 10.1002/ldr.1118
Hartemink AE. Soil fertility decline in the tropics with case studies on plantations. CABI (2003).
5. Kouadio ENG, Koffi EK, Messoum GF, Brou K, N DB. Diagnostic de l ' etat de fertilitédes sols sous culture cotonnière dans les principaux bassins de production de côte d 'ivoire. European Scientific J, ESJ (2018) 14(33):221–38.

Table 1: Evaluation criteria for soil fertility classes

Characteristics	Level of fertility				
	No limitations	**Low limitation**	**Moderate limitations**	**Severe limitations**	**Very severe limitations**
	> 0.08	0.08-0.06	0.06-0.045	0.045-0.03	< 0.03
N (%)	> 10	10-7.5	7.5-5	5-2	< 2
Sum of Exchangeable Bases (SEB) ($cmol^+/kg$)	> 60	60-50	50-30	30-15	< 15
BS (%)	> 25	25-15	15-10	10-5	< 5
CEC ($cmol^+/kg$)	5.5-6.5 6.5-7.2	5.5-6.0 7.2-7.8	5.5-5.3 7.8-8.3	5.3-5.2 8.3-8.5	< 5.2 >8.5

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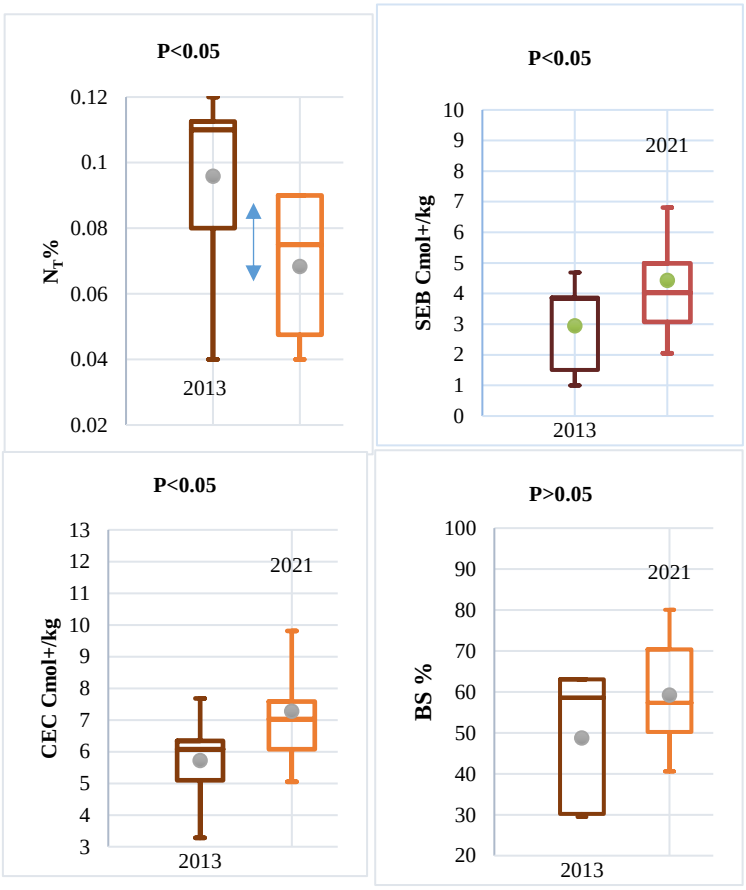

Figure 2: Boxplots of changes in soil chemical properties

1. The difference in soil physico-chemical properties between the 2013 and 2021 periods

The different boxplots highlight the most significant variabilities of each year (box length) and the differences between the 2013 study and the 2021. In general, many soil fertility indicators changed significantly.

- **Average total nitrogen**

The average total nitrogen content in 2013 to 2021 varies from 0.096 to 0.068 against the norm of 0.1 to 0.15%. Overall, the soils is largely poor in total nitrogen.

- **Sum of exchangeable bases**

The concentration of sum of exchangeable bases varies from 2.94 to 4.42 against the norm of 5 to 10 $cmol^+/kg$.

- **The cation exchange capacity**

varies from 5.72 to 7.28 $cmol^+/kg$ against the norm of 10 to 25 $cmol^+/kg$. The average CEC is low and below average.

- **Base saturation**

The northern cotton zone has base saturation rates (BS) that vary from 24.42 to 48.75% against the norm of 40 to 60% which is moderately low.

1. Cause of soil fertility decline

Most of the land in northern Côte d'Ivoire has been continuously cultivated for several decades, with fallow land having virtually disappeared, resulting in a decline in soil nutrient levels during both periods, most notably in 2013. This could be explained by the agricultural practices used on the cotton farms which are the overexploitation of the soil, inappropriate agricultural practices, and the use of insufficient chemical amendments.

2. Famers cope with soil fertility decline

Despite the poor Physico-chemical constraints of the soils in the cotton basin, the farmers persist in growing cotton because it is more economical than other crops. Indeed, cotton cultivation is the main economic resource in the savannah areas of northern Côte d'Ivoire. Cotton is one of the main cash crops. Farmers derive most of their agricultural income from it, to the point that this crop is called white gold.

3. Famers practice to improuve soil fertility

the use of mineral fertilisers in combination with organic matter from plant or animal debris can improve soil fertility and hence crop yields. the implementation of half-moon practices and, fallow systems.

4. Policy Implication

- Facilitate access to credit for small-scale farmers;
- Ensuring information and training for farmers;
- Practise a price incentive policy for agricultural inputs and products;
- Ensure that inputs are available in sufficient quantity and quality;
- Develop and disseminate appropriate low-cost materials/equipment;
- Strengthen the capacity of national structures directly involved in agricultural production.
- agricultural production.

5. Recommendation & Conclusion

To better understand the degradation process, we suggest establishing long-term monitoring sites, taking regular soil samples and examining management aspects, and storing them in a master database. With these data, monitoring models of temporal changes in soil fertility can be produced and improved for regular monitoring of soil fertility changes within the Côte d'Ivoire cotton basin. The study revealed the evidence of accelerated degradation degradation, soil impoverishment and shortage of arable land and the scarcity of arable land under strong demographic pressure pressure are the major agricultural problems. problems. It appears that the majority of soils are characterised by a high-medium level of fertility and a very low current state of physico-chemical characteristics.

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