Progress in Chemical and Biochemical Research

Journal homepage: www.pcbiochemres.com

Original Research Article

Impacts of Agricultural Practices on Physical and Chemical Qualities of Biophysical Environment in Save (Republic of Benin)

Mickael Vitus Martin Kpessou Saizonou[1*], Alassane Youssao Abdou Karim[1], Magloire Acakpo Nonvignon Gbaguidi[1], Sourou Koutchoro Nicephore Date[2], Azim Mohamed Abibou[1], Samson Ahognonhou Agossou[1]

[1] *Ecotoxicology and Quality Study Research Unit – Laboratory of Study and Research in Applied Chemistry - Polytechnic School of Abomey-Calavi University of Abomey-Calavi, Benin 01 BP 2009 Cotonou Benin*

[2] *Institute of Geography, Spatial Planning and Environment University of Abomey-Calavi, Benin 01 BP 2009 Cotonou, Benin*

ARTICLE INFO

Article history

Submitted: 2023-01-12
Revised: 2023-05-26
Accepted: 2023-06-02
Published: 2023-06-24
Manuscript ID: PCBR-2301-1244

DOI: 10.22034/pcbr.2023.380368.1244

KEYWORDS

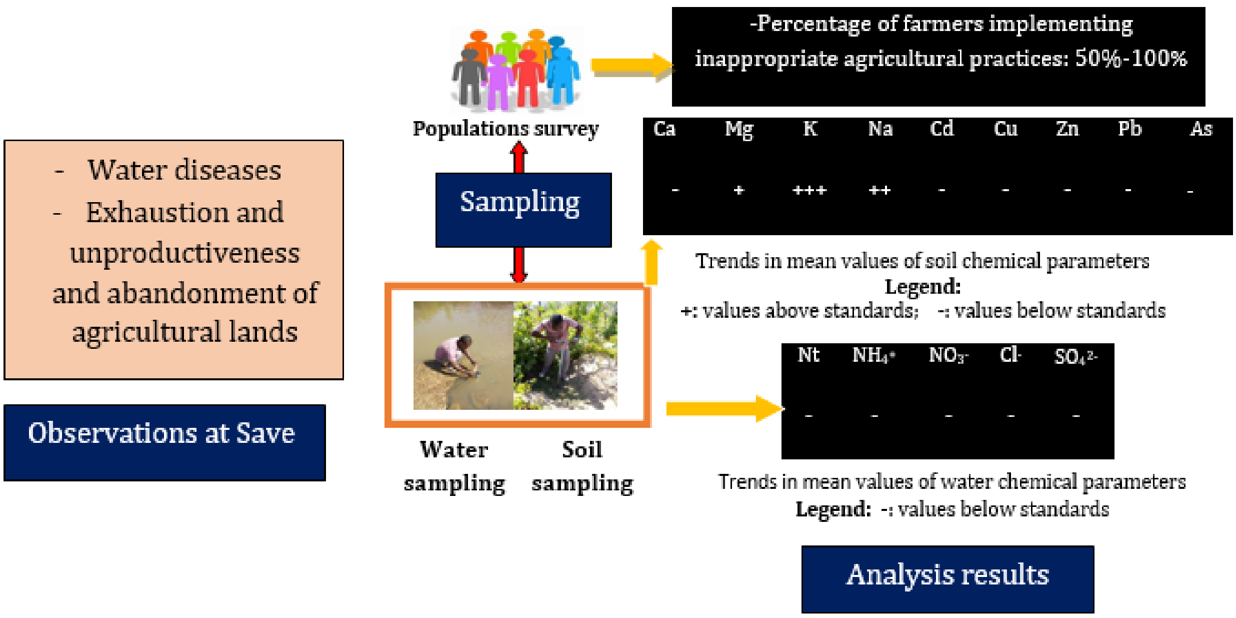
Agricultural practices
Biophysical environment
Save

ABSTRACT

Agricultural practices are increasingly affecting the environment. Various diseases related to environmental pollution are recorded everywhere due to new agricultural practices. Indeed, agricultural inputs, pesticides, and herbicides destroy the quality of waterways and soils and affect the health of populations as well as the use of machinery that is not suitable for agricultural activities. This is the case of Save in Benin. Certain water-borne diseases are common in the region and are linked by the populations to agricultural practices. This study aims to find the correlations between these practices and the quality of biophysical environment to confirm or not, the concerns of the populations. It was made by surveys with 150 people and analyses of samples of water and soil by standards methods in the area. The results of physical and chemical parameters obtained reveal positive correlations between agricultural practices and soil impoverishment. Indeed, for example, 21% of those enquired use only herbicide for land clearing and 49 %, intensely chemical inputs. Similarly, 50 % of soils contain arsenic. The values of parameters of surface waters are generally in line with the World Health Organization (WHO) recommendations. But on some sites, the total nitrogen concentration, of up to 2840 ppm, is above the standards and also that of magnesium, whose value is 2278 ppm. These findings provide information on the importance of the number of farmers using chemical inputs and the quality of soils and surface water. The results obtained partly justify the assertions of the populations regarding their concerns.

* Corresponding author: Mickael Vitus Martin Kpessou Saizonou
✉ E-mail: kpessou.saizonou@uac.bj

GRAPHICAL ABSTRACT



1- Introduction

Agricultural practices impact negatively soils [1].

In many developing countries, soils are exploited empirically and without profitable prospective planning for their restoration. Similarly, emphasis is placed on certain crops to improve the Gross Domestic Product (GDP) of the countries. In most West African countries, cotton cultivation occupies a prominent place economically and socially [2].

In addition, in Benin, the implementation of the Agricultural Mechanization Program has increased farming operations from one tractor for 100000 hectares in 2004 to one tractor for 2000 hectares from 2011. This represents more than 2800000 hectares fully mechanised corresponding to 40% of arable agricultural land (grubbing up, ploughing, sowing, maintenance, treatment, etc.) per year and this trend has continued for years. In the case of operations such as grubbing and ploughing, for example, tractors made available to producers before 2011 are not suitable.

Indeed, appropriate studies on the compatibility of these machines with the soil are not carried out upstream. Therefore the tractors destroy the structure of the latter because they are not adapted to the soil structure. All of this negatively affects productivity. The same observation remains valid for inputs (fertilizers and others).

Furthermore, according to Laurent [3], agricultural activity significantly changes the quality and dynamics of water in the environment. By transforming the plant cover, tilling the soil, and adding fertilizers and pesticides, it alters the cycle of water and its compounds.

The filling of watercourses, their eutrophication and the overexploitation of banks increase their continuous impoverishment. At Save in Benin, inadequate processes of mechanization of agriculture and the excessive and irrational use of fertilizers, pesticides, and other agricultural inputs and illegal dumping impacts negatively surface water and even groundwater. In this area, various cultures are developed, but the cotton cultivation is more intensive with harmful consequences on all the compartments of the ecosystem. Obviously agriculture is not only essential for the survival of living beings, but it is also a real source of pollution of ecosystems in return, concerning the agricultural practices. Le Guillou (2009) indicated that pesticides and fertilizers may contain pollutants, particularly metal trace elements such as chromium, copper, or lead. The molecules contained in pesticides and fertilizers are distributed in the environment either by volatilization during application to crops, or by percolation in the soil towards groundwater or by the runoff of molecules towards surface water.

Furthermore, the use of phosphate fertilisers increases the lead and cadmium content of the soil. Similarly, the input of nitrogen from fertilizers and the intensification of agricultural practices have significantly changed the nitrogen cycle. In fact, they enriched agricultural ecosystems with nitrates, particularly surface and ground water [4].

The Commune of Save in Benin is not immune to all these above mentioned phenomena. Some waterborne illnesses are common in the region and are linked by populations to agricultural practices. This study includes surveys and physical and chemical analyses of soils and surface waters. It aims to highlight the impacts of agricultural practices and physical and chemical qualities of the biophysical environment of the locality so as to support the observations of the populations and to consider the prospects for improving the quality of the environment.

2- Materials and methods

Soil and surface water sampling was carried out after surveys with farmers.

Presentation of the study area

Figure 1 displays the soil and surface water sampling sites.

Surface water

Surface water was collected from 6 sites in the Oueme and Okpara rivers in 1/2 litre weighted bottles and immersed in watercourses. The bottles were initially washed and dried prior to be on site, and then rinsed with the water to be sampled. Thereafter, the samples were stored in coolers at around 4 °C to be transported to the laboratory for physical and chemical analyses. The sites were chosen taking into account criteria such as topography, direction of water flow in the commune, and accessibility to the sites as did by a study made by Bachabi *et al.* [5].

Sampling

Soils

Soil samples were taken using an auger at a depth between 0-20 cm in cotton fields in 6 districts (four in intense production fields and two in low production fields). Five cotton fields were sampled and one yam field was chosen as a control for the physical and chemical analyses.

Analytical methods

Calcium, magnesium, potassium, sodium, cadmium, copper, zinc, and lead were measured through atomic absorption spectrometry using the SAA ICE 3000 series Thermo Fischer. Arsenic concentrations were also determined through atomic absorption spectrometry, but using the SAA ICE 3000 + VP100 series.

Finally, the total nitrogen contents are obtained by colorimetry method using DR 3800 spectrophotometer.

3- Results and Discussion

Agricultural practices and soil quality

The practices were sequenced at three levels: field preparation, crop maintenance, post-harvest, and impacts relative to each practice on the environment were identified.

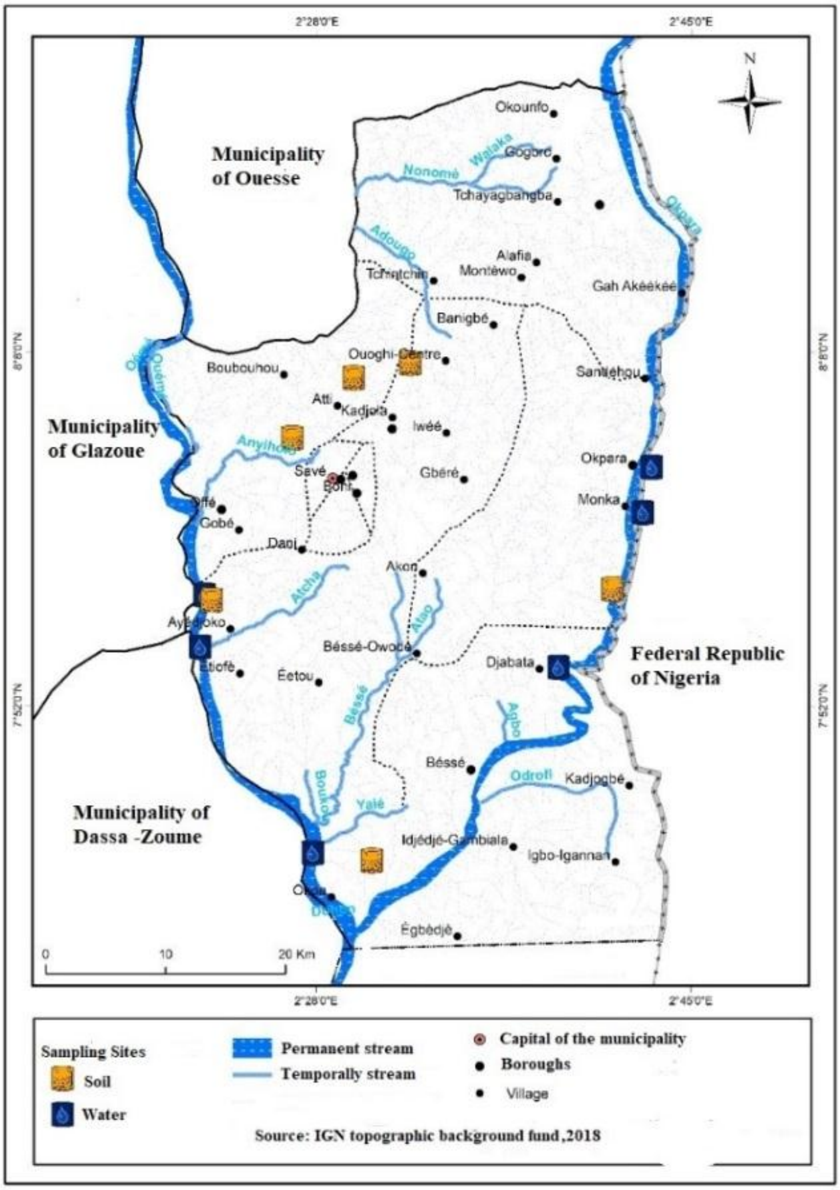


Fig 1 Surface water and soil sampling sites in Save

Table 1 Spatial distribution of soil sampling

Borough	Villages	Geographical coordinates
Offè	Gobe (E_1)	7° 56' 46'' N; 2° 23' 14'' E
Besse	Okpa (E_2)	7° 45' 01'' N; 2° 30' 31'' E
Okpara	Monka (E_3) (Gnam Field)	7° 57' 17'' N; 2° 41' 26'' E
Sakin	Ouoghi Gare (E_4)	8° 07' 29'' N; 2° 32' 14'' E
Adido	Igbo Iyoko (E_5)	8° 06' 49'' N; 2° 29' 48'' E
Plateau	Depot A (E_1)	8° 04' 06'' N; 2° 26' 53'' E

Table 2 Spatial distribution of surface water sampling

Borough	Villages	Water courses	Geographical coordinates
Offè	Gobe	Oueme	7° 57’ 00’’ N ; 2° 22’ 54’’E
	Ayedjoko	Oueme	7° 54’ 39’’ N ; 2° 22’ 43’’ E
Besse	Djabata	Okpara	7° 53’ 45’’ N ; 2° 38’ 59’’ E
	Okpa	Okpara, Oueme	7° 45’ 22’’ N ; 2° 27’ 50’’ E
Okpara	Monka	Okpara	8° 00’ 45’’ N ; 2° 42’ 48’’ E
	Oke Owo I	Okpara	8° 02’ 48’’ N ; 2° 43’ 12’’ E

Table 3 Percentage of farmers according to clearing techniques

Type of land clearing	Percentage of farmers (%)
Clearing by plowing	50
Hoe clearing and tall grass burning	8
Full burn	21
Herbicide total use	21

Agricultural techniques during field’s preparation

Table 3 presents the survey results of clearing practices. The agricultural techniques adopted by most of the farmers surveyed (50%) contribute to the fertilization of the soil because the plowed herbs decompose and enrich the soil with organic matter.

To circumvent the physical and even financial requirements of this agricultural practice, 8% of the farmers surveyed, do the clearing normally but burn the tall grass, while 21 consume everything, and then cultivate on slash and burn.

Finally, 21% use total herbicides to completely clear the fields. The use of fire and herbicides in agriculture harms soils by destroying microorganisms and earthworms, which play an essential role in the fertilisation process. This explains the need for artificial fertilizers to enrich soils and their negative effects on the environment. Table 4 lists the proportions of farmers according to the techniques for removing strains used in field preparation.

The results obtained indicate that 50% of the farmers surveyed resort to traditional techniques; namely, stump removal and the use of fire, while the remaining 50% use herbicides. Although it is evident that each of these agricultural practices is detrimental to the environment, the use of herbicides; however, amplifies these negative impacts, which are also observed in the region. In fact, much more crops require more time to grow naturally and farmers are forced to leave fallow land in looking for new, more fertile land.

Agricultural practices used for crop development

Table 5 indicates the survey results for tillage techniques.

Table 4 Percentage of farmers and tree stump removal techniques

Stump removal technique	Percentages of farmers (%)
Stump removal and use of fire	50
Stump removal and herbicide use	43
Stump removal before fire and herbicide use	7

Table 5 Percentage of farmers and tillage techniques

Types of plowing	Percentages of farmers (%)
Traditional (use of hoes and dabas)	86
Traditional-modern 1 (use of hoes, dabas, and agricultural machinery)	7
Traditional-modern 2 (use of hoes, dabas, agricultural machinery, and ox-drawn plows)	7

*Legend: daba is special type of hoe used in Africa

Table 6 (a) Cultivation techniques- type 1

Type of culture	Percentages of farmers (%)
Monoculture	86
Association of cultures	14

Table 6 (b) Cultivation techniques-type 2

Cultural method	Percentages of farmers (%)
Crop rotation	**93**
No crop rotation	**7**

The results show that manual plowing is practiced almost unanimously (86%). This process requires the deployment of a lot of energy and time, but has the advantage of preserving the textural structure of the soil due to the relatively shallow depth at which the daba penetrates the soil, unlike the deep blades of plows driven by oxen or those of agricultural machinery. Weak mechanization of agriculture (approximately 14%) is therefore noted at save which would however benefit from working for its improvement by prioritizing machines that should preserve the soil structure. The following tables indicate the percentages of farmers according to the two types of crop planting techniques practiced in the area. Crop rotation is done by alternating between cotton and a food crop (corn, yam, soybean, pepper, okra, or tomato) whose rapid growth requires nitrogen. Similarly, associations of cotton crops and food products, maize in general, are practiced. According to 93% of producers practicing crop rotation, the chemical fertilizers used during the year in which the cotton is grown continue to feed the soil the following year and boost good yield. This cultivation technique indicates the involvement of agricultural chemical inputs in the cultivation of food crops. All of the farmers surveyed (100%) admit to use chemical fertilizers for fertilization and pest control instead of organic fertilizers or pesticides. These farming techniques induce a significant impoverishment of the soil and 50% of respondents even acknowledged that to improve the yield of their crops they do not hesitate to overdose chemical fertilizers by multiplying by two, three, or even more, the recommended quantities. This practice destroys all the nutrients and reserves of the soils which are sometimes not renewed, even after ten years of follow.

Post-harvest agricultural techniques

The prevention of attacks on the cotton plants during a future cropping season by parasites justifies the stump removal and incineration of the plants within 3 weeks by 51% of the producers surveyed.

Table 7 Post-harvest farming techniques

Type of techniques	Percentages of farmers (%)
Incineration after stump removal of cotton plants within three weeks after harvest	51
Late stump removal of cotton plants or stump removal in a new season of field preparation	49

Conversely, 49% of them are unaware of these attacks and carry out stump removal late or consume all the cotton fields during a new crop preparation. Similarly, some farmers make excessive use of pesticides and all this presents the risk of the soil impoverishment because fire and pesticides destroy micro-organisms there. Finally, survey results reveal that a high percentage (86%) of farmers do not practice voluntary fallowing. This highlights the strong agricultural pressure exerted on the soils and the difficulties of their natural reconstitution in the municipality. Unfortunately, the impoverished lands are quickly abandoned for new, more fertile lands, thus creating the nomadism of farmers and its corollaries, in particular the intrusion extension of pollutants from agricultural practices into surface waters. According to Amonmide [6], the agrarian system practiced in Benin has evolved a lot since the 1960s and has led to the drastic degradation of organic matter levels and the drop in crop yields as predicted by Coulibaly et *al*. [7] and Pouya *et al.* [8] in their studies. Tables 8 and 9 demonstrate the results of chemical parameters of soils. The results indicate a calcium deficiency in all the samples. Particularly at E_4, the contents of all the nutrients analysed are below the standards, highlighting the imbalance of the soil structure of this field. E_6 presents a deficiency in total nitrogen and calcium and an excess in magnesium, sodium, and potassium. The other soil samples taken, especially in the cotton fields, also reveal an imbalance in the soil structure. Indeed E_1, E_2, and E_5, except magnesium for E_1, E_2, and total nitrogen for E_5 which respect the standards, all the other parameters are in deficiency or excess. All these imbalances (deficiency or excess) of soil chemical constituents in cotton fields could be due to developed agricultural practices; namely, the use of fertilizers, chemical pesticides and herbicides, and burning techniques, without natural fallowing. According to Ballot *et al.* [11], nitrogen, boron, and zinc are essential in the soil for plant growth. Growth delays could therefore be recorded in the fields of samples E_1, E_2, E_3, E_4, and E_6. In addition, the presence of phosphorus and magnesium is useful in the soil for the growth of plants. Fruit growth anomalies could also be recorded in the fields of samples E_4, E_5, and E_6. Comparing the observed soils destruction, studies carried out on the evolution of soil fertility in northern Cameroon in the cotton basins M'Biandoun *et al.* (2000) and Bassala *et al.* (2008) have highlighted the drop in soil nitrogen levels and the insufficient available phosphorus, exchangeable potassium, and magnesium [9,10].

All the MTE contents are lower than the AFNOR NFU 44-041 standards in contrast to the results obtained in the north of Benin by Bachabi *et al.* [5]. His study showed the presence of lead and arsenic with non-standard levels. As mentioned above, the presence of zinc in the soil is essential for the growth of crops or plants in general [11]. Sample 4 contains no zinc at all. This shows to what extent poor cultural practices, in particular the excessive use of chemical inputs, can deplete the soil of nutrients. Only zinc content of E_5 complies with the ASPITET standards. All the samples have a cadmium concentration following the ASPITET standards and lead and arsenic contents lower than the AFNOR and ASPITET standards. Arsenic was not detected in samples

2, 3, and 5. This could mean that agricultural practices have not caused pollution of all the soils of the commune concerning these metals. However, all samples contain traces of cadmium and lead while samples E_1, E_4, and E_6 contain traces of arsenic. The copper contents of E_2, E_3, E_5, and E_6 comply with the standards defined by ASPITET. On the other hand, those of E_1 and E_4 are lower than this. E_1 and E_4 do not contain copper. This not only indicates an imbalance in these two samples and could result from the cotton cultivation, but also bad practices in the multiple uses of surface water (laundry, dishes, and swimming) by the populations which would consequently induce negative impacts on the quality of the soil and surface waters.

Agricultural practices and surface water degradation

Physico-chemical parameters of surface water samples

Table 10 lists the results of physical and chemical parameters of surface waters. Apart from salinity, for which the standard for drinking water is not defined, all levels of the measured parameters are below the standards. These waters are favourable for irrigation in agriculture and conducive to the survival of aquatic species. However, all the samples were taken in the commune show salinity levels of 30 mg/L.

This non-negligible value could be linked to the use of chemical fertilizers by farmers, to the runoff of chemical fertilizer residues into surface waters during the rainy season, to other domestic uses of water, or bad practices in breeding. The consumption of this water by farmers would therefore present a potential danger to their health.

3.4. Summary of the assessment of impacts of agricultural activities on the components of the environment. Table 11 represents the Leopold matrix used to assess the impacts of agricultural activities on the environment in the municipality of Save at each phase of agricultural activity.

Table 8. pH and chemical nutrient contents of soil samples

Chemical parameters	Standards (ppm)	E_1 (ppm)	E_2 (ppm)	E_3 (ppm)	E_4 (ppm)	E_5 (ppm)	E_6 (ppm)
N total	1200-2200	***2840***	272	126	840	1512	220
Ca	2000-3200	102,71	122,64	54,34	48,12	152,25	65,75
Mg	360-720	408,07	668,29	367,12	82,42	***1670,87***	***2277,76***
K	60-100	***141,99***	***288,57***	***416,62***	34,41	***861,27***	***808,70***
Na	70-160	57,63	32,88	115,11	21,86	***178,20***	***232,04***
pH		6,06	7,08	7,34	6,57	6,83	6,37

Table 9 MTE contents of soils

MTE	AFNOR[1] standards	ASPITET[2] recommendations	E_1	E_2	E_3	E_4	E_5	E_6
Cd	2	0,05 - 0,45	0,13	0,13	0,10	0,13	0,11	0,16
Cu	100	2 – 20	0,24	2,13	2,02	0,15	3,72	3,20
Zn	300	10 – 100	0,88	5,72	3,98	n.d	10,26	6,20
Pb	100	9 – 50	2,73	1,28	4,63	1,38	2,52	3,94
As	19	1 – 25	0,03	n.d	n.d	0,09	n.d	0,16

*n.d: Not detecte

1 Contributions of Pedological Stratification to the Interpretation of Trace Elements Content

2 French Association of Standardization

Table 10. Physical and chemical parameters of surface waters

Parameters	WHO standards (Drinking water)	FAO standards (irrigation water)	E_1	E_2	E_3	E_4	E_5	E_6
pH	6,5<pH<8,5	6,0<pH<8,5	7,56	7,90	7,54	7,58	7,56	8,00
Electrical conductivity (µS/cm)	250	0-300	72,20	75,40	66,60	74,60	71,50	67,80
$O_{2\ diss}$ (mg/L)	> 5 $^{\alpha}$	>5 $^{\alpha}$	8,81	8,86	8,77	8,78	8,80	8,62
Salinity	Not mentioned	0-2000	30	30	30	30	30	30
NH_4^+ (mg/L)	0,5	0-6,43	0,28	0,16	0,38	0,25	0,47	0,17
NO_3^- (mg/L)	45	0-44,3	1,31	0,75	1,78	1,17	2,20	0,80
Cl^- (mg/L)	250 $^{\varphi}$	0-10	1,80	1,20	2,30	1,80	3,80	2,00
SO_4^{2-} (mg/L)	500 $^{\varphi}$	0-960	2,00	1,00	1,00	1,00	1,00	4,00

*Legend: φ values only at the level of Decree No. 2001-094 [12].

α Standard for Dissolved Oxygen (O_2 diss.) supplemented according to the Reference values of the Water Framework Directive [13,14,15].

Table 11. Leopold matrix of environmental impacts of agricultural activities

		Field preparatory phase							**Exploitation phase of agricultural products**		
	Agricultural activities per stage / **Components of the environment**	Clearing	Plowings	Sowing/ Planting	Weeding	Fertilizers using	Pesticides using	Herbicides using	Harvest	Transformation	Alimentation
Biophysical environment	Soils	−	−	+	+/−	−	−	−	+	+	+
	Vegetation	−	−	+	+/−	−	−	−	+	+	+
	Surface waters					−	−	−			
	Air	−			+/−	−	−	−	+/−	+/−	
	Cultures	+	+	+	+	+/−	+/−	+/−	+	+	
Human environment	Socio-economic activities	+	+	+	+	+	+	+	+	+	+
	Health	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+
	Local development	+	+	+	+	+	+	+	+	+	+

***Legend**: (+), (-), (+/-): Positive, negative, or more or less negative impact

This matrix indicates that during the different phases of agricultural activities, the two components of the environment; namely, the biophysical environment and the human environment, are impacted.

It also makes it possible to deduce that the sub-components of the environment most negatively impacted by agricultural activities are soil, vegetation, air, and water. The soil and vegetation are affected during the field preparation phase because of the use of herbicides and fire to clear stumps of trees and shrubs. However, when weeding, the soil and the vegetation are positively impacted if the weeding is done with a hoe or modern weeding tools that do not dig deep into the ground. On the other hand, the soil and vegetation are negatively impacted during weeding with selective herbicides.

Moreover, still, during the implementation phase of field activities, the four natural sub-components of the biophysical environment; namely, water, air, soil, and vegetation, are negatively impacted when agricultural chemical inputs are used.

Delaunois *et al*. [16] criticized mechanical work, in particular the use of large mechanical machines, which they consider to be poor agricultural practice, and Bispo *et al.* [17] indicated that poor agricultural practices, low organic restitutions, the addition of organic waste products, and the evolution of biogeochemical conditions cause the pH to change, while the additions of phytosanitary products modify the biological component of the soil and therefore the biodiversity they host. For these authors, the passage of tractors and heavy machinery destroys the soil structure. However, it should be put into perspective by noting that the agricultural mechanization in itself is not a bad practice, contrary to previous analyses and that it only becomes so when it does not respect the environment, especially when it involves very heavy agricultural machinery for plowing and weeding with deep blades which compact and destroy the soil structure.

For Doumbia (2007) [18], FAO (2015) [19], and Kouadio (2018) [20], the values of physical and chemical parameters and soil texture are indicators for assessing its good health, the life that takes place there, in this case, the life of micro-organisms and therefore determines its fertility. In addition to protect soil texture and controlling the use of phytosanitary products and agricultural chemical inputs, it is important that the concentrations of chemical constituents respect the appropriate values for good but above all healthy agricultural productivity.

Furthermore, Doumbia (2007) [18] mentioned that the basic exchangeable parameters, soil organic matter, pH, and fine elements are the foundations of productivity and sustainability and represent the main indicators of the evolution of physical and chemical fertility of the soil. All the previous observations related to the different agricultural practices and values of physical and chemical parameters of the soils and surface waters of the commune of save reveal the implications of the mentioned practices on the quality of the biophysical environment of the commune.

4- Conclusion

This study makes it possible to highlight modifications of the constituents of the soils in the commune of Save because of agricultural techniques practiced in the region. In fact, large segments of farmers use substantial amounts of pesticides and herbicides for clearing and weeding fields, chemical fertilizers for various crops but mainly for cotton. Nevertheless, the slash and burn technique is used by some farmers at certain stages in the production process. Several reasons underlie the implementation of these practices, which are sometimes motivated by delays in decision-making concerning the withdrawal of cotton stumps by certain farmers, the concern for speed in production, and the desire to improve the yields of cultures. The work also made it possible to assess the impact of agricultural practices on the quality of surface water which is, directly or indirectly, the receptacles for the residues of pesticides, herbicides, and chemical fertilizers used. These waters have salinity levels that make them unfit for human consumption. However, some farmers consume them in their fields and calls for awareness rising on the part of the socio-political authorities of the municipality.

References

[1] D. Acclassato, Ten years after the Maputo declaration on agriculture and food security: an assessment of progress, West Africa structure and content of country studies. *European Centre for Development Policy Management (ECDPM),* Special edition, *ROPPA, Benin study*, (2013).

[2]E. Aho, G. Capo-chichi, African cotton between traditions and modernity practices: the new paradigm of a social economy in West Africa. Bull. Search Agron. Benign.*Special Issue Sustainable Agricultural Development*, (2017) 35-48.

[3]F. laurent, Agriculture and pollution of water: modeling of processes and analysis of territorial dynamics. *University of Maine, Environmental Sciences*, (2012).
https://tel.archives-ouvertes.fr/tel00773259

[4]M. Le Guillou, Diagnosis and mapping of environmental pollution risks (water, plants, soil) by metallic trace elements around camelina farms in Kazakhstan. *University of Montpellier II (UM II), Master in Biology Geosciences Agro-Resources Environment, Functional Ecology and Sustainable Development, Livestock of Southern Countries: Environment, Development, and Internship. Report of Master*, (2009) https://agritrop.cirad.fr/555068

[5]A.A. Bachabi, A. C. Agbon, M. S. Issa, M. Boko, Impacts of Conventional Cotton Production on Water Quality in the Alibori to Benin Catchment Area. *European Scientific Journal*, 16 (2020) 436-454.

[6]I. Amonmide, G. Dagbenonbakin, C.E Agbangba, I. Akponikpe, Contribution to the evaluation of the level of soil fertility in cotton-based cropping systems in Benin. *International Journal of Biological and Chemical Sciences*, 13 (2019)1846-1860.

[7] K. Coulibaly, E. Vall, P. Autray, H. Nacro, M. Sedogo, Effects of permanent cotton-maize cultivation on the evolution of soil fertility indicators in western of Burkina Faso. *International Journal of Biological and Chemical,* 6 (2012) 1069-1080.

[8] M.B. Pouya, M. Bonzi, Z. Gnankambary, K. Traore, J.S. Ouedraogo, A. Some, M. P. Sedogo, Current soil fertility management practices and their effects on cotton production and on the soil in cotton farms in central and western Burkina Faso. *Cahiers Agricultures*, 22 (2013) 282-292.

[9]M. M'biandoun, J.M. Douzet, Evolution of the fertility of the soils under cultivation in the landscaping carried out in 1996. Report on the analysis of the results, IRAD-DPGT-SODECOTON. *Garoua, North Cameroon*, (2000). Tropicultura 24 (4) (2000) 247-252

[10] O.J.P. Bassala, M. M'biandoun, A. Ekorong, P. Asfom, Evolution of soil fertility in a cotton-cereal system in northern Cameroon: diagnosis and prospects, *sommaire/inhoud/sumario*, 26 (2008)240-245.

[11] C.S.A. Ballot, G. Mawussi, W. Atakpama, M. Moita-nassy, M.T. Yangakola, I. Zinga, S. Silla, W. Kperkouma, G. Dercon, B. Komlan, A. Koffi, Physico-chemical characterization of soils to improve cassava productivity (Manihot esculenta Crantz) in the Damara region in south-central Central Africa Republic.. *African Agronomy*, 28 (2016) 9-23.

[12] Decree No. 2001-094 of 20 February 2001 setting drinking water quality standards in the Republic of Benin, (2001) 1-15.

[13] Ifremer Environment, Hydrological parameter/Dissoled Oxygen *.France, Parameter sheet*, (2017).
https://ocean-indien.ifremer.fr/content/download/106171/file/Fiche_Oxygene_dissous.pdf

[14] J.L. Hubiche, The dynamics of life, water support of life: the oxygen of water. *Cahier Indicator N°1*, (2002).

https://www.loire-estuaire.org/upload/iedit/1/pj/43684_2860_CMB_206106_L2A1.pdf

[15] L. CRE, Dissolved oxygen. *Quebec, Article*, (2009) https://crelaurentides.org/wp-content/uploads/2021/10/fiche_oxygene.pdf

[16] A. Delaunois, Y. Ferrie, M. Bouche, C. Colin C. Rionde, Guide for the description and evaluation of soil fertility. *France, Tarn's Agriculture chamber and INRA of Montpellier*, (2013) https://tarn.chambre-agriculture.fr

[17] A. Bispo, C. Chenu, M. Griffon, E. Lemaire, C. Valentin C. Walter, What research on agricultural soils? *National Agency of Research (ANR)*, (2013) https://anr.fr/fileadmin/documents/2015/ANR_Plaquette_SOLS.pdf

[18] N.A. Doumbia, Diagnosis of soil fertility in the cotton zone of Mali: Studies on soil organic matter. *Republic of Mali, Rural Polytechnic Institute for Training and Applied Research (IPR/IFRA) of Katibougou, Master's thesis*, (2007) http://www.secheresse.info/spip.php?article43824

[19] FAO, Soil badge. Youth United Nations Global Alliance (YUNGA). *Learning and Action Series*, (2015). https://www.fao.org/yunga/resources/challenge-badges/soils/en/

[20] N.E. Kouadio, K. E. Koffi, B. J. Kouakou, F. G. Messoum, B. Kouame, B. D. N'guessan.Diagnosis of the fertility status of soils under cotton cultivation in the main production basins of Ivory Coast. *European Scientific Journal*, 14 (2018) 221-238.

HOW TO CITE THIS ARTICLE

Mickael Vitus Martin Kpessou Saizonou. Impacts of Agricultural Practices on Physical and Chemical Qualities of Biophysical Environment in Save (Republic of Benin). Prog. Chem. Biochem. Res., 6(2) (2023) 152-163.

DOI: 10.22034/pcbr.2023.380368.1244

URL: https://www.pcbiochemres.com/article_173363.html