International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Socio-Economic and Environmental Effects of Hydro-Agricultural Developments in the Hills Department (Benin, West Africa)

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Abstract: ***The development of hydro-agricultural infrastructure offers real possibilities for improving agricultural production but, have an impact on society and the environment. The objective of this study is to identify the effects of hydro-agricultural practices on the life the peasant, the environment and the health of the population in the collines Department. The methodological approach adopted enabled the investigation to collect the information about strategies and techniques for controlling water resources for agricultural purpose and provide information of the socio-economic developments in the collines department. The SWOT (Stregths Weaknesses Opportunities Threats) was used to analysis the hydro-agricol's pratices effects over soci-economic and environmental and development on the population life in hills department. On count 31, 12% of producers rise fertilizer dose to hope expansion of productivity capacity. This chemical fertilizer used to rise productivity capacity and protect field counter destroyers cause eutrophication. Eutrophication have like consequences the expansion of noxious species of the decline of oxygen who hand back difficult aquatics species life. For the sustainability of the techniques for controlling water resources without major impact on the life of the populations in the Hills, it is necessary to consider evaluating the negative and positive impacts, the degree of modification of the chemical structure of the soils and the state of vulnerability to pollution of water resources due to hydro-agricultural practices.***

Keywords: Socio-economic and environmental effect, hydro-agricultural developments, hills department.

1. Introduction

In Benin, the downward trend in rainfall and irregularities in the rainy seasons reported over the past decades (Afouda, 1990; Boko, (1998); Houndénou (1999); Ogouwalé (2006); Vissin (2007); Issa (2012), Loko and al (2013); Gbaguidi and al (2015)) have led to a degradation of the ecological environment with negative impacts on agricultural production. The Department of Hills, the national granary with strong agricultural production, suffers the repercussions of climatic variability. And to adapt to the impacts of rainfall variability, forms of hydro-agricultural development have been developed through the enhancement of very fertile humid ecosystems, which offer several agricultural and fish-farming possibilities (Orékan, 2000, Agbossou, 2002; Guibert and al, 2010; Gnaglè and al, 2011; Issa, 2012; Gbaguidi and al, 2015). The development of hydro-agricultural infrastructure offers real possibilities for improving agricultural production (Agbossou and al, 2012; Vissoh and al, 2012 and Atidégla and al, 2017) and has an impact on society and the environment. The objective of this study is to identify the effects of hydro-agricultural practices on the life of peasants, the environment and the health of the populations in the Collines Department. The Collines Department is located in the center of Benin (figure 1) in a subequatorial climatic region. The rainfall regime straddles a bimodal distribution in the south and unimodal distribution in the north (Bokonon-Ganta, 1987; Boko, 1988; Afouda, 1990; Houssou, 1998; Ogouwalé, 2006).

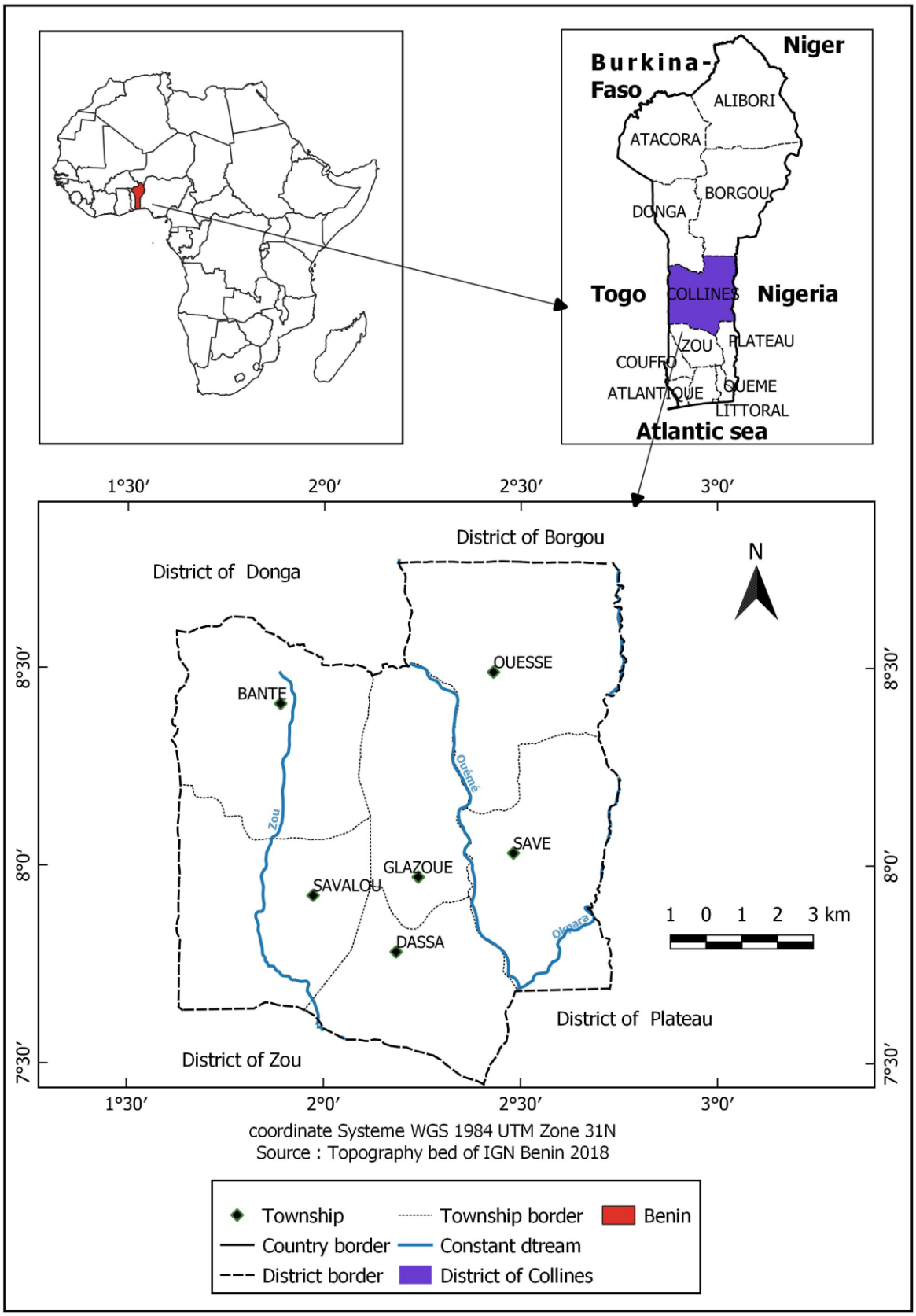

Figure 1: Geographical location of the Collines Department

2. Data and Study Methods

Sampling: The data used in this study come from investigations in real environment. They cover strategies and techniques for controlling water resources for agricultural purposes and provide information on the socio-economic and environmental effects of hydro-agricultural developments in the Collines Department. The information was obtained by a means of a field survey organized in the different localities of the study area (Table 1) through individual interviews and / or focus groups using a carefully drawn up questionnaire.

Table 1: Typology of sampling in the Hills (April, 2019; January, 2021)

Commune	Borough	Number of households	Sample	Surveyed population
Dassa-Zoumé	akofodjoulé	**1 330**	374	62
	soclogbo	**2 287**	138	31
savalou	savoluo-aga	**3 251**	150	35
	attaké	**2 105**	288	66
	lahottan	**1 290**	368	52
	kpataba	**2 314**	226	37
	logozohue	**1 072**	361	48
glazoué	kpakpaza	**1 208**	382	54
	ouèdèmè	**1 842**	226	29
bante	gouka	**3 175**	279	83
Savè	adido	**1 787**	150	26
	offé	**2 766**	216	53
ouesse	ouesse	**2 386**	138	19
	laminou	**3 165**	184	24
	odougba	**1 945**	78	13

The sample formed is made up of farmers, village group leaders, rural development agents with proven knowledge of issues relating to agricultural practices and water control techniques. A total of 632 agro-pastoral households has been add to 79 resource persons (local elected officials, agents of decentralized technical services of the MAEP). The criteria for choosing respondents is: to be at least forty years old; having lived in the community for the past thirty years; have knowledge of events on agricultural practices and techniques for controlling water resources in the study sector and have a modern or traditional infrastructure for hydro-agricultural development (for households).

Analysis method: The data collected was manually analyzed. A systematic analysis of cultivation techniques identified at the level of the Collines Department was carried out. The description of the hydro-agricultural developments provided information on the factors favoring the development of endogenous strategies for mobilizing water resources and the modes of operation of the perimeters and the state of the infrastructure. From the SWOT (figure 2), the socio-economic and environmental effects of hydro-agricultural developments on the life of the populations in the Collines Department were determined and analyzed.

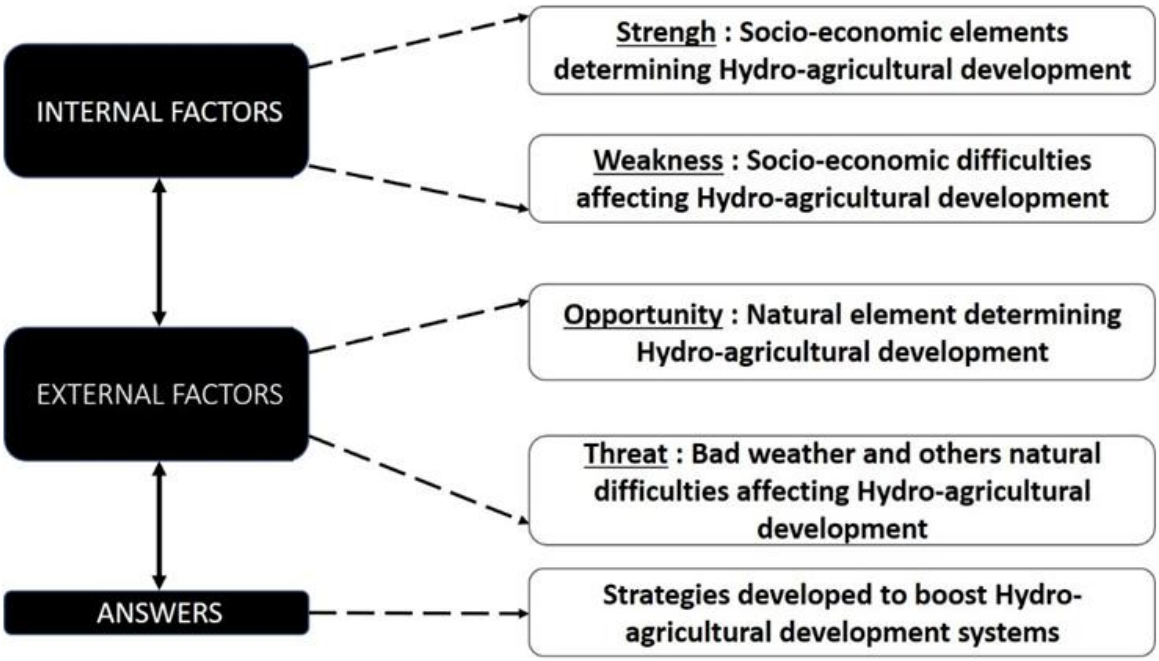

Figure 2: Framework adapted from the SWOT (Strengths-Weakness-Opportunities-Threats) model of analysis of strengths and weaknesses in the realization of hydro-agricultural developments

3. Results

Socio-economic impacts of hydro-agricultural developments in the Hills

Hydro-agricultural developments have contributed to improving the living conditions of farmers. The advantages linked to the development of hydro-agricultural infrastructure are the remarkable involvement of women in activities, the performance of production systems and the assurance of food security. According to 25.84% of respondents, women are involved throughout the production chain but remain more active during the maintenance and harvest phases. The income from these activities gives women a certain autonomy. Also, the development of

irrigated perimeters has contributed to the multiplication of crop yields. This performance can be explained in the study environment by the fact that the crops manage to meet their water needs, but also the producers involved benefit from training on technical itineraries for crops, especially rice. The training courses organized relate to the preparation of trays or beds, sowing methods, irrigation methods, and the work schedule. In addition to training, there is the possibility of using machines that allow the work to be carried out in a timely manner and to limit the impact of vagaries of rainfall, without forgetting the possibility of using inputs (chemical fertilizers, pesticides). In terms of food security, the farmers involved (43.14%) recognized that with the perimeters, they produce rice and other crops, part of which is intended for household food and the rest for food sale. Likewise, they have become producers of market garden products themselves and can consume some of them, whereas in the past these products became scarce during the dry season and selling prices were not within their reach. The income from the sale of market gardening products allows them to have easier access to other foodstuffs during this lean food period. In addition, part of the foodstuffs produced on the irrigation schemes is sold to the markets of the surrounding localities, which facilitates the access of other populations to these different products. The socio-economic effects of the operation of hydro-agricultural facilities analyzed using the SWOT model are summarized in Figure 3.

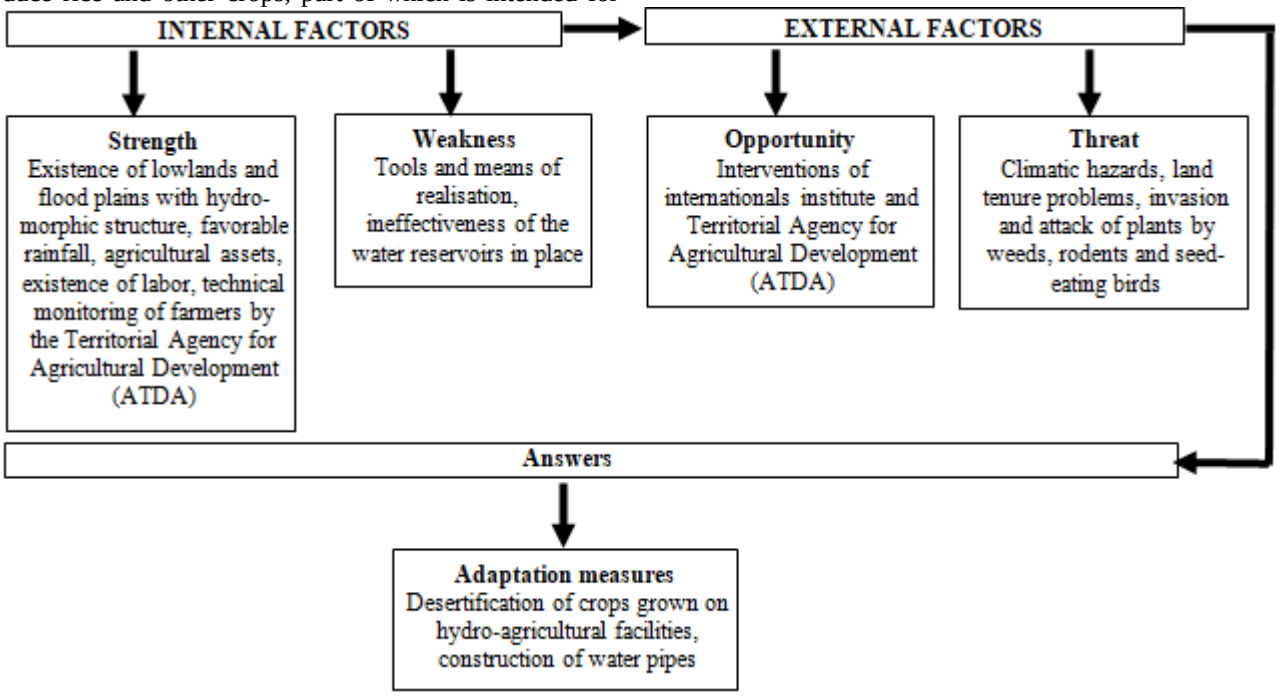

Figure 3: Analysis diagram of the socio-economic effects of the operation of hydro-agricultural facilities using the SWOT model

Environmental and health effects linked to hydro-agricultural developments in the Hills

In the Collines Department, rivers carry the rest of the chemical products and fertilizers used in agricultural cultivation through runoff. The massive and not always perfectly dosed inputs of chemical fertilizers and potentially pesticides lead to diffuse pollution within the hydro-agricultural domain. This affects groundwater and can also contaminate surface runoff collecting drainage water downstream from irrigated areas. According to farmers, herbicides and insecticides which dry out grasses to facilitate clearing and kill or prevent insect pests from destroying crops, respectively, are used. However, the phosphates contained in these products cause eutrophication of the water (excess nutrient) with the corollary of the growth of harmful species and a decrease in oxygen making aquatic life difficult (Lamodi, 2013). Besides water pollution, the use of chemical fertilizers on developed sites also pollutes the atmosphere. According to Alizé (2006), regardless of the spreading technique used, only part achieves its objective, the rest diffuses into the air. Tables 2 and 3 respectively show the doses of chemical fertilizers and pesticides used according to the cultivated areas. Analysis of these tables shows that producers do not comply with the doses of chemical fertilizers recommended by ATDA officers. According to investigations 31.12% of producers using these fertilizers admitted that they increase the doses of chemical fertilizers in order to hope for a better yield. However, these products are prohibited for phytosanitary treatment in market gardening. Their misuse leads to the accumulation of chemical compounds in the soil, notably nitrate and phosphorus, thus modifying its chemical structure.

Table 2: Doses of chemical fertilizers used per hectare in the Hills
(Source: Fieldwork, February 2021)

Type of chemical fertilizer	Cultures	Doses recommended by SCDA	Quantity used by farmers
Nitrogen, phosphorus, potassium (NPK)	Local maize Improved maize	100Kg/L 200Kg/ha	2, 5 bag/ha 4, 5 bag /ha

	Rice	150Kg/ha	3, 5 bag /ha
Urea	Local maize Rice	45 to 80 Kg/ha 50 Kg/ha	1 bag /ha 1, 5 bag /ha

Table 3: Doses of chemical fertilizers used according to the cultivated areas
(Source: Fieldwork, February 2021)

Commercial Name	Active ingredients	Culture on which ones the product is used	Pests controlled	Quantity in liter (L) recommended per hectare (ha)
SHARP 480 SL	Glyphosate 480g/L Isopropylamine480g/L	Rice	Weeds	1L
GRAMOS SHARP SUPER	Paraquatchloride 276g	Rice		1L
K-optimal	Acetamiprid 10+ Lambdacyalothin 15g	Pepper, Cowpea	Caterpillars aphices	1L
DEKAT-D	Dimethylamine 720g	Rice	Weeds	1L
COGA 80 MP	Mancozèbe	Vegetable crops	Mushrooms	400g
PACHA25 EC	Acetamiprid 10g+ Lambdacylaloth 15g	Vegetable crops	Caterpillars, aphid, fruit fly	1L
Force UP	Glyphoosate 480g/L Isopropylamine	planting	Weeds	1L

Caption:
L: Liter
g: Gram, g +: Gram plus
g / L: Gram per liter

Since chemical fertilizers and pesticides are toxic, their use is fraught with risks for the environment and the health of populations. The Léopold Matrix (Table 4) made possible to identify environmental risks from the various hydro-development activities.

Table 4: Matrix for identifying the sources of environmental risks and the components of the affected environments
(Source: Fieldwork, February 2021)

Activities Component of the environment		Deforestation	Plowing	Seed	Used of chemical fertilizer	Used of chemical product	Crops
Bio-physical environment	Flora	-	-	-	-	-	x
	Air	-	x	-+	-	-	x
	Water	x	x	x	-	-	x
	Ground	-	-	-+	-	-	-
	Wildlife	-	-	-	-	-	x
Humain environment	Humain heath	-	-	-+	-	-	x

X = No risk-+ = Medium risk-= High risk

The analysis of Table 4 shows that certain agricultural practices linked to hydro-agricultural developments such as deforestation, sowing, the use of chemical products and fertilizers affect the environmental components of the study environment. Farmers are not yet developing any strategy to reduce or avoid the environmental risks associated with HAD. In addition, the health risks associated with hydro-agricultural developments are consecutive to the development of water-borne diseases (diarrhea, bilharzia, etc.). Indeed, the development of agricultural water resources and vegetation in the study environment favors the proliferation of mosquitoes, among which the Anopheles vectors of the plasmodium are found. With the presence of these anopheles, populations are exposed to malaria. Nearly 60% of respondents reported cases of malaria often recorded during high water periods in the Collines department. The relationships between hydro-agricultural developments and bilharziasis are undoubtedly the most obvious (Henry-Chatier and al., 2000). Molluscs, intermediate hosts of the parasite, exist on hydro-developed sites and certainly constitute a factor in the transmission of this disease both in its urinary form and through excretion.

4. Discussion

The operations of hydro-agricultural developments in the Collines Department have ensured the food self-sufficiency of households, income from production has enabled access to health care and children's education, clothing needs and others make financial reserves. The results obtained are in line with the work of Boumboundi, 1990, Lingani, 1992, Joachim and al, (2018); Sawadogo, 2018. These have shown that the hydroagricultural development infrastructures promote the opening up, the electrification and the drinking water supply of villages, the development of socio-sanitary and school infrastructures, the improvement of the conditions of life of populations and working conditions of producers. Similar results obtained in Benin (Agbossou and Danvi, 1996; Vissoh and al, 2012; Yabi and al, 2012; Atidégla, 2017) have shown that the development of irrigated perimeters contributes to the improvement of

agricultural income with social consequences remarkable. The sometimes uncontrolled use of chemical fertilizers and pesticides has resulted in contamination of surface water, groundwater, sometimes groundwater by infiltration with consequences on the condition of structures in operation, degradation of plant cover and soil. The phosphate residues released cause eutrophication of surface water, the growth of harmful species and the reduction of oxygen in the water with consequences for the difficulties of aquatic life. These results are in line with those of Imene and al, (2016); Yonkeu and al, (2020). In addition, the mobilization of agricultural water resources in the Hills has encouraged the proliferation of anopheles and other vectors responsible for water-borne diseases. This could expose populations to malaria and other diseases linked to water contamination and soil degradation, especially since water is a determining element in the development cycle of the vector responsible for malaria (Somé, 2010). These identified health impacts have also been reported by Handschumacher and al., (1996); Parent (1999); Parent and al. (2002); Zoungrana (2001; 2002) in Burkina; Badjito and al (2014); Mondet and al (2010) on the state of Karnataka in India; Atidégla and al (2017) in the floodplain of Todé-gbamè and Codjo (2017) in Benin. According to these authors, the transmission of malaria has become permanent since the irrigation schemes. Hydro-agricultural developments have potential impacts on people and the environment. For the sustainability of the techniques for controlling water resources without major impact on the life of the populations in the Hills, it is necessary to consider evaluating the negative and positive impacts, the degree of modification of the chemical structure of the soils and the state of vulnerability to pollution of water resources due to hydro-agricultural practices.

5. Conclusion

The issue of developing hydro-agricultural facilities is of paramount importance for the enhancement of lands liable to flooding but fertile for agricultural production. And hydro-agricultural developments constitute the main techniques envisaged for the total or partial control of water resources for agricultural purposes. In the Department of Hills, the management of infrastructures which have proved their worth by contributing in particular to the development of the agricultural sector remains essential. In view of the socio-economic, environmental and health effect of the operation of the developed infrastructure on the life of the populations and the environment, it is urgent that measures be taken for the sustainability of the agricultural sector in the Collines Department.

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