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Investigations on the Ziga Dam Upper Sides Agricultural Pollution Issues in Central Burkina Faso

Souleymane Nacro
Institut de l'Environnement et de Recherches Agricoles
CREAF/Kamboinsé, 01 BP 476 Ouagadougou 01
Email: snacro2006@yahoo.fr; Tel. : +226 70742265; Fax : +226 25340271

Abstract **– In this study, we have investigated the problem of the agricultural pollution of the upper sides of the Ziga dam, Burkina Faso. Our results showed that the farmers were young, male and poorly or not educated. They used unsafe chemicals to control pests but some of these pesticides were prohibited. Four chemical families were found in used in this area. Crops were irrigated through furrows and small wells ploughed in the upper sides of the dam. These bad agricultural practices endangered highly the dam because of pesticide pollution and sand up. As a consequence, human and animal health and the environment were at risk. Farmers admitted the illegality of their settlement in the upper sides of the dam but gave several reasons to justify this situation. Nearly 60% of the annual incomes of the farmers were made up of the sale of legumes specially tomato and onion. Thus, the problem of the agricultural use of the upper sides of the dam was primarily an economical one.**

Keywords **– Ziga Dam, Burkina Faso, Agriculture Pollution, Pesticides, Sand Up.**

I. INTRODUCTION

Drinking water supply for Ouagadougou city is provided at 70% from the Ziga dam, which is located at 50 km East of the city that hosts about 2 million inhabitants. The retaining reservoir with a capacity of 200 million m³ was constructed in a 20,800 km² watershed. Drinking water supply for Ouagadougou from this dam was launched on 10th July 2004.

The completion of this major project was backed-up with the implementation of a 'government scheme for the mitigation of environmental impacts'. Environmental, human and sociological impacts of the structure were mainstreamed by that scheme. Nonetheless, the upper sides of the dam were still being harnessed with agricultural activities with all the serious consequences this could entail in the short and medium terms. Actually, this farming business could be source of chemical or organic pollution and siltation.

The issues of water resources pollution (surface and underground waters) and siltation of water courses or reservoirs are documented worldwide, at various levels (in developing countries and developed countries alike). Reference [1] indicated that in France, respectively 36% and 25% of surface waters and underground waters are of poor quality because of their content in pesticides. Reference [2] in their study of the integrated management of water resources and of the sources of pollution of the heights of Cameron in Malaysia reported not only on water pollution by pesticides but also on the siltation of these resources because of erosion resulting from agricultural activities. Remnants of pesticides that were found in water included endosulfan, aldrin, dieldrin and endrin. The rapid developments of agriculture, urbanization, the development of infrastructures and deforestation in the heights of Cameron contributed to severe erosion. Thus, agriculture was responsible for a land loss estimated at 480 metric tons/ha/year. When analyzing sources of pollution of the river, [3] found that the Nile River receives a large amount of industrial, agricultural and domestic wastes. Organo-chloride remnants were found in all the samples at different spots of the river. Reference [4] described the siltation level of Lake Rose in Senegal. That lake, where salt is extracted from, used to run over 8 km with a width of 1.5 km; nowadays it is only 4.5 km long and 800 m large. According to these authors, that lake is assaulted from all sides, first of all by siltation due to the Paris-Dakar rally, the construction of houses on the upper sides, which stops the surface waters from running into the lake. Reference [5] does not present a brighter situation of the Congo River. Actually, a 200-day sailing on the river is now impossible, not only because of the decrease in rainfalls in the Sahel, but also because of erosion which is accelerated by intense deforestation. Besides, there is a problem of pollution of the river's waters. Reference [6] in a book ironically titled 'The future is a former lake: Traditional Knowledge, Biodiversity and Resources', depicted the progressive and irreversible destruction of Lake Chad, with human, ecological and, economic consequences beyond price. This lake, which was one of the largest in Africa, shrank considerably over the past forty years. In 1963, it used to cover an area of about 25,000 km². Since 2008, that area is evaluated at about 2,500 km², which is a mean regression of 500 km²/year ([7]).

In Burkina Faso, several authors have already considered the issues of water resources pollution and siltation. Reference [8] studied the silting of mud in 5 reservoirs of that country. He showed that the phenomena was essentially related to erosion on the slopping basins which could be inflicted by wind, geology, waters, or be man-induced. He stressed that the two later forms of erosion were the most frequent ones in Burkina Faso. Factors related to these forms of erosion are rains, nature of soils, vegetation cover, slope, deforestation and agriculture. Reference [9] focused on the pollution of the Yitenga dam in the Central Plateau region of the country and the threats to human health for the populations living on the sloping basin of that dam. Reference [10] studied

the environmental and health impacts of using fertilizers on the irrigated scheme of Mogtédo, Central Burkina Faso. He evidenced that water resources of that area of Burkina Faso were highly polluted and that such a situation had not just environmental impact, but mostly health impacts. Lastly, [11] assessed the pollution of surface waters in the city of Ouagadougou, established a profile of pollution sources and suggested some mitigation solutions. After showing that all the wastewater outfalls of the city run into water bodies that are used to supply the population, [11] made an analysis that revealed ratios of organic matters that are ten times higher than the normal ratio. Households and industries were the major pollutants of water basins of the Ouagadougou city.

II. Material and Methods

Semi-structured interviews were conducted with 76 vegetable growers and 26 rice farmers exploiting the upper sides of the Ziga dam. These farmers originated from 6 villages in the rural communes of Absouya and the Ziniaré commune. The total number of farmers who settled on these sides was 200. The information was supplemented by informal questions asked to farmers'organizations leaders and to the Ziga Project Board.

The results of interviews were analyzed with the Excel 2007 software.

III. Results and Discussion

2.1. Some few socio-demographic characteristics of the target population

The socio demographic characteristics deal with group age, sex, education level and, level of organization.

2.1.1. Age and sex of vegetable farmers

We presented in Fig. 1, the different age groups of vegetable farmers who were interviewed.

The target population was relatively young as more than half of the farmers were between 10 and 20 years and 70% of the population was not above 40 years (Fig. 1). The overwhelming majority of farmers were men (96.15%) against only 3.85% women. Only 39.4% of vegetable farmers were land owners, others were hired.

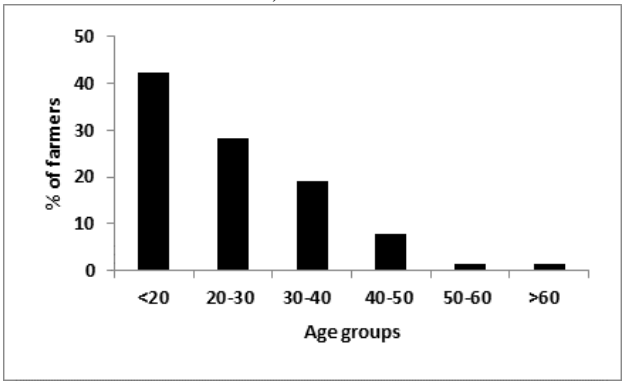

Fig.1. Age groups of farmers

2.1.2. Education level of vegetable farmers

Education level of vegetable farmers is illustrated by Fig. 2.

A large majority (70.5%) of vegetable farmers who farmed the upper sides of the Ziga dam had no schooling whether formal or non-formal (Fig. 2). Only 15.4% of farmers had some literacy in Mooré, a national language; 10.2% had the level of elementary school education. Others had either Koran education (2.6%) or secondary school level (1.3%).

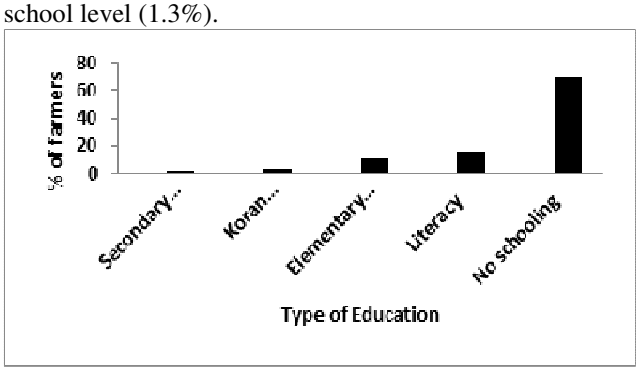

Fig.2. Education level of vegetables' farmers

2.1.3. Mean farm area

The mean farm areas used by vegetable farmers are presented in Fig. 3.

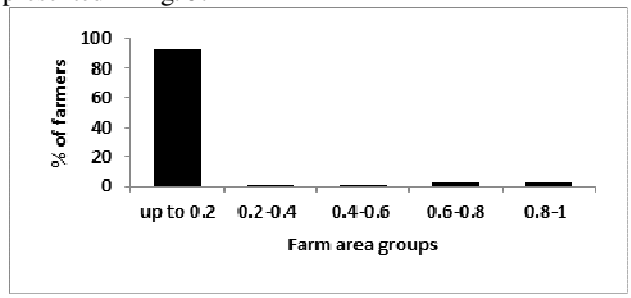

Fig.3. Mean farm areas of vegetables' farmers

In general, farmers used small plots. Vegetable farmers used plots ranging from 0 to 1 ha. Up to 92.2% of farmers had the smallest plots (Fig. 3). Rice growers' plots were larger than those of vegetable farmers. Actually, only 50% of these farmers had plots equalizing 0.4 ha or less, and nearly 75% of them used plots measuring between 0 and 0.8 ha. Nearly 27% of rice growers harnessed plots measuring at least 1 ha.

2.1.4. Organization level of vegetable growers

Slightly more than half of vegetable farmers (55%) were affiliated to no farmers' organization. Pure agriculture had the largest number of organized farmers (36%). Some farmers were also affiliated to organizations related to livestock (6.4%) or to livestock associated with agriculture (2.6%).

2.1.5. Types of technical training received by vegetable famers

The 2/3 of vegetable farmers (65.4%) received no technical training in agriculture. Others were trained on the construction of stony windrows (13%), manure pits (7.7%), the two latter techniques (6.4%), zaï, a traditional water conservation technique (1.3%) and other techniques (5%).

2.2. Agricultural practices

In this section, we present some agricultural practices observed on the upper sides of the Ziga dam and which are likely to endanger the structure and the health of both humans and animals. Such practices were applied to vegetables and rice. We were not able to analyze the data on the doses of fertilizer used by farmers because measurement units that were used were quite heterogeneous and inconvertible. Nonetheless, [12] reported mean doses of 800 kg of NPK/ha and 400 kg of urea (46%)/ha used in the Oubritenga province where our study zone is located.

2.2.1. Pests control methods

Table 1: Type of pesticides used by farmers

Active ingredient	Chemical family	Type of pesticide	Level of use (%)
Carbofuran	Carbamates	Insecticide	1,4
Lambda cyhalotrine	Pyrethrinoids	Insecticide /acaricide	86,9
Profenos	Organo-phosphorous	Insecticide	3
Cypermethrine + endosulfan	Pyréthrénoïdes + organo-chlorés	Insecticide	5,7
Mancozeb	Dithiocarbamates	Fungicide	3

We did an inventory of the different pest control methods used by vegetable farmers. Vegetables growers used mainly chemical pesticides (96.1%) to control insect pests and diseases. Other control methods were used, but to a very insignificant extent: traditional chemical control, cultural control and, biological control. The list of chemical pesticides recorded is presented in table 1.

Pesticides used by vegetable farmers were essentially insecticides of the following families: carbamates, pyrethrinoids, organochlorates and organophosphorous. An antifungal agent of the dithiocarbamates sub-family was also used. Lamda cyhalothrin was the most used active ingredient (86.9%). The use of some other molecules was less (table 1). The mean dose was 0.93 liter of commercial product /ha and the mean number of applications during a single cropping season was 7. The majority (92%) of farmers used brooms, 4% of them used sprayers and 4% herbs as pesticides application tools.

Of all these pesticides, only lambda cyhalothrin, profenos, and cypermethrin were authorized in Burkina Faso as they have been homologated by the Sahelian Council of Pesticides. All vegetable farmers protected themselves when applying pesticides: 47% of them wore gloves, 33% used masks and 20% had head-ties on. The use of pesticides on rice was low; only 12% of rice growers applied chemical pesticides.

2.2.2. Storage of pesticides and vegetable farmers' perception of the risks associated with the use of pesticides and precautions taken

We report on the perception of vegetable farmers regarding the risks associated with the use of chemical pesticides. That perception is described in terms of symptoms after the use of pesticides.

The ¾ of vegetable farmers recognized none of the symptom associated with the use of chemical pesticides. Other growers (27%) recognized four types of symptoms including belly bloating, skin and/or eyes' irritation, common cold and dizziness.

Pesticides were preferably stored in the field (in fact, pesticides were buried in the field and dug up later for applications). The other places used for the storage of these pesticides are listed in decreasing preferential order: house, shed and, rooms in the house.

The wraps were buried by 65% of growers, 34% abandoned them in the field, while 1% recycled them.

Farmers took precautions in the case of intoxication after pesticides application. Nearly 80% of vegetable farmers took no precaution in case of intoxication. But when precautions were taken in that situation, some of the growers (13%) would drink oil, lemon or vinegar while others sought traditional medicine for their treatment.

2.3. Some economic data on vegetables farms

We presented in Fig. 4, the mean incomes of the farmers (all economic activities inclusive) who were involved in this study. The annual incomes of the farmers varied from $ 20.5 for cowpea to $ 446 for tomato (Fig. 4). The most cost effective agricultural activities were tomato and onion production, because the incomes generated by just these two commodities represented 55.7% of the mean cumulated incomes of farmers.

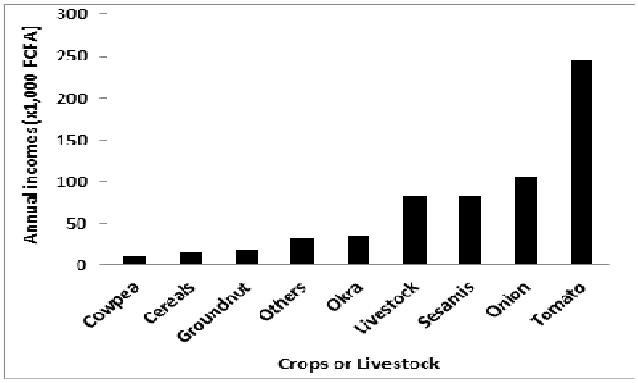

Fig. 4. Mean annual incomes of farmers (1,000 FCFA = $ 1.7).

2.4. Farmers' perception of problems associated with farming on the dam's upper sides

We recorded vegetables growers' perception of problems associated with the farming on the upper sides of the Ziga dam.

The ¾ of growers were informed about the prohibition of all agricultural activities on the upper sides of the dam. Besides, they were conscious of some signs of the degradation of these upper sides. The listed signs included:

- The presence of ravines and gullies;
- Water induced erosion;
- The existence of degraded soil.

Besides, farmers listed several reasons for the prohibition of farming on the uppers sides of the dam. The major reason mentioned was the dangerousness of

pesticides for human and animal health. Actually, that reason scored 25% of the votes of farmers. The second reason was the siltation of the dam. Other reasons included pollution coupled with siltation, and just pollution.
The reasons listed by farmers to contravene the prohibition of farming on the upper sides were:

- The non-fulfillment of compensation provisions;
- The occupancy of ancestors' lands;
- Other non-explicit reasons.

IV. Discussion

Farmers on the upper sides of the Ziga dam were mostly composed of youth, with little or no formal education. They were men, very few of whom were heads of households; the majority of them was either employed or paid laborers. Most of them received at least, one technical training in the course of their career. They used pesticides in a non-secured manner to control pests but some of these chemicals were not authorized. They dug furrows and wells on the upper sides of the dam to bring water to their plots. They acknowledge illicitness of farming on the upper sides of the dam, but mentioned several reasons to justify these practices even though they were conscious of the risks associated with this farming. Nearly 60% of the annual incomes of farmers stemmed from vegetable namely tomato and onion.

Our results clearly showed that the illegal farmers of the upper sides of the Ziga dam were guilty of bad agricultural practices that can endanger the environment and, human and animal health, and, also in the medium term, hamper the supply of drinking water to the cities of Ouagadougou and Ziniaré. Actually, farming on the upper sides of the dam is highly risky because of the application of chemical pesticides, chemical fertilizers and organic manure. These risks are firstly for farmers themselves because of the non-secured manner they used these pesticides. According to [13], when adequately used, chemical fertilizers, organic manure and cover plants are important inputs in productive agricultural systems. Nonetheless, the misuse of chemical fertilizers associated with the oversupply of organic manure is responsible for the production of nutriments (nitrogen, phosphorous and potassium) which can turn out to be problematic pollutants. As pollutants, they inflict damages to animals and plants in aquatic ecosystems and, when they are in significant amount in drinking water, they are responsible for earnest human health problems ([14]; [15]; [16]; [17]).

In addition, to pollution by agricultural inputs, there is the problem of siltation. That situation seems to be customary in the whole country, even though the use of resources within the Nakambé watershed where the Ziga dam is located presents a very peculiar challenge. Reference [10] described a very disquieting health and environmental situation on the irrigated scheme of Mogtédo, Central Plateau of Burkina Faso. Siltation of water basins is common in Burkina Faso ([8]).

The illegal farming of the upper sides of water basins is a common phenomenon in Burkina Faso ([12]). The youth of the Oubritenga province where the Ziga dam is located are known to be seasonal farmers of lands on the upper sides of water courses or dams throughout the country. They colonize these upper sides for vegetable growing. Once the season is over, they go back to their homes and come back at the next cropping season. This is an irresponsible manner of farming lands, and therefore it cannot be environmental friendly or respectful of human and animal health. These observations are in agreement with our findings because we showed that the farmers were mainly young men, and most of them were simply paid agricultural laborers.

The issue of illegal farming of the upper sides of the Ziga dam is foremost an economic problem. Actually, we showed that the mean annual incomes of farmers was at almost 60% from tomato and onion growing. The farming of the upper sides of the dam seeks to provide vegetable farmers with consistent earnings. Closeness of the site with the major vegetable's market of Burkina Faso, the Ouagadougou city, is like an air inlet. Shortcomings with the governmental scheme to alleviate environmental impacts provide arguments to these illegal farmers. Nonetheless, the farming of the upper sides of the dam is unacceptable enough to still continue. Yet, it is interesting to know that farmers themselves acknowledge the existence of most of the risks related to the unauthorized farming of the upper sides of the dam, though they give reasons for so doing. This situation is continuing despite the coercion measures implemented by the Ziga Project Board in collaboration with its field partners on the site.

Reference [18] reported on the local management of water resources of the rural commune of Bérégadougou in the Comoé province of Burkina Faso. He explained that thanks to the participation and involvement of all stakeholders, regulations for a sustainable management of the upper sides of water courses of that commune were developed and were successfully implemented, thus enabling the preservation of these shared resources. From the perspective of integrated water resources management, it is possible to come up with a solution to the issue of illegal farming of the upper sides of the Ziga dam.

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AUTHOR'S PROFILE

Dr. Souleymane Nacro

was born in 1959 in Abidjan, Côte d'Ivoire. He earned a diploma in Mathematics, Physics, Chemistry and Biology in 1981 at the University of Niamey, Niger. In 1984, he graduated from the University of Ouagadougou with a MSc. in agronomy. He earned a PhD in biology at the University of Rennes 1, France. In 2012, he received a MSc. in integrated water resources management from the International Institute of Water and Environment Engineering, in Ouagadougou Burkina Faso.

He was a research assistant from 1985 to 1994 in Bobo-Dioulasso, Burkina Faso at the Institute of Environment and Agricultural Research (INERA). He was recruited by the West Africa Rice Development Association (WARDA) as an Integrated Pest Management (IPM) consultant from 1995 to 1997. From 1998 to 2000, he was an IPM consultant for the Food and Agriculture Organization of the United Nations (FAO). He was the national coordinator of the IPM program for Burkina Faso from 2001 to 2009. Since 2010, he teaches Entomology and IPM in a Master course at the University of Ouagadougou. From 2009 to 2013 he was the Director of both Fasobiocarburant SARL and Fondation Fasobiocarburant respectively a biofuel company and an organization that promotes sustainable biofuel production in Léo, South Burkina Faso. He resumed his senior entomologist position at INERA, Kamboinsé, Ouagadougou in August 2013.

Dr. Nacro authored about 50 publications including paper published in peer-review international journals, extension journals, books or book chapters. He supervised the research work of about 30 Master and 3 PhD students.

Here is a list of selected publications:

Souleymane Nacro and Jean-Pierre Nénon, 2006: Anatomy of the female Reproductive System and the Ultrastructure of the Egg's Envelopes of *Orseolia oryzivora* (Diptera: Cecidomyiidae). *Journal of Entomology* 3 (1): 16-22.

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Dr. Nacro is member of several professional associations including the Entomological Society of Burkina Faso, the African Association of Insect Scientists, the International Association for the Plant Protection Sciences and the Entomological Society of America. He received several scientific awards during the be-annual forum of National Scientific and Technological Research in Burkina Faso.