

# **A Comprehensive Study of the Negative Externalities of Increase Use of Chemical Pesticides in Rice Production: A Case Study of Smallholder Farmers in the Aveyime Community, Ghana**

Abiemo Jerome Edem\*, Mizunoya Takeshi  
University of Tsukuba

## **Abstract:**

Rice production is an important economic activity among indigenous smallholder farmers. Harvest from rice fields is either sold to earn income, or contributes to household food security. In the Aveyime community of southern Ghana, rice production among farmers in the past, was characterized by the use of organic pesticides for the control of pests and disease, as well as compost and farm yard manure, to improve soil fertility. However, with the advent of chemical fertilizers and pesticides, the majority of farmers converted from organic to conventional systems of rice production, without considering the negative externalities related to the use of pesticides. This paper explores farmers' knowledge of pesticide use. It also estimates and compares the private and social Benefit-Cost Ratios (BCR) of organic and conventional systems of production. Discussion of results and the conclusion will be based on primary and secondary data sources. It is expected that the study, will reveal a significant knowledge gap among farmers in the use of pesticides. This is a major reason for the current associated increase in social cost, such as environmental and health costs. Recommendations from this study will help determine future strategies for chemical pesticide monitoring and policy formulation to promote environmental sustainability in Ghana.

**Keywords:** Benefit-Cost Ratio, Conventional System, Externalities, Pesticides.

## 1. Introduction

Rice production is an important economic activity among smallholder farmers in Ghana serving as source of income and household food security. The current production system of rice, depends on the use of pesticides to control harmful pest and diseases, a practice which poses environmental and health risk (Tetteh Anang 2015). Pesticide is any substance or mixture of substances intended for preventing, destroying or controlling any pest (Frimpong et al. 2012). According to Fianko (2011) the commonly used pesticides in Ghana are insecticides, herbicides, fungicides, fumigants, fertilizers and growth regulators. But most pesticides are toxic, hence their use is highly regulated internationally, nationally and regionally by regulations and conventions (Alabi et al. 2014). However, pesticides that are banned for agricultural purposes in 52 countries due to their hazardous nature are being used in Ghanaian agriculture (Glover-Amengor and Tetteh 2008). Although the extensive use of pesticides in Ghana has contributed greatly to increased food supply, farmers' dependence on them, have caused tremendous harm to humans health, agricultural land, ground and surface water, as well as biodiversity. In 2010, 15 farmers died from suspected pesticide poisoning in Upper East region. Most of these deaths resulted from the misuse, poor handling and storage of pesticides (PAS and partners 2012).

The Aveyime community, located in the North Tongu District of the Volta Region, is one of the major rice producing sites in Ghana. The area cultivated to rice form between 90-95 percent of total irrigable area, while the remaining areas are put under vegetables especially during the minor season when available water becomes limited (Amoatin and Acheampong 1997). In the past, the production of rice in this community made use of organic pesticides to control weeds, insects and diseases. But with the introduction of pesticides, the majority of farmers are now heavily reliant on these chemical which are sourced from the open market. The farmers focus on their immediate direct costs of pesticide usage. The direct costs which include the cost of pesticides purchase, its application and materials use in application, often ignores the hazardous effects of pesticides use to human health, environment and the society as a whole. Boussemart *et al* (2010) review on the spread of pesticides in agriculture systems, indicate that farmer's do not bear any costs associated with negative environmental externalities and do not reap any direct benefit from positive ones.

Over the past years, few research works have been carried out on the use of pesticides in rice production in Ghana. Ragasa *et al.* (2013) survey reveal that the adoption rate of pesticides, especially herbicides among farmers was high across all the rice ecologies in Ghana. Fianko (2011) also indicates that farmers have overused pesticides. He argues that the increase use of pesticides poses health risk to farmers and consumers. Nevertheless, both research works did not estimate the external costs related to pesticide usage among smallholder farmers. This study aims to evaluate the environmental impact, with major focus on the social cost, such as environmental and health costs of pesticide usage by smallholder rice farmers. The study will also estimate and compare the private and social Cost-Benefit Ratios (BCR) of organic and conventional systems of rice production. It is expected that information provided in this study, will help direct pesticide policy in Ghana.

## **1.1 Problem Statement**

The demand for rice as a major food security crop in Ghana has increased over the years. A recent national survey revealed that the country's self-sufficiency in rice production stands at 30 per cent, leaving a deficit of 70 per cent. Thus, the government, through the rice sector policy, seeks to increase rice production by promoting acreage expansion and the use of higher input intensities.

In view of this, most smallholder rice farmers in Ghana, especially those in the Aveyime community believe that the use of chemical pesticides and fertilizers, are the solutions to increase yield and income levels, rather than land area expansion. The majority of these farmers tend to depend on pesticides to avoid yield losses due to competition from pests, without adequate knowledge of their limitations. The farmers focus primarily on some aspect of their immediate direct cost, such as the cost of purchase and application of pesticides. They often ignore health cost (eg. treatment of pesticide ailments and loss working days), damage to the environment, especially groundwater contamination and related externalities. In line with this, most research works in the rice sector, mainly focus on yield maximization and marketing of rice. Unfortunately, no significant efforts have been made to estimate the external costs of pesticides, to facilitate an effective policy on their usage, for environmental and agricultural sustainability in the country.

## **2. Objectives**

The overall objective of this study is to investigate environmental impact of the increase use of chemical pesticides among smallholder rice farmers in Aveyime, Ghana. The study will:

1. Identify the most common chemical pesticides used by rice farmers;
2. Evaluate farmers' knowledge on the environmental and health costs of pesticides usage;
3. Estimate and compare the private and social benefit-cost ratios of organic and conventional systems of rice production; and
4. Identify alternative pest control methods and provide information for policy review.

## **3. Research methodology**

### **3.1 Research design**

The research will employ the mixed methods approach, an integration of qualitative and quantitative analysis. This research approach involves collecting both quantitative and qualitative data. The core assumption of this form of inquiry is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone (Creswell, 2013).

The Contingent Valuation Method (CVM) will also be employed to quantify respondents' willingness-to-pay (WTP) to improve groundwater contamination in the study area. An open-ended WTP bid for a hypothetical "new technology" to clean up groundwater, which serves as a major source of drinking water in the Aveyime community, will be carried out. The WTP question will be developed and administered after a preliminary focus group discussion with respondents. The study assumes that respondents WTP indirectly access the cost of groundwater contamination by pesticide. Shultz & Lindsay (1990) work in New Hampshire, USA, employed the WTP for a hypothetical groundwater protection plan. They argued that research methodology can be used to estimate the value which people place on various water resources and can help to predict whether water policies and projects will be accepted by the public.

### 3.2 Study area

**Figure 3.2.1 Map of North Tongu District**



Source: Ghana Statistical Service, 2014.

The study will be conducted in Aveyime in the North Tongu district of the Volta region of Ghana (Fig. 1). The district lies within latitude 5° 47' North to 6° North and longitude 0° 5' East. The total area of the district is 1460 km square, which is about 7.1% of the Volta Region. The total population estimate in 2010 stands at 87,777 inhabitants, of which 57 percent are engaged in agriculture. The district has a tropical climate with two distinct rainy seasons. The major rainy season starts from mid-April to early July and the minor from September to November. The average annual rainfall varies from 900mm to 1100mm with more than 50 percent occurring in the major season. The mean temperature is 27°C the daily minimum and maximum temperature is 22°C and 33°C respectively. The district is predominantly composed of medium to moderately coarse textured alluvial soils with heavy clay underneath. These soils are difficult to cultivate because they have low

water holding capacity. They are however, suitable for rice and sugarcane cultivation under irrigation. Aveyime is the only area suitable for rice production in the district (GSS 2014). The total area cultivated to rice is 2090 hectares with an annual production of 6479 metric tons ([http://mofa.gov.gh/site/?page\\_id=1729](http://mofa.gov.gh/site/?page_id=1729)).

### **3.3 Population and sampling approach**

The study population is smallholder rice farmers in Aveyime-North Tongu district in the Volta region of Ghana. A reconnaissance survey was carried out in the proposed study area to familiarization with farmers and rice production systems. The district was selected purposely because it is one of the major rice producing sites in Ghana. Also, there is a current increase use of chemical pesticide among farmers in the area. The stratified sampling procedure will be employed to categorize farmers into two main strata: conventional and organic rice farmers. From each stratum, the simple random procedure will be employed to select interviewed farmers. A total of 300 farmers will be interviewed, which will include 270 conventional and 30 organic rice farmers respectively.

### **3.4 Instrumentation and data collection**

The study will use pre-tested questionnaires in a one-on-one interview with rice farmers to collect primary data. Two trained enumerators from the Ministry of Food and Agriculture (MOFA) will aid in the administration of questionnaires. The questionnaires will include both open and close ended questions to aid the collection of qualitative and quantitative data. The questions will be written in English, but to ensure that respondents understand and respond to questions appropriately, the enumerators will conduct the interview in their local language called interview Ewe. Health official(s) from the Battor Municipal Hospital will also be interviewed, to gather information on health cost associated with pesticide poisoning in the study area. The one-on-one questionnaires will comprise of three major categories of questions based on (i) demographic and production information of respondent rice farmers (i.e., age, sex, educational background, system of production, area cultivated to rice, production cost, yield, income etc.), (ii) pesticide use practices and management (i.e., types of pesticide used, frequency of pesticide application, the use of protective clothing, knowledge of pesticide hazards, disease conditions associate with the use of pesticides, cost treatment etc.), and (iii) farmers' Willingness-to-Pay (WTP) to clean up contaminated groundwater and Willingness-to- Accept (WTA) organic farming over conventional farming systems.

Secondary data on the lists of registered and banned pesticides will be obtained from the Environmental Protection Agency (EPA). Data will also be obtained from reviewed literature and database of relevant organizations.

### **3.5 Data Analysis and interpretation**

Data collected, will be coded and processed using the Statistical Package for Social Sciences (SPSS). Further analysis will be done with the aid of descriptive and inferential statistics.

## Reference

- [ 1] Alabi, Omotayo Olugbenga, Federal Capital Territory, Alimi Folorunsho Lawal, Extension Services, Ayodeji Alexander Coker, Extension Technology, Yisau Akanfe Awoyinka, and National Planning Commission. 2014. “Probit Model Analysis of Smallholder ’s Farmers Decision to Use Agrochemical Inputs in Gwagwalada and Kuje Area Councils of Federal Capital Territory , Abuja , Nigeria Omotayo Olugbenga Alabi Department of Agricultural-Economics and Extension , Faculty O.” *International Journal of Food and Agricultural Economics* 2 (1): 85–93. doi:10.1073/pnas.1011013108.
- [2] Boussemart, Jean-Philippe, Hervé Leleu, and Oluwaseun Ojo. 2010. “The Spread of Pesticide Practices among Cost Efficient Farmers,” no. Umr 8179.
- [3] Creswell, J.W., 2013. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- [4] Fianko, Joseph R. 2011. “Agrochemicals and the Ghanaian Environment, a Review.” *Journal of Environmental Protection* 02 (May): 221–30. doi:10.4236/jep.2011.23026.
- [5] Frimpong, K. S., Philip O Yeboah, John J Fletcher, John Pwamang, and Dickson Adomako. 2012. “Assessment of Synthetic Pyrethroids Pesticides Residues in Cocoa Beans from Ghana.” *Food Science* 49: 9871–75.
- [6] Ghana Statistical Service (GSS). 2014. “2010 Population and Housing Cencus, District Analytical Report, North Tongu District.” [http://statsghana.gov.gh/docfiles/2010\\_District\\_Report/Eastern/NORTH\\_TONGU.pdf](http://statsghana.gov.gh/docfiles/2010_District_Report/Eastern/NORTH_TONGU.pdf).
- [7] Glover-Amengor, M, and Fm Tetteh. 2008. “Effect of Pesticide Application Rate on Yield of Vegetables and Soil Microbial Communities.” *West African Journal of Applied Ecology* 12 (1978): 41–47. doi:10.4314/wajae.v12i1.45749.
- [8] “Improving the Competitiveness of Local Rice.pdf.” n.d.
- [ 9] Ministry of Food and Agriculture (MOFA) 2010. [http://mofa.gov.gh/site/?page\\_id=1729](http://mofa.gov.gh/site/?page_id=1729)
- [10] PAS and partners. 2012. “PESTICIDE CRISIS The Need for Further Government Action,” no. April.
- [11] Ragasa, Catherine, Awere Dankyi, Patricia Acheampong, Alexander Nimo Wiredu, Antony Chapoto, Marian Asamoah, and Robert Tripp. 2013. “Patterns of Adoption of Improved Rice Technologies in Ghana.” *IFPRI Working Paper N 35*, no. July.
- [12] Shultz, Steven D., and Bruce E. Lindsay. 1990. “The Willingness to Pay for Groundwater Protection.” *Water Resources Research* 26 (9): 1869–75. doi:10.1029/WR026i009p01869.
- [13] Tetteh Anang, Benjamin. 2015. “Factors Influencing Pesticide Use in Smallholder Rice Production in Northern Ghana.” *Agriculture, Forestry and Fisheries* 4 (2): 77. doi:10.11648/j.aff.20150402.19.