Economic Effect of Inorganic Pesticide Use on *Fadama* II Rice Farming in Ibaji Local Government Area, Kogi State, Nigeria

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Abstract
This study investigated the economic effect of inorganic pesticide use on Fadama II rice farming in Ibaji L.G.A, Kogi State, Nigeria. A total of 120 pesticide users were selected through multi-stage random sampling procedure from three Fadama Community Associations (FCAs) in Ejule ojiebe, Iyano, and Odeke of Ibaji L.G.A. Data collected through structured questionnaire were analyzed using descriptive statistics, gross margin analysis, multiple regression analysis, and mean score. The results revealed that fadama rice farming in the study area is generally practiced by females who are in the active labour age range of 31-50 years, with an average farm size of 2ha. Awareness on Integrated Pest Management (IPM) system and its level of adoption was high. The result also showed that the average gross margin for rice farming per hectare in the study area was ₦ 68,500 and the benefit cost ratio was 1.95, indicating the profitability of rice production enterprise in the study area. Effect of inorganic pesticide on farmers' output has a positi ve correlation and significant at 1%. This study recommends that fadama rice farmers should be encouraged through extension facilities to expand the scale of pesticide use in other to take advantage of economies of scale in applying the actual quantity of inorganic pesticide and other new technologies.

1. INTRODUCTION

Fadama are flood plains and low-land areas underlined by shallow aquifers and found along Nigeria's major river systems. *Fadama* has five components viz capacity building, pilot asset acquisition support, rural infrastructure investment, demand-driven advisory services and project management, monitoring and evaluation. The *fadama* agriculture is characterized by mixed cropping and livestock production. The major crops are cereals such as maize, rice, wheat and sorghum; vegetables like onion, garlic, fluted pumpkin, cabbage, garden-egg, carrots, lettuce, cucumber, potatoes, pepper and okra; grain legumes (cowpea); and tuber crops such as potatoes.

The National *Fadama* Development Project phase one was implemented between 1992 and 1999 and was adjudged successful. First Fadama project focused on farming along the floodplains, but *Fadama* II and III moved beyond the floodplains to cover a diverse range of agro ecosystems, productive activities, land and water uses (Bukar 2009).

Fadama lands are a geomorphologic phenomenon that resulted from the combination of slow river bed accumulation and periods of high rainfall runoffs that caused extensive flooding and deposition of materials over the flood plains. These flood plains cover some three million hectares country-wide and extend throughout all ecological zones, showing a great variation in ecology, land use and different economic and environmental values. They amount to about 25,000 sq. km or about 3% of the total land area of Nigeria. Most of the fadama area is situated along the main rivers of which, about 0.3 million ha (12 %) are found in the Northern region and about 0.4 million ha or 14% are found in the Middle Belt Region. Most of the *fadama*, 1.8 million ha (74%) are found in the southern zone (Anaso,1994). The soils of *fadama* are subjected to seasonal flooding and are naturally rich in nutrients deposited in the plains at the recession of the flood. Large volumes of sediments are seasonally discharged into the flood plains and help to renew the fertility of the soils. The abundance of water and the seasonal supply of fresh alluvium make these soils fertile and suitable for rice and other crops such as maize and sugarcane.

Food and Agriculture Organization of the United Nations (FAO, 2008) defines pest as: "Any form of plant or animal like or any pathogenic organism that is injurious or potentially injurious to plants, plant products, livestock or people". This definition covers a wide range of organisms (plants, animals and micro-organisms) that reduce the productivity of agriculture, destroy produce or render it unfit for human use, and includes organisms (vectors) that transmit diseases causing debilitating conditions in agriculture or public health. Although all organisms causing any damage to crops can be regarded as potential pests, it is usual to use the term strictly for organisms causing significant (economic) damage.

They could be classified into weeds like spear grass, water weed; birds such as *Quelea*; rodents like *Rattus sp*; mollusk like the small African snail; insects such as rice weevils; nematodes like Root knot nematode; and helminthes.

Developing countries have recorded enormous pre- and post harvest losses of crops due to pests (IFPRI, 1996). The UN Food and Agriculture Organization (FAO, 2004) has estimated pre-harvest crop losses due to weed infestation, plant diseases, arthropods (largely insects and termites), and vertebrate pests (rodents and birds) to be around 30 to 35%, and post-harvest losses (grain storage) amounted to an additional 10–20%. In Africa and Asia, pre harvest losses are estimated at 50 percent of crops (FAO, 2004). These alarming losses must be reduced if an increasing world population is to be fed largely from existing farmland.

The relatively more modern methods of pest management could be grouped into inorganic pesticides and organic strategies. The organic (non-chemical) strategies of pest management include plant breeding, the use of biological control agents, biotechnology (biopesticides and genetic engineering), and Integrated Pest Management (IPM). "Integrated Pest Management is an approach to enhancing crop and livestock production, based on an understanding of ecological principles, that empowers farmers to promote the health of crops and animals within a well-balanced agro-ecosystem, making full use of available technologies, especially host resistance, biological control and cultural practices. Inorganic pesticides are used only when the above measures fail to keep pests below acceptable levels, and when assessment of associated risks and benefits (considering effects on human and environmental health, as well as profitability) indicates that the benefits of their use outweigh the costs. All interventions are need-based and are applied in ways that minimize undesirable side-effects." (FAO, 2008). It is a flexible approach, which combines a range of pest control methods that simultaneously generate highest value to the farmer and environmentally acceptable and sustainable outcomes

Chemicals have played an important role in improving the lives of millions of people worldwide. The use of chemicals has been integrated into every aspect of human life. They play an important role in intensive agriculture. They offer the most attractive low cost method of increasing output per hectare of land and give the farmer a high economic return for his labour and investment (Anaso, 1994). The potential for inorganic pesticide application is considerably increased in developing countries where its advantages seem to have not been fully explored.

Inorganic pesticide is the most effective method of controlling most insect pests, weeds and diseases. Despite intensive research into alternative methods, pesticides remain our most powerful tool in pest management in spite of popular pressure to have their use curtailed. Higher standard of living by an ever-increasing human population and the preference for 'clean produce' would undoubtedly mean increased use of inorganic pesticides. Without chemical control, man's crops would be ravaged by disease, insect pests and weeds and severe loss of food production would undoubtedly occur. Inorganic Pesticides are increasingly been used to control insect pests, disease attacks and to produce weed-free crops. Inorganic Pesticides are also playing a leading role in controlling pests of public health importance (Nguyen and Tran, 1997).

A number of studies (Headley, 1968; Carlson, 1977; Oerke *et al*., 1995) have attempted to measure pesticide productivity and concluded that the value of the marginal product of pesticides exceeds the marginal factor cost of the pesticide. However, Pingali and Carlson (1985) estimated simultaneous equation models involving crop and pesticide demand and found overuse of pesticides. Thus the result of studies in respect of pesticide utilization is mixed since some found over utilization of these chemicals while others found underutilization depending on the methodology employed hence, there is need for further research into pesticide utilization.

Ibaji local government area is a rice growing area which attracted a project called *Fadama* II from the state Agricultural Development Project. The *Fadama* II package involves the use of pesticides and Integrated Pest Management (IPM) system for control of insects.

However, a management survey conducted by Kogi State Agricultural Development Project (KADP) in 1993 showed that only 0.35% of total input cost for sole crops was spent on chemical pesticides. For mixed crops, 0.46% was spent on chemical pesticide. This level of investment is too low to make any reasonable impact on the total output.

How ibaji rice farmers utilize this pesticide need to be investigated. Do they over utilize it as claimed by Pingali and Carlson, 1985 or under utilize it.

There is certainly a need to investigate and find out the effect of pesticide on the income of *Fadama* farmers. Also, addressing the issue of Integrated Pest Management (IPM) system is necessary to bring to limelight, the new method for pest management and control.

It is in view of the above that the following research questions emerge; What is the level of awareness of Integrated Pest Management? Is there any increase in farmers' output due to inorganic pesticide use? What is the application cost?

The objectives for this study are therefore to; describe the demographic characteristics of the respondents; determine the level of awareness and adoption of the use of Integrated Pest Management (IPM) system; determine the costs and returns in *Fadama* II rice farming and also determine the effect of inorganic pesticide use on the farm income of *Fadama* II users in Ibaji L.G.A of Kogi State, Nigeria.

2. MATERIALS AND METHODS

This study was carried out in Ibaji Local Government Area of Kogi State, Nigeria. Ibaji Local Government Area is located on the Eastern flank of Kogi State. It is separated from Edo State to the west by the Niger River, and bordering Delta State in the south. It's headquarter is in the town of Onyedega on the Niger River in the northwest of the area. The north easterly line of equal latitude and longitude passes through the LGA. It has an area of 1,377 km² and a population of 128,129 by the 2006 census. Geographically, it is located between longitude $6^{0}45^{1}$E and $7^{0}00^{1}$E and latitude $6^{0}45^{1}$ and $7^{0}00^{1}$N. Its population is primarily Igala speaking tribe (KADP, 2008).

Cultivation of food crops such as rice, vegetables, yam, cassava, sorghum, maize, millet, cowpea, and groundnut predominate the agricultural practice in the Local Government Area, while mixed cropping is the common farming system. The major occupation engaged is crop farming but a lot of fishing activities are carried out on the river banks.

The study area have two distinct seasons - the wet (raining) season which starts around the month of April and last for 6 months while the dry season last for 6 months with harmattan period lasting for 3 months.

A multi-stage random sampling procedure was used in selecting the sample.

Stage 1: Three *Fadama* Community Associations (FCAs) in Ejule ojiebe, Iyano, and Odeke of Ibaji L.G.A, Kogi State, Nigeria were purposively selected. This is because *Fadama* Development Project (*Fadama* II) was located only in these communities of Ibaji L.G.A.

Stage 2: Four *Fadama* User Groups (FUGs) were randomly selected from the list of *Fadama* User Groups in each of the *Fadama* Community Associations to bring the total FUGs selected to twelve.

Stage 3: Ten *Fadama* users were randomly selected from the twelve villages that constituted the *Fadama* User Groups. A total of one hundred and twenty respondents were used for the study.

Primary data were collected from the respondents who are the users of agricultural inorganic pesticides using structured questionnaire. The data collected include: quantity, price and application costs of inorganic pesticides; farm size, type of crops grown; yield and prices of outputs and other relevant variables. Secondary data were obtained from journals, Kogi State Agricultural Development Project (KSADP), *Fadama* Coordination Unit and other related publications.

Descriptive statistics such as frequency and percentages were used to describe the demographic characteristics, level of awareness and adoption of IPM system by *Fadama* II farmers. Cost and returns were calculated with the use of Gross margin analysis while effect of inorganic pesticide on farmers' output was measured using multiple regression analysis.

Model Specification:

i. Gross Margin Analysis

GM = TR – TVC................................ (1)

Where;

GM = Gross Margin (₦)
TR = Total Revenue (₦)
TVC = Total Variable Cost (₦)

It is believed that if a business can recover its variable cost, then, it is capable of continuing in the short run.

ii. Multiple Regression Analysis

Regression analysis: A multi-factor production function investigated in this study is expressed mathematically as;

$Y = f(X_s)$
$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, e_i)$
$Y = \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+e_i$

Where:
Y= Output (kg)
β_0= Intercept (kg)
β= Marginal effect of X_S on Y
X_1= Capital consumption (₦)
X_2= Educational status (number of years spent in school)
X_3= Farming experience (years)
X_4= Cost of pesticide (₦)
X_5= Cost of herbicide (₦)
X_6= Age of the farmer (years)
X_7= Labour input (man-days)
e_i= Error term

A priori expectations

It is expected that
b1>0, b2>0, b3>0, b4>0, b5>0, b6>0, b7>0

Three functional forms of the equation above were analyzed and the one with best fit selected as the lead equation. The lead equation used was based on the R^2 and the value of the estimated coefficients. The functional forms:

The linear functional form:
$Y = b_0+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+e_i$

The Semi-log functional form:

$$Y = b_0+b_1LnX_1+b_2LnX_2+b_3LnX_3+b_4LnX_4+b_5LnX_5+b_6LnX_6+b_7LnX_7+e_i$$

The Double-log functional form:

$$LnY=b_0+b_1LnX_1+b_2LnX_2+b_3LnX_3+b_4LnX_4+b_5LnX_5+b_6LnX_6+b_7LnX_7+e_i$$

3. Results and Discussion

Table 1: show that about 36 percent of the respondents were in the age range of 41-50 years. Sixty-four percent of the respondents were in the range of 31-50 years old. The mean age was 45 years. This could be explained that most of the respondents were still energetic for rice farming. It is common knowledge that farming in developing countries like Nigeria is labour intensive and as such, requires a lot of labour, and this is in agreement with the findings of (Aliou, 2006) who reported that average age of rice farmers in Cote D'voire, a developing country in West Africa was 41 years. Ogundele and Okoruwa (2006) asserted that only those farmers within the productive age group of 20-45 years are likely to posses the necessary strength to carry out farming operations.

About 77 percent of the respondents were females while only 23 percent were males. This is in contrast with Adeoti (2006), who reported that more men were found in farming than women. Findings of this research in respect to gender may be attributed to the fact that more women are involved in rice farming due to the less tedious nature of its operations after cultivation. Men in the study area are into yam production and fishing.

Sixty-nine percent of the respondents were married while only 12 percent were single. This implies that, rice farming in the study area was mostly carried out by married women with the youths migrating to urban areas in search of 'white collar job' which is not forth coming.

Household size of most respondents ranged from 4-9 members (73 percent) to those with less than 4 members (20 percent). The mean household size was about 7 members per household. It is expected that, members of the household will serve as source of cheap labour on the farm. The range of household size is lower when compared with what is obtainable in the Northern part of the country, which recorded an average size of 13 members per household (Salisu, 2001). This may be attributed to socio-cultural factors outside the scope of this study.

About 39 percent of the respondents had primary education, 32 percent had no formal education; 24 percent had secondary education, while only 5 percent attended tertiary institutions. It is thus obvious that the educational standard of the respondents are generally low, but not as low as other region in Nigeria, especially South eastern Nigeria and Northern part, (Akinsanmi and Doppler, 2005). This relatively higher educational status may encourage acceptance of innovation which may raise farm productivity and income.

About 53 percent of the respondents had farm sizes of 1-3 hectares, 37 percent had farm sizes that is above 3 hectares. The mean hectares of land in the area are 2 hectares. This confirms the result of a study carried out in south-eastern Nigeria (Agwu and Anyanwu, 1996) where the number of hectares cultivated per farmer was found to be about 1.5 hectares.

About 47 percent of *Fadama* II rice farmers in the study area had annual income of ₦10, 000.00 to ₦100, 000.00 from rice production. This implies that, rice farming in the study area is still at the subsistence level. Mikloda (2006), associated low income with poverty. Also, according to Amalu (2005), over 90% of the country's food supply comes from the agricultural population who are smallholder farmers.

As seen in Table 2; 87.5 percent of the respondents were aware of the IPM system. About 12 percent of the *Fadama* II rice farmers in the study area were not aware of the modern method of pest management. It can be opined from the result that, the concept of Integrated Pest Management system is widely known in the study area. 83 percent of respondents adopted the IPM system. Seventeen percent of the total respondent who are users of inorganic pesticides did not adopt the new IPM system.

Table 1: Distribution of Respondents According to Demographic Characteristics.

Demographic Characteristics	No. of Respondents	Percentage (%)
A. Age Category (years)		
Less than 20		
20-30	14	12
31-40	34	28
41-50	43	36
51-60	20	17
Above 60	9	7
Total	**120**	**100**
B. Sex		
Male	27	23
Female	93	77
Total	**120**	**100**
C. Marital Status		
Single	15	12
Married	83	69
Divorced	6	5
Widow	8	7
Widower	8	7
Total	**120**	**100**
D. Family Size (number)		
Less than 4	24	20
4-9	88	73
Above 9	8	7

Total	**120**	**100**
E. Educational Status		
Informal Education (0 years)	38	32
Primary Education (1-6 years)	47	39
Secondary Education (6-12 years)	29	24
Tertiary Education (Above 12 years)	6	5
Total	**120**	**100**
F. Farm Size (hectares)		
Less than 1	12	10
1-3	63	53
Above 3	45	37
Total	**120**	**100**
G. Income Level (₦)		
Below 50,000	10	8
50,000-100,000	47	39
110,000-150,000	35	29
Above 150,000	28	24
Total	**120**	**100**

Source: Field Survey, 2011.

However, 76 percent of the IPM system adopters' agreed that high cost of hired labour, profitability, and convenience of IPM practice were the major reasons for adopting the IPM system. While, 75% of the non-adopters agreed on lack of awareness as the main reason for not adopting IPM practice. Twenty-five percent of the non-adopters viewed lack of training/extension and convenience of inorganic pesticides as reasons for rejecting the IPM system.

Results on cost and return analysis in Table 3, suggests that an average of 25bags of 100kg paddy rice was realized from a hectare of rice farm, with a bag costing ₦5000. This gives a total return of ₦ 125,000 and a total variable costs of ₦56,500 with gross return of ₦ 68,500. A positive gross margin reveal that rice farming in the study area was profitable, since it is believed that if a business can recover its variable cost, then, it is capable of continuing in the short run. Benefit Cost Ratio of 1.95 implies that, every 1₦ invested in rice farming generates revenue of ₦1.95k. Indicating that rice farming in the study area is viable.

Table 2: Farmers Level of Awareness and Adoption of Integrated Pest Management (IPM) Syste

1. Awareness on IPM system	**No. of Respondents**	**Percentage (%)**
Yes	105	87.5
No	15	12.5

Total	**120**	**100**
2. Adoption of the IPM system		
Yes	100	83
No	20	17
Total	**120**	**100**
3. Reasons for Adoption		
High cost of Hired Labour	1	1
Profitability	10	10
Convenient	13	13
All of the above	76	76
Total	**100**	**100**
4. Reasons for Non-adoption		
Lack of awareness	15	75
Lack of training/extension	0	0
Convenience of inorganic pesticides	0	0
No. II and III above	5	25
All of the above	0	0
Total	**20**	**100**

Source: Field Survey, 2011.

Table 3: Gross Margin Analysis of *Fadama* II Rice Farming per Hectare

S/N	Items	Total quantity	Unit cost (₦)	TR/TC (₦)
A	**Returns**			
.	Rice output	25 bags (100kg)	5000	125,000
	Total Returns (TR)			125,000
B	**Variable Costs**			
I	**Labour cost**			
	Land preparation (including nursery)	12 MD	900	10,800
	Planting (including transplanting)	11 MD	500	5,500
	Weeding	7 MD	500	3,500
	Pesticide application	2 MD	500	1000
	Fertilizer application	6 MD	500	3000
.	Harvesting	8 MD	500	4000
	Bird Scaring	5 MD	500	2500
	Total Labour Cost			**30,300**
II	**Operating Input Costs**			
	Seeds	1 Bucket	2000	2,000
	Fertilizer	4 Bags	3000	12,000
	Pesticide	2 litres	700	1,400
	Herbicide	6 Litres	800	4,800
	Transportation	LS	-	5000
	Miscellaneous	LS	-	1,000
	Total operating input cost			**26,200**
	Total Variable Cost (I + II)			**56,500**

C	**Fixed costs**	
	Depreciation of fixed assets excluding land (tools and equipment)	7500
	Total Fixed Costs (TFC)	7500
	Total Costs (TC) = TFC+TVC	64,000
	Gross Margin = TR-TVC	68,500
	Benefit-Cost Ratio (TR/TC)	1.95

Source: Computed from field survey data, 2011.
Note: MD= Man-day LS= lump sum

The regression result of the estimated lead equation (Double log) in Table 4, shows that, the coefficient of multiple determination (R^2) of 0.81 implies that 81 percent variability in the output of rice enterprise was explained by the model while the remaining 21 percent could be attributed to error and omitted variables. The F-value of 0.67 which was significant confirms the significance of the entire model. Amount spent on inorganic pesticides and herbicides were found to be positively correlated to farmers' output and significant at one percent. This suggests that an increase in the amount spent on these important variables, will lead to increa[illegible] Page 1068 output from rice production. This is [illegible] *priori expectation* of the study. Also, man-days of labour revealed a positive relationship with output. This relationship was significant at 5 percent level or probability (95 percent confident). By implication, the more man-days of labour used in rice production, the higher the output from the enterprise.

Table 4: Regression result for the effect of inorganic pesticide use on the farm output of *fadama* rice farmers.

Variables	**Linear**	**Semi-lg**	**Double-log**
Constant	-0.669(-20527.682)	**-4.913(-1.083E6)	*2.161(1.114)
Cost of pesticide	2.101(3.799)	**3.088(75137.166)	**4.015(0.229)
Age	0.174(60.976)	0.192(6270.871)	0.110(0.008)
Man-days of labour	1.427(47.547)	*2.157(90490.673)	*2.487(0.244)
Farming experience	2.101(10539.021)	0.994(29944.016)	1.524(0.107)
Capital consumption	0.345(0.262)	0.419(20742.017)	1.648(0.191)
Educational status	**3.316(15596.349)	-0.528(-9407.135)	0.352(0.015)
Cost of herbicide	**7.305(7.961)	**5.478(161228.009)	**6.253(0.430)
R^2	0.700	0.731	0.808
Adjusted R^2	0.681	0.715	0.796
F-value	**37.349	**43.553	**67.211

Source: Computed from field survey data, 2011.
*= Coefficient significant at five percent (5%) level of significance, (that is, 95% confident).
**= Coefficient significant at one (1%) level of significance, (that is, 99% confident).
Values in parenthesis are the coefficient of each production variable.

Tabulated Values

$F_{120, 7}$	$T_{120, 7}$
$F_{10} = 1.77$	$T_{10} = 1.658$
$F_5 = 2.09$	$T_5 = 1.98$
$F_1 = 2.79$	$T_1 = 2.617$

The regression result of the estimated lead equation (Double log) is presented as;

$$Y = 1.114 \times X_1^{0.229} \times X_2^{0.008} \times X_3^{0.244} \times X_4^{0.107} \times X_5^{0.191} \times X_6^{0.015} \times X_7^{0.430}$$

$$Y=1.114+0.229X_1+ 0.008X_2+0.244X_3+0.107X_4+0.191X_5+0.015X_6+0.430X_7$$

(2.161) (4.015)** (0.110) (2.487)* (1.524) (1.648) (-0.352) (6.253)**
0.033 0.000 0.913 0.014 0.130 0.102 0.725 0.000

This result validates the findings of Alimi and Ayanwale (2004) who reported a positive correlation between pesticide and rice farmers' output, significant at 5%. Nguyen and Tran (1997) in similar studies reported a positive relationship between labour and pesticide with paddy rice productivity in Vietnam. The level of significance was 10%. Similarly, the positive coefficient of farming experience, labour and pesticide cost is in conformity with earlier findings by Ojo (2000); and Ogundari and Ojo (2005).

4. CONCLUSION

Farmers' level of awareness and adoption of the IPM system is quite encouraging. *Fadama* II rice farming is economically advisable. Also, inorganic pesticide played a significant role in farmer's income from rice production.

More extension facilities should be provided to farmers, so as to expand the scale of inorganic pesticide use.

5. Recommendation

1. New technologies aimed at saving labour and increasing farm level productivity adaptable to the farming conditions in the area should be developed to solve the problems of unavailability and high cost of labour.

2. Removing import duties on inorganic pesticide meant for agricultural use. This can be achieved by separating custom import tariff between pesticides for agriculture and those for other uses.

3. Diagnose pest problems affecting *fadama* crop production as the basis for *Fadama* Community Association (FCA) members to develop a shared vision on priority needs and IPM opportunities.

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