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Profitability of different sawah rice production models within lowlands in Nigeria

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Abstract

This paper examines the profitability of different sawah rice production models within lowlands in Nigeria. This is predicated on the fact that since the introduction of sawah production technologies by Japanese institutions in Nigeria, different typologies as found applicable within the farmers' environment had been adopted. The study was carried out in Nigeria and covered 12 fields in Nigeria with 80 farmers randomly selected. A structured questionnaire with a reliability coefficient of 0.85 was used to elicit information on socio-economic characteristics, farm characteristics and costs incurred on variable and fixed inputs and output. Descriptive statistics was used to describe the data while gross margin analysis was used to determine the profitability of different sawah production models. The results show that majority of the farmers are about 42 years of age having quranic form of education, belonging to at least one farmers group and have been farming for about 12 years. The land tenure system is predominantly through inheritance, while those on hired the land have an average period of about 6 years as the tenancy period with a rent rate of ₦2000 per month. The gross margin analysis shows that spring based sawah typology is the most profitable either with farmers renting power tiller or those owning power tillers.

Key words: Sawah, profitability, gross margin, power tiller, rice, lowlands, Nigeria.

Introduction

Food production is at the heart of the West African economy and agriculture which involves 70% of the workforce of the region is looked upon to provide. The demand for rice in sub-Saharan Africa in general is growing much faster than for any other grain, with both the rich and the urban poor relying on it as a major source of calories. The preferential behavior of consumers has meant that social stability may be impaired when rice becomes suddenly unavailable or unaffordable. It then implies that rice availability and rice prices impact directly on the welfare of the poorest West African consumers who are the least food secure. Since consumption runs ahead of local production, imports have become inevitable and occur at an annual growth rate of about 8% [1]. Fourteen countries in sub-Saharan Africa (SSA) import more than 6 million metric tons (t) of rice annually in addition to more than 12 million tons produced locally [2]. Rice is an important staple food crop in many parts of SSA, yet SSA is food insecure in rice and loses over one billion USD in foreign exchange annually. Nigeria, Madagascar, Guinea, Ivory Coast and Tanzania are the leading rice producing countries.

Since the beginning of the new millennium, imports have further soared, with the Food and Agricultural Organization of the United Nations (FAO) predicting that as much as 4 million tons of rice may be imported annually into the region. The best solution for this problem for SSA is to make improvements in rice production, postharvest handling and processing and utilization technologies so that locally-produced rice can compete in quantity and quality with the imported one. Such actions will help increase farmers' incomes, satisfy rice consumers and contribute to the economies of SSA countries [3].

Production of rice from local effort has preoccupied policy makers in the region for many years. This is more so because of the suitability of most of the agroecological and climatic regions of West Africa for rice cultivation. Indeed, the establishment of the West Africa Rice Development Association (WARDA) was to rice-target, integrated agricultural programmes in most of the countries, was envisaged and planned. Kormawa and Akande [4] assessed comparative advantage in the production of rice in West Africa. This was to provide a guide to how rice expansion programme can be effective, and influence changing policy framework in most of the countries. It seems to be more appropriate to pursue domestic policies which tend towards guaranteeing competitive production regime [1]. Kormawa and Akande [4] noted that not all countries producing rice in West Africa are doing so at socially economically competitive level. The countries that have demonstrated the possibility of translating their natural resources into a status of comparative advantage in production are Mali, Sierra Leone, Nigeria and Burkina Faso. Other countries show varying degrees of being competitive depending on the techniques of production.

Nigeria is both the biggest consumer and importer of rice in West Africa because it is a major cereal crop of immense value and popularity. It has become a major staple food for the household in both urban and sub-urban areas of the country. Thus, the rapid increase in demand for rice in the past three decades in the country is due to rapid population growth, increased urbanization and people's preference for rice as a conventional food among others. Increased consumption has generated national demand estimated at 5 million metric tons of milled rice. Consumption of rice has grown from 3 kg per capita in the 70s to over 25 kg currently. Current domestic production is estimated at 3.2 million metric tons thereby creating a deficit of about 1.8 metric tons of the rice demand. To fill the gap, annual importation of rice is estimated to cost about US$700 million in foreign exchange annually [5].

Nigeria has all the ecological zones for rice production with about 5 million hectares. These include the flood plains, inland valleys and the upland ecology. The Federal Government of Nigeria has put in place several policies to tackle rice production problems over the years based on the existing potential for rice production in Nigeria. Several authors [6-8] have asserted that sawah rice farming system is the only solution to the long awaited green revolution in West Africa. This is predicated on the existing potentials for rice production. The numerous small inland valleys found scattered across the country where water control is the main problem offer the best rice ecology. Inland valley bottoms and hydromorphic fringes cover about 50 million hectares in West Africa [9], of which about 10 million hectares have potential for small-scale irrigated sawah based rice farming. Wakatsuki *et al.* [10] reported that the potential of sawah based rice farming is enormous in West Africa in order to stimulate the long awaited green revolution. This is predicated on the fact that the agro-ecological conditions of the core region of West Africa are quite similar to those of northeastern Thailand, where is one of the rice centers in the country. Ten to twenty million ha of sawah can produce additional food for more than 300 million people in future. The sawah based rice farming overcomes soil fertility problems through the enhancement of the geological fertilization process, conserving water resources, and the high performance multi-functionality of the sawah type wetlands. Sawah is a sustainable rice cultivating system [11], consisting of land management and irrigation. The land management is leveling, bonding, puddling and transplanting. This technique leads to higher yields [12] and sustainable production irrespective of fertilizer use [13]. Significant breakthroughs which have always been an obstacle to higher rice yield that was accomplished through sawah was the ability to utilize the inland valleys and floodplain for sustainable rice production, effective water control for rice production in inland valleys for high rice yield, the use of sawah eco-technology to overcome the shortage of fertilizers through microbial nitrogen fixation on sawah plots. It has been estimated that out of over 300 million ha lowland available and suitable for rice production in West Africa, the cultivation of 100 million ha using the sawah rice technology which guarantees 5 t ha^{-1} rice yield would ensure and sustain food security and thus the realization of the long expected green revolution in West Africa.

The sustainable productivity of sawah is more than 10 times greater than that of upland rice fields. Due to geological fertilization processes and well-known bio-physico-chemical processes of inundated sawah soils as described [14], sustainable productivity of 1 ha of sawah may be equivalent to more than 10 ha of upland fields. This value was estimated by assuming that the mean yield of upland rice without fertilizer application is 1 t/ha and the mean yield of sawah rice without fertilizer application is about 2 - 2.5 t/ha. To sustain the yield, upland fields have to lie fallow (3-year cultivation and 12-year fallow, for example). On the other hand the lowland sawah rice can be cultivated continuously for more 20 years as it has been the case in many Asian countries. Thus sustainable productivity of sawah is 10-12.5 times higher than that of upland rice field, i.e. 12.5 = (2-2.5/1) x (15/3).

The characterization of lowlands gave rise to different rice production systems in the lowland. These are sawah typologies as reported by Wakatsuki *et al.* [15] that various sawah development models with different irrigation options depend on the characteristics of valley bottom diversity in each agroecological zone. Fig. 1 summarizes the various types of rice ecologies observed in West Africa excluding deepwater rice on flood plains and mangrove swamp rice. Although production is now only 25% of total, upland rice is still common in terms of area, but without soil conservation measures upland rice is very fragile and degrades environment. The topography of West Africa is dominated by peneplains that are very flat with few undulations.

Wakatsuki *et al.* [15] classified in decreasing order of importance sawah typologies as spring irrigable, typical irrigable lowland, flood prone lowland, water harvestable lowland and lowland but upland ecology. The description above is very important in the case of sawah rice production due to the fact that sawah rice production technology involves an eco-technology which is a man-made environment with leveled and bunded rice fields with inlet and outlet connecting irrigation and drainage. The first year of sawah land development is always labor

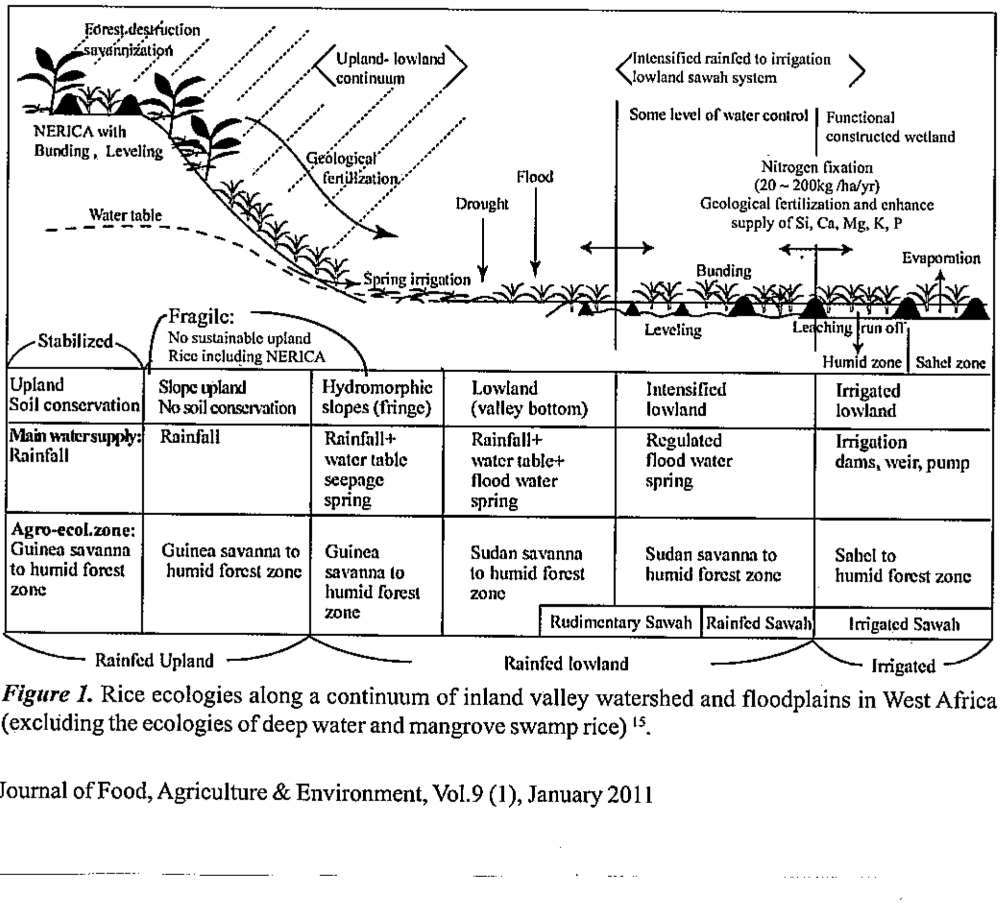

Figure 1. Rice ecologies along a continuum of inland valley watershed and floodplains in West Africa (excluding the ecologies of deep water and mangrove swamp rice) [15].

intensive and it is required that in order to enhance the profitability and sustainability of rice production, the developed plot is kept for at least 10 years if not permanently. This will enable the spread of the cost of development of the plot over the years of continuous rice production. However, the ability of farmers to invest, keep the investment and benefit from the investment of time, energy, and money on land development to be used for sawah plots is highly dependent on the tenure rights they have over such land.

Methodology

The study was carried out in Nigeria and covered 12 fields in Nigeria with 80 farmers. Most of the fields covered are in Bida area of Niger state, while a village (Pampaida) was covered in Kaduna state and Akure in Ondo state. Villages covered in Bida area include Shabamaliki, Ejeti, Ekapagi, Nasarafu, Etsuzegi and Gadza. Bida, has a clayey loamy, sandy soil, under the guinea savannah ecology and is 137 m above sea level and lies on longitude 6°01'E and latitude 9°06'N in Niger State of Nigeria. Data were collected in between August 2009 and June 2010 in all the villages where sawah rice production technology had been introduced and adopters of sawah technology were interviewed. A structured questionnaire with a reliability coefficient of 0.85 was used to elicit information on socio-economic characteristics, farm characteristics and costs incurred on variable and fixed inputs and output. Descriptive statistics was used to describe the data while gross margin analysis was used to determine the profitability of different sawah production models.

Results and Discussion

The socio-economic characteristics of the respondents covered in this study were presented in Table 1. This combines their personal and farm characteristics. The table shows that majority of the farmers is about 42 years of age having quranic form of education, belonging to at least one farmers group and has been farming for about 12 years. The land tenure system is predominantly through inheritance, while those on hired the land have an average period of about 6 years as the tenancy period with a rent rate of ₦2000 per month. Respondents are predominantly Nupe with rice as the most preferred crop for production as rooted in their culture.

From Table 2, the variations in the cost of developing different sawah typologies (spring based, flood plains, stream/river based, pond integrated and pumping machine based is a product of the morphology of the valley, reflected in the degree

Table 1. Socio-economic characteristics of respondents.

Socio-economic/farming characteristics	Description
Age	Mean = 41.96
Educational level	Predominantly Quranic
Membership of Farmer group	Predominantly members
Farming experience	Mean = 12 years
Land tenure system	Predominantly inheritance
Tenancy period	Mean = 5.92 years
Rent rate	Mean = ₦2000
Share cropping	Predominantly owners
Farming system	Rice based
Culture	Nupe based
Household size	Mean = 4.6

Table 2. Cost of sawah development activities (first year only, per ha).

		Spring based (mean slope 1.5%) No constraints	Floodplains (Fadama) based (0.5%mean slope) Flood/Drought	Stream/river based (mean slope 1%) Dyke/Weir	Pond-integrated (mean slope 1%) Pond construction	Pumping machine based (1% mean slope) Fuel cost	Non sawah (mean slope 2%)
Clearing & De-stumping	10-20 mandays @ N500 per manday	N10.000	N10.000	N10.000	N10.000	N10.000	N5.000
Bunding	20-30 mandays @ N500 per manday	N15.000	N10.000	N12.500	N12.500	N12.500	NA
Ploughing (Power tiller rent cost)	20-30 mandays @ N500 per manday	N15.000	N10.000	N12.500	N12.500	N12.500	NA
Puddling. leveling. soil movement. surface. Smoothing (Power tiller rent cost)	30-50 mandays @ N500 per manday	N30.000	N20.000	N25.000	N25.000	N25.000	NA
Pumping Machine cost	N150.000 7 years						
Pumping machine Depreciation cost	@15% of N150000/ year						
Power tiller cost	N750.000						
Power tiller life span	5 years (straight line depreciation method)						
Power tiller work rate	3 ha/year for new sawah development.3-5 years of life span						
Power tiller depreciation cost	@20% of N750000/ year						
Canal construction	@N15.000/100m/ha	NA	NA	N15.000	N10.000	NA	NA
Peripheral canal	@N5.000/100m/ha	N5000	N5.000	N5.000	N5.000	N5.000	NA
Linkage canal	@N5.000/100m/ha	N5000	NA	N5.000	N5.000	N5.000	NA
Interceptor canal	@N5.000/100m/ha	N5000	NA	N5.000	N5.000	N5.000	NA
Dyke construction	@N60.000/20x5x3m/3ha/3	NA	NA	N20.000	NA	NA	NA
Pumping machine	3-20 days @N3000/day/	NA	N15.000	NA	N9.000	N60.000	NA
Flood control /sand bags/labour	@N100.000/150x2x2m/3ha/3	NA	N40.000	N10.000	NA	NA	NA
Pond construction	@N210.000/20x20x2m/3ha/3				N70.000	NA	NA
Sub total (a)		N85.000	N 110.000	N 120.000	N 164.000	N 135.000	N 5000

of sloppiness and the cost of harvesting water/water management for these sawah types. With the spring based type with a slope of 1.5% ₦30,000 was required for the puddling and leveling of the sawah, the difference in cost of this operation in other sawah typologies which is ₦5,000 and ₦10,000, respectively, is due to volume of soil movement as a result of the steeper slope in spring based sawah. Variations also exist in the cost of constructing canals while construction of dyke, flood control, pond and the cost of pumping machine which are specifics of river based, flood plain, pond integrated and the pumping machine based, respectively. Therefore, the spring based sawah type has the lowest cost of development per hectare which is ₦85,000 while the pond integrated type has the highest cost of ₦164,000 to develop a hectare of sawah. However, the additional cost of cultivating rice in the developed sawah which is ₦68,700 is uniform for for the spring based, flood plain, river based and pond integrated based sawah type but ₦20,000 higher for the pumping machine based type put at ₦87,700. With this additional cost, the spring based type has the lowest total cost of ₦153,700 while the pond integrated type has the highest total cost of production put at ₦232,700. However, the seemingly high investment in developing sawah and cultivation of rice is adequately compensated by the high yield of rice from the different types of sawah which ranges from 4.5 to 5 tons/ha. At ₦75,000 per ton the highest gross income is ₦337,500 and ₦300,000 as the lowest. With the deduction of the total cost of production and cost of power tiller development the actual net income for the first year of sawah development is ₦36,300 with a loss of ₦36,200 as lowest. Nevertheless this cannot be accepted as total loss since the income from fish has not been added.

In Tables 3 and 4 the cost of cultivating sawah in the subsequent year is not as high as that recorded in the first year, which is ₦134,200 as highest and ₦86,700 as lowest. This is due to the fact that there may be no need for construction of new canals, dykes and bunds. All it may require is to maintain the existing ones whose cost is put at 20% of constructing new ones. This reduction in the total cost of production coupled with a slash in the cost of power tiller for development brought a favourable increase in the actual net income put ₦228,300 and ₦147,050 as highest and lowest, respectively. This wide increase in profit margin attest to the fact that sustaining land tenancy for a long period of time, at least ten years guarantees maximal returns from sawah technology (Table 5).

Conclusions

The study has clearly shown that due to the prevailing topsequences of the lowlands in Nigeria, the types of adaptable sawah rice production technology varies. These variations have implications for land management practices and consequently the profitability of these typologies. From the gross margin analysis the spring based had the highest profitability among the sawah models. The non-sawah model is now here comparable to the sawah models. This underscores the importance of farmers adopting the sawah models and the reason for farmer practicing the non-sawah method to be unable to break even.

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Table 3. Cost and income Sawah rice cultivation(first year only per ha).

		Spring based (mean slope 1.5%) No constraints	Floodplains (Fadama) based (0.5%mean slope) Flood/Drought	Stream/river based (mean slope 1%) Dyke/Weir	Pond-integrated (mean slope 1%) Pond construction	Pumping machine based (1% mean slope) Fuel cost	Non sawah (mean slope 2%)
Nursery preparation							
Land clearing and bed preparation	2mandays @ N500 per manday	N1000	N1000	N1000	N1000	N1000	N1000
Seed cost	30-60kg @5kg/N1000	N6000	N6000	N6000	N6000	N6000	N12.000
Sawah field Management and maintenance	20-60mandays @N500 per manday	N10000	N10000	N10000	N10000	N30000	NA
Transplanting Labour cost	20 mandays @ N400 per manday	N8000	N8000	N8000	N8000	N8000	N5000
Cost of line	5bundles @N300/bundle	N1500	N1500	N1500	N1500	N1500	NA
Weeding Herbicides	6litres@N1200/litre	N7200	N7200	N7200	N7200	N7200	NA
Cost of fertilizer	6bags@N2500/50kg	N15000	N15000	N15000	N15000	N15000	NA
Fertilizer labour cost	4 mandays @ N500 per manday	N2000	N2000	N2000	N2000	N2000	NA
Bird Scaring	15-45 mandays @ N200 per manday	N3000	N3000	N3000	N3000	N3000	N10.000
Harvesting	15 mandays @ N700 per manday	N10000	N10000	N10000	N10000	N10000	N10000
Threshing	10 mandays @ N500 per manday	N5000	N5000	N5000	N5000	N5000	N2500
Subtotal (b)		N68.700	N 68.700	N 68.700	N 68.700	N887.000	N 40.500
Total Cost of production (Including first year development cost only)		N 153.700	N 178.700	N 188.700	N 232.700	N 223.700	N45.500
Yield	5tha^{-1}	4.5tha^{-1}	4.0tha^{-1}	4.5tha^{-1}	4.5tha^{-1}	4.0tha^{-1}	1.5tha^{-1}
Gross income	N75000/t	N337.500	N300.000	N337.500	N337.500	N300.000	N112.500
Net Income for farmers renting power tiller		N183.800	N121.300	N148.800	N104.800	N76.300	N67.000
Power tiller cost for development US (5000 x 1.2. 1.5. 2.0)/10ha		N 15000	N 90000	N 112500	N 112500	N 112500	NA
Net income for farmers owning power tiller		N 30800	N 31300	N 36300	- N 7700	- N 36200	N 67000

Table 4. Cost of Sawah rice cultivation(Subsequent year per ha).

		Spring based (mean slope 1.5%) No constraints	Floodplains (Fadama) based (0.5%mean slope) Flood/Drought	Stream/river based (mean slope 1%) Dyke/Weir	Pond-integrated (mean slope 1%) Pond constrution	Pumping machine based (1% mean slope) Fuel cost	Non sawah (mean slope 2%)
Pumping machine	2-15 days @N3000/day/ 60% of new construction	NA	N10.000	NA	N5.000	N30.000	NA
Ploughing. (Power tiller rent cost)	7-10 mandays @ N500 per manday	N5.000	N3.500	N4.500	N4.500	N4.500	NA
Puddling. leveling. soil movement. (Power tiller rent cost)	10-15 mandays @ N500 per manday	N10.000	N7.000	N8.000	N8.000	N8.000	NA
Power tiller Work rate	10ha/year. 5-10years of life span						
Canal.Dyke. Pond. Flood Control. maintenance	20% of new construction	N3.000	N13.000	N14.000	N17.000	N3.000	NA
Nursery preparation							
Land clearing and bed preparation	2mandays @ N500 per manday	N1000	N1000	N1000	N1000	N1000	N6000
Seed cost	30-60kg @5kg/N1000	N6000	N6000	N6000	N6000	N6000	N12.000
Sawah field Management and maintenance	20-60mandays @N500 per manday	N10000	N10000	N10000	N10000	N30000	NA
Transplanting Labour cost	20 mandays @ N400 per manday	N8000	N8000	N8000	N8000	N8000	N5000
Cost of line	5bundles @N300/bundle	N1500	N1500	N1500	N1500	N1500	NA
Weeding							
Herbicides	6litres@N1200/litre	N7200	N7200	N7200	N7200	N7200	NA
Fertilizer							
Cost of fertilizer	6bags@N2500/50kg	N15000	N15000	N15000	N15000	N15000	NA
Fertilizer labour cost	4 mandays @ N500 per manday	N2000	N2000	N2000	N2000	N2000	NA
Bird Scaring	15-45 mandays @ N200 per manday	N3000	N3000	N3000	N3000	N3000	N10.000
Harvesting	15 mandays @ N700 per manday	N10000	N10000	N10000	N10000	N10000	N10000
Threshing	10 mandays @ N500 per manday	N5000	N5000	N5000	N5000	N5000	N2500
Subtotal (c)		N86.700	N 102.200	N 95.200	N 103.200	N 134.200	N 45.500
Yield	$5tha^{-1}$	$4.5tha^{-1}$	$4.0tha^{-1}$	$4.5tha^{-1}$	$4.5tha^{-1}$	$4.0tha^{-1}$	$1.5tha^{-1}$
Gross income	N75000/t	N337.500	N300.000	N337.500	N337.500	N300.000	N112.500
Net Income for farmers renting power tiller		N250.800	N197.800	N242.300	N234.300	N165.800	N72.000
Powertiller cost for sawah based farming US 95000 x 1.1. 1.25. 1.5)/50ha		N 22.500	N 16.500	N 18.750	N 18.750	N 18.750	NA
Net income for farmers owning power tiller		N 228.300	N 181.300	N 223.550	N 215.550	N 147.050	N 72.000

N150 = 1$ Mean prices at Ghana and Nigeria sites, paddy price is 500$/ton

Table 5. Profitability of different sawah models.

	Sawah types	Cost of development	Cost of rice production	Total cost of production	Gross income	Net income for farmers renting power tiller	Net income for farmers owning power tiller
1st year	Spring based	N85.000	N 68700	N 153700	N 337500	N 183800	N 30.800
	Floodplains (Fadama) based	N 110.000	N 68700	N 178700	N 300000	N 121300	N 31.300
	Stream/river based	N 120000	N 68700	N 188700	N 337500	N 148800	N 36.300
	Pond-integrated	N 164000	N 68700	N 232700	N 337500	N 104.800**	- N 7700
	Pumping machine based	N 135000	N 88700	N 223700	N 300000	N 76300	N 36200
	Non sawah	N 5000	N 40500	N 45500	N 112500	N 67000+	N 67000
		Maintenance cost	Cost of rice production.	Total cost of production	Gross income	Net income for farmers renting power tiller	Net income for farmers owning power tiller
2nd year and others*	Spring based	N18000	N 68700	N 86.700	N 337500	N 250.800	N 228.300
	Floodplains (Fadama) based	N33500	N 68700	N 102.200	N 300000	N 197.800	N 181300
	Stream/river based	N26500	N 68700	N 95.200	N 337500	N 242.300	N 223550
	Pond-integrated	N34500	N 68700	N 103.200	N 337500	N234.300	N 215550
	Pumping machine based	N45500	N 88700	N 134.200	N 300000	N 165.800	N 147050
	Non sawah	N5000	N 40500	45.500	N 112500	N67.000	N 72000

*The cost of production has been adjusted by 5% inflation rise while no increase was adjusted for yield and gross income.

** This is not an actual loss because the income from fish has not been included.