TROPICULTURA, 2001, **19**, 4, 161-165

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Economic Evaluation and Prospects for Double Rice Crop Production in Humid Forest Inland Valley Ecosystems of South Eastern Nigeria

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Keywords: Inland valley – Double rice crop – Income – Labour productivity – Intensification

Summary

The inland valleys of the humid forest ecology show considerable potential for double rice crop production because of a longer rainfall regime; but this is not commonly practised. The question as to wether the magnitude of farm income from a second rice crop would lead to its adoption was evaluated. Data was obtained between March and August 1999 from farmers fields and from an on-farm late trial with improved inputs between September and December 1999 in the Ozu Abam inland valley near Bende in South eastern Nigeria.

Results indicate that a second rice crop within the year will improve farmer income by 74 percent.

Labour costs will reduce by nine percent while capital operating costs will double with the use of improved inputs. However labour bottlenecks due to competition with upland crops, absence of mechanised dryers, power tillers and storage facilities may limit the adoption of double rice cropping.The availability of these farm level equipment and infrastructure may facilitate the adoption of double rice crop production technology in humid forest inland valley ecosystems.

Résumé

Evaluation économique et perspectives d'une double saison culturale de riz dans un bas-fond d'une forêt humide au sud-est du Nigeria

Les bas-fonds des forêts humides présentent des potentialités pour pratiquer deux saisons culturales de riz par an à cause d'une bonne répartition des précipitations. L'objectif de cette étude était d'évaluer les revenus générés par la riziculture ainsi que sa faisabilité.

Pour cela, des essais ont été réalisés, d'une part, chez des fermiers (entre mars et août 1999) et, d'autre part dans un champ expérimental (entre septembre et décembre 1999). Ce champ se situait dans un bas-fond de Ozu Abam près de Benda au sud-est du Nigeria et il a été exploité en utilisant des intrants. Les résultats obtenus montrent que la réalisation de deux récoltes par an a permis d'augmenter le revenu des fermiers de 74%. Les charges de structures ont été réduites de 9% tandis que les charges proportionnelles ont été doublées. Toutefois, la pratique de cette deuxième saison culturale présente plusieurs contraintes: concurrence avec le riz de montagne, manque de séchoirs mécaniques, manque de logements des récoltes. La résolution de ces problèmes est nécessaire pour envisager l'extension de cette pratique.

Introduction

One strategy by which intensification of agricultural production can be achieved with minimal environmental stress is to improve production in the inland valleys. The inland valleys comprise the toposequence of valley bottoms and minor flood plains which are often submerged for part of the year, their hydromorphic fringes and contiguous upland slopes and crest contribute run off and seepage to the valley bottom (1, 5). They differ from fadamas in that they have streams which also define the shape and character of the valley.

The inland valleys of the humid forest ecology show considerable potential for double rice crop production annually because of a longer rainfall regime; but double rice cropping is not commonly practised by farmers due perhaps to labour and capital constraints (3). The magnitude of farm income contributed by a second rice crop within the year would probably justify the dissemination of the technology to farmers in the humid forest inland valley ecosystems. The objective of this paper therefore is to evaluate the economic costs and returns and identify the perceived constraints and prospects for double rice crop production in humid forest inland valleys. This will provide baseline information for futher evaluation of the technology under intensive agricultural in humid inland valley ecosystems.

Methodology

Ozu Abam village is the site selected for the Inland Valley Consortium project in the humid forest ecology of

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Received on 16.11.00. and accepted for publication on 15.03.01.

Nigeria. The village has several inland valleys devoted to rice production under poor water control systems. Ozu Abam is located 15 kilometers north east of Bende (Latitude 5°34'N and longitude 7°37'E) in Arochukwu local government area of Abia state, Nigeria. Mean annual rainfall is approximately 2220 mm with three dry (< 60 mm rainfall) season months and about 240 days of rainfall on the average. Rainfall distribution is bimodal, peaking in July and September respectively. Annual ambient temperature range from 20°C to 32°C with a mean of 26°C.

In the 1999 farm production season 30 randomly selected farmers in one of the Ozu Abam inland valleys (Ubidia-Awalo) were allowed to grow rice using their own improved varieties with one weeding but without fertilizer input. A second crop rice was planted in September after the first crop was harvested by farmers in August 1999. Four varieties, namely WITA-1, WITA-4, FARO-44 and the farmers local best, SUAKOKO-8 were planted on five hectares of the same valley. Since farmers were not used to second rice cropping, the late season crop was researcher managed. Inputs such a fertilizer and a second weeding were done in the second rice crop. Labour for all farm activities were obtained from within the village at the going wage rate in 1999. The second late rice crop was harvested at the end of December 1999.

Yield samples were obtained from both the first (early) and second (late) rice crop fields. Thirty-two samples were obtained from 20 m^2 plots in farmers fields in the early season crop. Forty samples (10 samples per rice variety) were obtained at harvest from the second season rice crop. Output price as at December 1999 was obtained from the village market. Cost of production was recorded for labour, capital operating costs and land rent. Labour wage rates were obtained for nursery raising, land clearing, land preparation (packing and tilling) transplanting, weeding, bird scaring, harvesting, threshing and milling. Labour wage rates were usually based on a per "paddy" basis.
A "paddy" is about 0.089 hectares. This constitute a standard rice field size upon which all wages for labour and rent on land were based (3, 5). Milling costs was based on a service charge by millers in the village while bird scaring costs were based on a mean monthly cost. Conversion rate from paddy rice to milled rice is 0.66 following Onwueme and Sinha (7).
Capital operating costs include purchased rice seeds, interest on borrowed capital tools/equipment. Land rent is the only fixed capital item. Seed and tools were purchased by farmers from the local market. Farmers borrowed money from various sources for rice cultivation and interest paid on the loan were used to estimate cost and return in both early and late season rice cultivation. Other information collected from the village include mean landholding for rice, rice varieties cultivated by farmers, proportion of rice output that is sold, consumed at home and kept as seed stock. Data is computed using means and percentages and presented in tables and figures. Analysis of variance was used to test the statistical significance in yield of the different rice varieties planted in the second season.

Results and discussions

1. Landholding, rice varieties, productivity of labour in early and late rice output

Table 1 indicates the land area allocated to rice and other arable crop enterprises by farmers in Ozu Abam village. Mean area per household is 0.653 hectares or 7.33 fields of rice. The fallow rotation intensity (8) indicates that rice is continuously cultivated in the inland valley every year. In contrast, farmers allocate a mean of 0.409 and 0.345 hectares to the upland crop enterprises of cassava (CBCM) and yam (YBCM) based crop mixtures.

Table 1
Land Resource Allocation in Cassava (CBCM) Yam (YBCM) and Rice enterprises in Ozu Abam Inland Valley

Item	Rice	CBCM	YBCM
Mean area (ha) per household	0.653	0.409	0.345
Mean number of Fields/household	7.33	4.13	3.40
Total number of fields	220	132	105
Fallow rotation intensity	100	14.29	14.29

CBCM = Cassava based crop mixture
YBCM = Yam based crop mixture

Table 2
Rice varieties cultivated by farmers in Ozu Abam Inland Valley

Variety	Number of fields	Percentage
Suakoko-8	113.50	52
IR-5	59.75	27
Faro-15	36.25	16
Faro-29	10.5	5
Total	220	100

Table 3
Yield (tons/ha) and Productivity of Labour (kg/person day) in First and Second Rice Crop in Ozu Abam Inland Valley

Season/ Variety	Yield (Tons/ha)	n	SE	cv (%)	SD	Labour productivity (kg/person/day)
First season Improved varieties	2.54	32	0.06	13.00	0.33	13.77
Second season						
WITA-1	2.50	10	0.33	44.11	0.99	13.52
WITA-4	3.63	10	0.35	29.80	1.06	19.63
FARO-44	2.00	10	0.14	20.50	0.41	13.33
Suakoko-8	2.71	10	0.24	27.00	0.73	14.69

Table 4
Analysis of Variance on the Yield of Second Season Rice Varieties in Ozu Abam Inland Valley

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-ratio
Between groups	3	15.32	5.11	6.64*
Within groups	36	27.82	0.77	
Total	39	43.14	-	

* Significant at 0.05

Table 5
Production Costs, Input use and Returns per hectare for first (early) rice crop in Ozu Abam Inland Valley, 1940.

Item	Unit price (₦)	Unit/ha	Value (₦/ha)
Rice output (milled)	34000	1.68 tons	57,120
Capital operating costs			
Seed	24	30.4 kg	729.60
Tools	1341.1	1	1341.10
Invest on Capital	3166.06	1	3166.06
Total capital operating cost			5236.76
Labour costs			
Nursery	200	1 Manday	200
Land clearing	213.76	33.26"	7109.66
Packing	225.88	17.41"	3932.57
Land preparation	382.62	18.43"	7051.69
Transplanting	182.04	20.22"	3680.85
Fertilizer application	-	-	
First weeding	216.30	28.30"	6121.29
Second weeding	-	-	
Bird scaring	39.14	32.13"	1257.57
Harvesting and thresting	134.89	36.51"	4924.83
Milling	3200	2.54 tons	8128
Total labour cost			42406.46
Total variable cost			47643.22
Gross margin			9476.78
Fixed cost			
Land rent	3616.63	1 ha	3616.63
Total cost			51,2556.85
Net farm income			5863.15
Returns par naira invested			0.11

NB : ₦100 = US$ 1.00

Rice varieties in the study area were all improved varieties (Table 2). The important varieties cultivated by farmers Suakoko-8 or "Sofinco" in the local language.

Suokoko-8 was found in 52 percent of the farmers fields; IR-5 was found in 27 percent of the fields, FARO-15, 16 percent and FARO-29, five percent. Suokoko-8 is the farmers local best and was introduced into the study area in the early 1980's during the iron toxicity trials by the International Institute of Tropical Agriculture. Iron toxicity is still a major problem in the Ozu Abam inland valley and farmers have discovered that this variety is fairly resistant to the problem. In contrast, FARO 29 or BG 90 is one of the earliest improved varieties introduced into the area, but it is beginning to loose popularity among the farmers because of poor yield.

Rice is a commercial crop in Ozu Abam village. About 78 percent of farmers rice output is sold while 13 percent is consumed at home. Nine percent is retained as seed stock. Table 3 shows the yield (tons/ha) and productivity of labour (kg/person day) in first and second season rice crops in the Ozu Abam inland valley. Mean paddy obtained from the first (early) rice crop was 2.54 tons per hectare. The highest yield was obtained from the second rice crop of WITA-4. WITA-4 gave a yield of 3.63 tons per hectare of paddy rice, followed by the farmer's local best, Suakoko-8 with 2.71 tons per hectare. FARO-44 gave the poorest yield of 2.00 tons per hectare in the second rice cropping.

The table further indicates that labour is most productive for WITA-4 and least productive for FARO-44. Hence land and labour productivity will be most productive for WITA-4 and Suokoko-8 in the rice producing inland valleys of Ozu Abam. Table 4 indicates the analysis of variance on yield of second season rice varieties in the study area. The calculated F-value of 6.64 suggests that there is a significant difference among the second season rice varieties with respect to their yield (tons/ha) in Ozu Abam inland valley.

2. Cost and returns in early and late season rice output

Table 5 shows the production costs and returns for the early rice crop in the Ozu Abam inland valley. Total value of output is ₦ 57,120 per hectare obtained from 1.68 tons of milled rice. Total operating capital amounts to ₦ 5,236.76 per hectare or 10 percent of the total cost of production. Total labour cost (₦ 42,206.46) accounts for 83 percent of total costs while land rent (fixed costs) account for seven percent of the total cost of production. The most important cost item is milling which accounts for almost 16 percent of the total cost of production. Farmers on the average are likely to net ₦ 5,895.63 per hectare from the early rice crop. This results in a return of 11 kobo for every naira invested in the early rice crop.

Table 6 presents the production costs and return for the second (late) rice crop for the best variety (WITA-4) in the Ozu Abam inland valley. Total value of output (₦ 81,600) per hectare was obtained from 2.40 tons of milled rice. Total operating capital account for 21 percent of the total cost of production. Labour costs account for 74 percent of the total cost of production while fixed costs account for five percent of the total cost of production. The total operating capital doubled from the first (early) season planting while total labour costs declined. This is because farmers weeded once in the early rice crop while two weedings were done in the second (late) rice crop. This second weeding accounted for an extra cost of 11 percent. Similarly, fertilizer purchase and use together accounted for about 16 percent of the total cost of production. Labour charges increased by 23 percent for transplanting because labourers were asked to plant according to a recommended spacing of 20 cm by 20 cm instead of the traditional staggered planting. By contrast, land clearing and 'packing' costs reduced by 50 percent because of reduced incidence of weeds and plant biomass which made both activities easy after the harvest of the first rice crop in August 1999.

Table 6
Production Costs, Input use and Returns per hectare for second rice crop (best variety WITA-4) in Ozu Abam Inland Valley, 1999.

Item	Unit price (₦)	Unit/ha	Value (₦/ha)
Rice output (milled)	34000	2.40 tons	86,600
Capital operating costs			
Seed	24	50 kg	1,200
Tools	1,341.1	1	1,341.10
Fertilizer costs	30	300 kg	9,000.00
Interest on capital	3,166.06	1	3,166.06
Total capital operating cost			14,707.16
Labour costs			
Nursery	200	1 Manday	200
Land clearing	106.88	33.26"	3,554.83
Packing	112.94	17.41"	1,996.29
Land preparation	382.62	18.43"	7,051.69
Transplanting	227.27	20.22"	4,494.30
Fertilizer application	199.93	11.24"	2,247.21
First weeding	277.92	28.30"	7,865.1
Second weeding	277.92	28.30"	7,865.1
Bird scaring	39.14	32.13"	1,257.57
Harvesting and threshing	134.89	36.51"	4,924.83
Milling	3200	3.63 tons	11,616.00
Total labour cost			53,042.92
Total variable cost			67,750.08
Gross margin			3,849.92
Fixed cost			
Land rent	3,616.63	1 ha	3,616.63
Total cost			71,366.71
Net farm income			10,233.29
Returns par naira invested			0.14

NB : ₦100 = US$ 1.00

Table 7
Production Costs, Input use and Returns per hectare for second (late) rice crop (farmers best, Suakoko-8) in Ozu Abam, 1999.

Item	Unit price (₦)	Unit/ha	Value (₦/ha)
Rice output (milled)	34,000	1,79 tons	60,860.00
Capital operating costs			
Seed	24	50 kg	1,200
Tools	1,341.1	1	1,341.10
Fertilizer costs	30	300 kg	9,000.00
Interest on capital	3,166.06	1	3,166.06
Total capital operating cost			14,707.16
Labour costs			
Nursery	200	1 Manday	200
Land clearing	106.88	33.26"	3,554.83
Packing	112.94	17.41"	1,996.29
Land preparation	382.62	18.43"	7,051.69
Transplanting	227.27	20.22"	4,494.30
Fertilizer application	199.93	11.24"	2,247.21
First weeding	277.92	28.30"	7,865.1
Second weeding	277.92	28.30"	7,865.1
Bird scaring	39.14	32.13"	1,257.57
Harvesting and threshing	134.89	36.51"	4,924.83
Milling	3200	2,71 tons	8,672.00
Total labour cost			50,099.00
Total variable cost			64,806.16
Gross margin			- 3,946.1
Fixed cost			
Land rent	3,616.63	1 ha	3,616.63
Total cost			68,422.79
Net farm income			- 7,562.79
Returns par naira invested			- 0.11

NB : ₦100 = US$ 1.00

Net farm income from second (late) rice crop production is about ₦ 10,233.12 per hectare. This implies that income from a second rice crop using improved inputs and management will actually exceed the first (early) rice crop returns by 43 percent. Together, farmers will make 74 percent more income from second (late) rice cropping in Ozu Abam inland valley. On the other hand cost of production increased by 39 percent using improved inputs in the second season cropping.

Table 7 shows that under the same improved production methods as WITA-4, Suakoko-8 (i.e. the farmers local best) would make a negative return of 11 kobo on every naira invested. This may justify the absence of fertilizer use and two weedings by farmers when they plant this variety in the study area. Farmers maintained that the inland valley is fertile and hence there was no need to apply fertilizer.

3. Constraints and prospects for adoption of double rice crop production in Ozu Abam inland valley

Farmers observed that even though rice yields from late season planting were high and required less winnowing, a primary constraint to the adoption of the technology is its competition with upland crops for labour. Best results for double rice cropping can be obtained by planting early between the months of March and July for the first (early) rice crop and between August and December for the second (late) crop. However, this crop calendar may conflict with the upland cropping system. Labour bottlenecks are likely to arise in the months of March and April which are also the land preparation months for the upland crop enterprises of yam and cassava based crop mixtures (Figure 1). Provision of power tillers may enable farmers overcome labour bottlenecks that may be associated with early rice cropping.

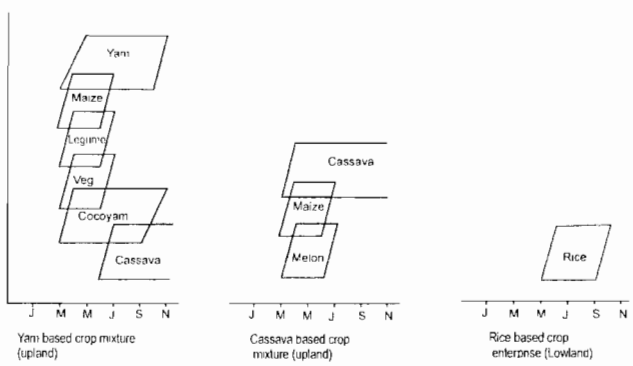

Figure 1: Major Arable cropping systems and calendar in Ozu Abam Inland Valley Ecosystem; Southeast Nigeria

Presently, farmers tend to adjust their lowland production months to the upland production months such that inland valley cultivation tend to commence after planting in the upland fields. Adjusting to double rice crop production may not be difficult for (tenant) farmers who do not own upland field but they may require wage labour for timely harvest of the early rice crop and replanting of the second crop between July and August when most labour will be allocated to weeding in upland fields. But because weeding is a female activity (2, 3) in both upland and lowland productions, while land preparation and planting of rice in the lowland are male dominated

activities, the scarcity of labour during this period is not envisaged.

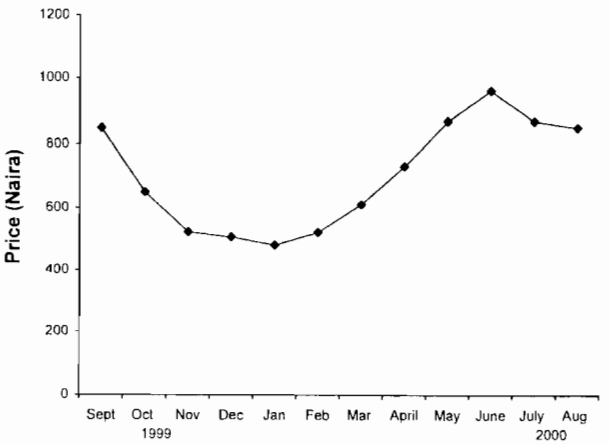

Figure 2: Mean mounthly price (Naira) of millied rice per bushel in the study area

The typical seasonal price pattern for rice which is presently harvested once a year in the study area in shown in figure 2. Rice prices begin to decline from the harvest time (because supply is large relative to demand) and rises to a peak (in June/July) prior to the next harvest. Hence as the market anticipates the increase quantity and lower prices which the new harvest will bring, prices tend to fall rapidly one to two months (August, September) before the harvest begins. Poor on-farm storage and rural infrastructure coupled with the fact that farmers need to offset debts borrowed during the production season, force them to sell most of their output at harvest when prices are relatively low. The adoption of two rice cropping per year may help even out the seasonal price peaks in (May, June and July) and troughs (December and January) within the production season. This is because the anticipated harvest of the first rice crop in the months of July and August will reduce rice prices in the hitherto peak months of June and July. The harvest of the second rice crop may stabilize prices well into the next cropping season. However, storage facilities may be necessary to enable farmers store their rice output. Otherwise, they may be forced to sell all proceeds at the time of harvest; a situation that may result in low prices for rice in the study area.

Finally another constraints to double rice cropping is that the early season crop will be harvested during the rainy season (July, August). The rains will make the traditional open-air drying difficult. This implies that a blow dryer would be required to enable farmers take advantage of the high prices of rice during this period.

Conclusion

Double rice crop production technology is feasible in humid forest inland valleys because of a favourable rainfall regime. Evidence suggests that a second rice crop within the year will improve farmers income by 74 percent under improved management.

However, there are some perceived constraints to farmer adoption of double rice crop production. These include labour bottlenecks due to competition with upland crops early in the season; the absence of mechanized dryers, power tillers and storage facilities. Partial mechanization is recommended because there is need to even out labour bottlenecks with intensification of rice production and improve drying during the rain months. The initial acquisition of power tillers and blow dryers will depend heavily on external support from government or non government organisations as the cost of investments in such technologies will be significant for small scale farmers in the study area. However, there is need for further studies to determine the cost and benefits of such an envisaged technological change on the production process (especially with respect to the demand for labour and capital outlay). There is also a need for further studies to ascertain the consequences of mechanization on the institutional, social, administrative and political systems of the study area.

Acknowledgements

I wish to express my gratitude to Drs L.T. Ogunremi, National Coordinator, Inland Valley Consortium (IVC) Nigeria and S.M. Misari, Director, National Cereals Research Institute Badeggi, Niger State, Nigeria and the funding agency of the IVC – SPIRIVWA project in Nigeria, the CFC and FAO for giving me the opportunity to be part of this development oriented research project.
My thanks also go to the two anonymous referees for their useful suggestions and comments on the paper.

Literature

1 Andriesse W. & Fresco L.O., 1991. A characterization of rice-growing environnements in West Africa. Agriculture, Ecosystems and Environnement, 33: 377-395.

2. Ezedinma C.I., 1998. The effect of population pressure and gender on farm labour use in the cassava producing zones of Sub-Saharan Africa. African Journal of Root and Tuber Crops, Vol **3** N°2. pp. 7-11.

3. Ezedinma C.I. & Obiefuna J.C., 1997. Sustainability issues in the development of rice producing inland valleys: a case study of Ubibia-Awalo in Southeastern Nigeria. In: Sustainable agricultural investment in Nigeria. Proceedings of the 13th annual conference of farm management association of Nigeria held at Federal University of Agriculture, Umudike Nigeria, 12th-15th Aug. pp. 227-234.

4. Ezedinma C.I., Olaniyan G.O. & Obiefuna J.C., 1996. Detailed characterisation of Ubibia-Awalo inland valley near Bende in Southeastern Nigeria: Land use and socio-economic chararcteristics, National contribution to the Inland Valley Consortium (IVC). Annual workshop in Bouake, Ivory-Coast 18-22 Nov. 11p.

5. Izac A-M., Swift M.J. & Andriesse W., 1991. A Strategy for inland valley agro-ecosystems research in West and Central Africa. RCMP Research Monograph N°5. Resource and Crop Management Program IITA Ibadan, Nigeria 31p.

6. NCRI: FUTO, 1998. Detailed characterisation of the Ubidia-Awalo inland valley agro-ecosystems in Southeastern Nigeria. Interim report prepared for the Inland Valley Consortium unit, Bouake, Ivory Coast, July 40p.

7. Onwueme I.C. & Sinha T.D., 1991. Field crop production in tropical Africa, C.T.A., Wageningen, The Netherlands.

8. Ruthenberg H., 1980. Farming systems in the tropics. Oxford University Press, London. 313 p.

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