

NIGERIAN AGRICULTURAL DEVELOPMENT STUDIES

Vol. 1, No 1, 2000

**J.G. Adewale and
L.T. Ogunniyi
G.S. Umoh and A.J. Adegeye**

*Assessment of the Rural Banking Scheme in Ogbomoso Zone of Oyo State
Optimal Farm Plan and Risk in Wetlands (FADAMA) Agriculture: The Case of Inland Valleys*

M.A.Y. Rahji

An Analysis of the Determinants of Agricultural Credit Approval/Loan Size by Commercial Banks in South Western Nigeria.

F.A. Kuponiyi

Mass Media in Agricultural Development: The Use of Radio by Farmers of Akinyele Local Government Area of Oyo State, Nigeria.

B.O. Agbeja

Production Efficiencies in Forest Exploritation and Regeneration in Ago-Owu and Shasha Forest Reserves, Osun State

A.O. Akinsorotan

Government withdrawal of Fertilizer Subsidy and Its Effects on Use by the Small Scale Farmers in Kajola Local Government, Oyo State, Nigeria

Tunde Ajayi

Analysis of Motivation Factors for Agricultural Trainees at the International Institute of Tropical Agriculture's Human Resource Development Programme Responsiveness of Cotton Output Supply to Price and Non-Price Factors in Nigeria: An Econometric Analysis

T.O. Oni

S.O. Odebode and C.G. Ajala

Fortification of Wheat Flour with Soyabean in the Preparation of Snacks by Women in Ibadan North Local Government Area of Oyo State, Nigeria

**B.T. Omonona, E.J. Udoh,
and M.I. Owoicho.**

Urban People's Perception and Causes of Poverty: A Case Study of Agbowo Community in Ibadan.

V.O. Akinyosoye

Agricultural Development Projects (ADPs) and Food Crops Production in Nigeria since the 70s.

Nigerian Agricultural Development Studies Vol. 1 No. 1, 2000

OPTIMAL FARM PLAN AND RISK IN WETLANDS (FADAMA) AGRICULTURE: THE CASE OF INLAND VALLEYS

G.S. UMOH

**Dept of Agricultural Economics/Extension
University of Uyo, Uyo.**

and

A.J. ADEGEYE

**Dept. of Agricultural Economics
University of Ibadan, Ibadan.**

A variant of the Linear Programming model – target MOTAD was used to determine the optimal farm plan and risk in inland valley farming in Akwa Ibom State, Nigeria. Findings reveal high degree of risk in existing (farmer) plan and sole vegetables. Risk plays an important role in farmer's decision making as multi cropping is practised to reduce the impacts of risks on farm returns. The results suggest crop diversification and implementation of risk reducing policies in order to raise agricultural output from this farming system.

INTRODUCTION

Since the mid 1960s, the agricultural sector of the Nigerian economy has faced increased urbanization and rapid population growth. Food production has failed to respond adequately to increases in the demand for food. This has led to sharp and frequent increase in food prices. As at 1995, the Central Bank of Nigeria, reported that the food index accounted for 69.1 percent of the household expenditure. The situation has been exacerbated by rapid expanding population, which, while putting pressure on land had increased the demand for food. Paradoxically, while land remains inelastic, the Nigeria annual population growth rate is put at 2.1 per cent. The pressure from the expanding population and the concomitant increasing demand for food has resulted in exploitation of limited land resources including wetlands, for the production of additional food.

The current food crisis has pushed many into wetlands farming. The wetlands have now become important to many people, especially those living along the coastlands. For instance, Udofia and Inyang (1987) identified flood plains and swamps farming as the fourth type of agricultural system in Akwa Ibom State. It is also contended that in a way, the wetlands are more important than the upland farm in that they can be

March, 2000

used all year round. In spite of the great potentials of wetlands for agricultural purposes, little or no empirical economic analysis has been carried out in Nigeria. At best, efforts have been concentrated on a particular crop such as swamp rice (Fatokun, 1980; Eremie, 1985; Olagoke 1991; Onyenweaku, 1994). Again, where such analyses are carried out, risk, a major factor in wetlands farming is not considered.

Agricultural production decisions are generally made subject to the interaction of many factors such as weather, diseases, insect infestation, technology, private and public policies. Product prices, yields and input prices are usually not known with certainty when investment decisions are made. These often result in returns displaying high variability of farm income which are unstable with the farming system and with the climatic changes, policy and institutional settings. Given this scenario, an assessment of the attitudes of farmers towards risks constitute an important consideration.

This paper investigates the optimal farm plan and risks for farmers in Akwa Ibom State, by developing risk models for inland valleys. Inland valleys constitute one of three broad types of wetlands found in the study area. Others are the flood plains and mangrove swamp.

METHODOLOGY

Sampling Procedure

Multi-stage sampling approach was used in collecting the primary data used in the study. First, inland valleys location were selected. This was followed by selection of villages in the locations. Finally, 150 inland valley farming households were randomly selected from the villages. Data on inputs used, output, crop enterprises, market prices were obtained. Historical data on crop yield, and prices were obtained from Akwa Ibom State Agricultural Development Programme (AKADEP), while data on consumer price index which was used in deflating the historical gross margin was obtained from the Central Bank of Nigeria Annual Report and Statement of Accounts (various issues).

Analytical Technique

The Target – MOTAD

The static Linear Programming (LP) model is one of the widely used farm planning techniques. Many studies in Africa (Clayton, 1961, Ogunfowora, 1970; Shapiro, 1973; Abalu, 1975; Crawford, 1982) have used this technique to solve a variety of farm management problems. However, given that the risks associated with outcome of farm income affect farmers decision making, it is necessary to incorporate risk into the analytical framework. This consideration suggests the need to use both LP and risk programming models. In this study, we employ the target – Minimization of Total Absolute Deviation (target – MOTAD)

programming model (Tauer, 1983; Adubi, 1992) to analyse inland farmer's shortrun behaviour under risk.

In the model, the farmer is assumed to evaluate risk on the basis of safety as first criterion i.e. he minimizes the probability of his farm output falling below his subsistence requirements. This safety first criterion is introduced as a risk constraint into a Linear Programming model of a representative farm. The decision criterion used measures risk as a mean absolute deviation from expected returns and minimizing the variance of returns. The model is therefore a two – attribute risk and return model. Return is measured as the sum of the expected returns of activity multiplied by their individual activity level. The total absolute deviation is then varied parametrically so that a risk – return frontier is traced (Tauer, 1983.) The model is given as

$$\text{Max } E(z) = \sum_{j=1}^n c_j x_j \quad (1)$$

Subject to

$$\sum_{j=1}^n a_{ij} x_j < b_i \quad (i = 1, \dots, m) \quad (2)$$

$$T - \sum_{j=1}^n c_j r x_j - Y_r < 0 \quad (r = 1, \dots, s) \quad (3)$$

$$\sum_{r=1}^s P_r Y_r = \lambda \quad (\lambda = m \dots > 0) \quad (4)$$

$$x, y > 0$$

Where

- $E(Z)$ = Expected returns of the plan or solution to the plan (in naira)
- C_j = expected level of activity j (in naira)
- x_j = level of activity j
- a_{ij} = technical requirements of activity j for resource
- b_i = level of resources i
- T = target level of returns (in naira)
- C_{rj} = returns to activities j for state of nature or observation (in naira)
- Y_r = deviation below T for state nature or observation r
- P_r = Probability that state of nature or observation r will occur
- λ = a constant, parameterized from M to O

- m = number of constraints or resource equation
- S = number of states of nature of r observations
- M = large number (represents the maximum total absolute deviation of return of the model)

The computational procedure of the model involves two steps. First, a conventional linear programming maximization problem is formulated and solved to determine the highest points on the efficiency frontier. Secondly, the element of risk is formulated as a matrix of gross margin deviation from expected returns. Points on the risk-efficiency frontier are obtained by decreasing the value (λ) parametrically in arbitrary ways. Along the efficiency frontier, the target-MOTAD model minimized the mean absolute deviation for any given expected gross margin. This minimizes the standard deviation of returns to the farm, measured by the estimation:

$$\text{Std. Dev.} = \frac{\pi s}{D^2(s-1)} \quad (5)$$

Where

- S = number of states of nature
- D = estimated mean absolute deviation to the farm

The mean absolute deviation (MAD) or D for an activity (j) and for the whole farm over all states of nature (years) is estimated as follows:

$$D = S^{-1} - \sum_{r=1}^s (cr_j - c_j) x_j \quad (6)$$

$$D = S^{-1} - \sum_{r=1}^s \sum_{j=1}^n (cr_j - c_j) x_j \quad (7)$$

All variables are as earlier defined.

This transformation into standard deviation allows the model to determine a set of efficient farm plans along the E - σ or E - variance efficiency frontier.

Table I presents the existing and normative plans for inland valleys. The existing plan is the farmer's plan as practiced on an average inland valley farm in the study area. The normative plan (VII) is based on the profit maximizing model. This plan is likely to be selected by a risk neutral farmer. In order to see the effects of risk of variation of expected income on the farm plans, parameterized risk minimized plans were also obtained (plans II & VI).

RESULTS AND DISCUSSION

Optimal Farm Plans for Inland Valleys

Table 1: Existing and optimal plans with minimized risks for inland valleys

Enterprises	Existing plan		Risk Minimized Plans		Profit Maximizing		Plan VII
	I	II	III	IV	V	VI	
Net Return(s)	31709.60	14856.79	25426.02	29169.02	32091.75	35294.83	54532.70
FL	0.01 (9.90)	-	-	0.4 (5.0)	0.05 (4.49)	0.10 (9.90)	-
FL/PP/OK	0.4 (39.40)	0.07 (14.58)	0.28 (39.44)	0.25 (31.25)	0.35 (38.46)	0.40 (39.60)	-
CS/FL/OK	0.21 (20.79)	0.21 (43.75)	0.21 (26.58)	0.21 (26.25)	0.21 (23.08)	0.21 (20.79)	-
CS/CY/FL	0.1 (9.90)	-	0.02 (2.82)	0.10 (12.50)	0.10 (10.99)	0.10 (9.90)	1.10 (100)
CS/CY/MZ/FL	0.20 (19.80)	0.20 (41.67)	0.20 (28.17)	0.20 (25.00)	0.20 (21.98)	0.20 (19.80)	-
Total Cropped Area (ha)	1.01	0.48	0.71	0.80	0.91	1.01	1.10

Note: Figures in parentheses are the percentage of cropped area to the total cultivated area.

- FL = fluted pumpkin
- FL/PP/OK = fluted pumpkin/pepper/okro
- CS/FL/OK = cassava/fluted pumpkin/okro
- CS/CY/FL = cassava/cocoyam/fluted pumpkin
- CS/CY/MZ/FL = cassava/cocoyam/maize/fluted pumpkin

Source: Field Survey 1997/98.

Table I presents the existing and normative plans for inland valleys. The existing plan is the farmer's plan as practiced on an average inland valley farm in the study area. The normative plan (VII) is based on the profit maximizing model. This plan is likely to be selected by a risk neutral farmer. In order to see the effects of risk of variation of expected income on the farm plans, parameterized risk minimized plans were also obtained (plans II & VI).

Considering the resource situation in the study area, the maximum attainable income with the profit maximizing plan is N54,532.70. The plan is based on 1.10 hectare of cassava/cocoyam/fluted pumpkin (CS/CY/FL) mixture. This plan is associated with a maximum variability over 6 years measured by total absolute deviation (TAD) at N11,000. As TAD was decreased and parameterized from N11,000 to zero, a set of minimized efficient plans (II to VI) were generated. In plan VI, at TAD of N8800 the expected return is N35294.83, fluted pumpkin (FL), fluted pumpkin/pepper/okro (FL/PP/OK), cassava/fluted pumpkin/okro (CS/FL/OK) and cassava/cocoyam/maize/fluted pumpkin (CS/CY/MZ/FL) entered the solution in this plan. The area under cultivation of CS/CY/FL that came into the solution in normative plan decreased to 0.01 hectare so also the total cropped area. This explains the variability associated with the production of fluted pumpkin in inland valleys. As risk in terms of variability reduced, the area cultivated for fluted pumpkin also reduced.

Generally, it is observed that when farmers shift from existing to risk minimized plans, cropping activities decreased. Sole fluted pumpkin failed to enter the risk minimized plans as from plan IV. The hectare cultivated with CS/FL/OK and CS/CY/MZ/FL did not change while that for FL/PP/OK fluctuates, changed from 0.35 to 0.25 hectare in plans, V to IV, and increasing to 0.28 hectare in plan IV and decreasing noticeably from plan IV (0.28 hectare) to plan II (0.07 hectare). All these changes are accompanied with a decrease in income.

The risk and return levels of different farm plans under inland valleys farm are presented in Table 2. It shows the return to farm resources and the estimates of minimized standard and coefficient of variation corresponding to these plans. The coefficient of variation indicates the estimated risk level of operation under the plans. It measures the variation in return and reflects the change in risk accompanying increased hectareage of the higher risk enterprises.

It is to be observed that under the existing or farmer's plan, farmers are operating at a risk level of 7.01 percent. The highest risk level is obtained in plan II. However, this high risk level can be averted if farmers shift to enterprise mix with less variability in returns to farm resources. These are plan IV to VI. The profit maximizing plan is less risky than farmer's plan. This implies that farmers can increase their level

Table 2: Risk and return level of different farm plans in Inland valleys

	Farmers plan I	Risk II	Minimized III	Plans IV	Profit Maximizing V	Plan VI
Returns to						
(a) Farm resources R(N)	31709.60	14856.79	2426.02	29169.02	32091.75	54532.70
(b) Minimized Standard Deviation (SD)	2222.72	2430.27	1920.38	1385.66	1331.87	1489.45
(c) Coefficient Variation of Return (%)	7.01	16.37	7.55	4.7	4.15	4.22
					4.22	5.94

Source: Estimated from L.P. results.

of profit with less level of risk. It seems that farmers are yet to maximally cultivate the inland valleys to realize their full profit potential.

Risk Level o Enterprises

Table 3: Estimated risk level of enterprises in the inland valleys

Enterprises	Standard Deviation (N)*	Expected Gross Margin(N)	Risk Measure
FL	8775.22	24,385	0.36
FL/PP/OK	7916.82	28,029	0.28
CS/FL/OK	1968.77	25,508	0.08
CS/CY/FL	6915.02	49,664	0.14
CS/CY/MZ/FL	2058.46	30,962	0.07

* The standard deviation is estimated using the formula.

$$S.D = \frac{\pi S}{[D2(s-1)]^{1/2}} \text{ as earlier defined.}$$

Source: Estimated from L.O. results

Using estimated standard deviation as a measure of risk (variance of returns) under estimated Return – Absolute Deviation (E – A) criterion for each crop enterprise, the risk level of each crop enterprise in inland valley farming were computed and shown in Table 3. Among the various crop combinations identified in the inland valleys farming in the study area, sole fluted pumpkin is the most risky enterprise. This is followed by fluted pumpkin/pepper/okro (FL/PP/OK) enterprise. Given the weak resistance of vegetable to risk elements in inland valleys farming (flood and drought), the high risk level associated with the cultivation of fluted pumpkin is not surprising. It is to be noted that if a crop is planted sole, there is no diversification whatsoever and, therefore, the risk is not spread. The high risk associated with the cultivation of vegetables on the inland valleys continues to show on the high risk level recorded by FL/PP/OK enterprise – an all vegetable mixture. With the replacement of one of the vegetables with cassava in cassava/fluted pumpkin/okro (CS/FL/OK), the risk level is shown to drastically reduce (0.08). This suggests that farmers should include crops other than vegetables in their mixtures in inland valley farming to reduce risk. This will ensure their continued stay in this farming system.

CONCLUSION

This study presents alternative farm plans, crops enterprises and their associated risk levels in inland valley farming. Findings indicate that high degree of risk is associated with the existing farm plan in the study area. The profit maximizing or normative plan which disregard risk is slightly less risky than the existing plan, but is still more risky compared with some of the risk-efficient plans. Equally, among the various crop enterprises, sole vegetables are more risky than when planted in mixtures.

The study has also made it clear that risk aversion plays a very important role in farmer behaviour. Risk aversion may explain why farmers are interested in multi-cropping. By producing a combination of crops, they can obtain a reasonable expected return at lower levels of risk.

The results have important implications for national agricultural development policies. In the first instance, the result implies that the sets of alternative plans along with associated risks involved must be derived as has been done in this study. The farmer can then choose a particular plan based on his personal attitude to risk. Secondly, policy makers should focus attention on correction of some of the variables, such as imperfect market structure that could reduce returns to the farmers. Since inland valley farmers are operating under extreme climatic conditions – flood and drought, a government insurance programme targeted at wetland (fadama) farmers would lower the risks for this important farming system. This might be one of those rare opportunities for raising agricultural output.

REFERENCES

- Abalu, G.O.F. (1975) Optional investment decisions in perennial crop production: a linear programming approach. *Journal of Agricultural Economics*, 26:383-398.
- Adubi, A.A. (1992) An empirical analysis of production risk and attitudes of small farmers in Oyo State, Nigeria. *Unpublished Ph.D. Thesis, University of Ibadan.*
- Central Bank of Nigeria (1995) *Annual Report and Statement of Accounts, December.*
- Clayton, E.A. (1961) Economic and Technical optima in peasant agriculture. *Journal of Agricultural Economics* 14:337-346.
- Crawford, E.W. (1982) A Simulation study of the growth of small farms in northern Nigeria. *International Development Paper 2. Michigan State University, East Lansing, MI.*
- Eremie, S.N. (1985) Economics of small holder irrigated rice production with special implication in the River Basin Development Authorities in Nigeria. *Unpublished Ph.D Thesis, University of Ibadan.*

- Fatokun, O.Y. (1980) A Comparative study of upland, swamp and irrigated rice production in Ogun, Niger and Kwara States of Nigeria. *Unpublished M.Sc. Thesis, University of Ibadan.*
- Ogunfowora, O. (1970) A Linear Programming analysis of income opportunities and optimal farm plans in peasant farm. *Bulletin of Rural Economic and Sociology*. 5:223-249.
- Olagoke, M.A. (1991) Efficiency of resource use in rice production systems in Anambra State, Nigeria in DOSS, C.R. and C. Olson (eds) Issues in African Rural Development. *Winrock International, Arlington, Virginia* 21-38.
- Onyenwaku, C.E. (1994) Economics of Irrigation in Crop Production in Nigeria. In Doss, C.R. and C. Olson. (eds) Issues in African Rural Development 2. *Winrock International, Arlington, Virginia* 129 – 137.
- Shapiro, K.H. (1973) Efficiency and modernization of African agriculture: a case study in Geita district, Tanzania. *Unpublished Ph.D. Thesis, Stanford University, Stanford. C.A.*
- Tauer, L.W. (1983) Target MOTAD. *American Journal of Agricultural Economics* 65:607-610
- Udofia, W.E. and I.B. Inyang (1984) Land and People of Cross River, in Abasiattai, M.B(ed) Akwa Ibom and Cross River States: The land, the people and their culture. *Wusen Press Ltd. Calabar, pp 1 – 25.*