NIGER AGRIC J. 37 (2006) 1-10

OPTIMUM CROP COMBINATIONS UNDER LIMITED RESOURCE CONDITIONS: A MICROLEVEL STUDY IN YAURI, KEBBI STATE, NIGERIA

BY

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ABSTRACT

The paper examines resource allocation pattern for 60 smallholder farm households in Yauri Agricultural Zone, Kebbi State and attempts to develop optimum combination of farm enterprises, considering available resources and existing management practices. Linear programming technique was used for optimizing resources. Multi-stage stratified random sampling was used in selecting respondents to obtain the information necessary to formulate farm plans for a representative farm household in the survey area during the 2003 cropping season. Data were generated using the cost-route approach. Results revealed a divergence between the existing and optimum farm plans under both capital situations. Farm resources were thus not optimally allocated and after optimization, farm income and employment of labour (human and bullock) could be increased. At the margin, N1.00 in borrowed capital could yield up to N1.80 in additional farm income. Overall, cereal/legume based cropping patterns showed dominance in both the existing and optimum plans. Sensitivity analysis revealed that wages for human labour were high and more land should be brought under cultivation in order to increase farm income. It is suggested that effective farm advisory services that will educate farmers on the efficient allocation of their resources and extension programmes be encouraged, coupled with strong financial support.

INTRODUCTION

Efficient allocation of resources through optimum combination of enterprises by small holder farmers among their usually multiple goals of providing food for the family throughout the year, accumulating monetary income and ensuring minimum use of paid labour has been evasive in smallholder farm economy in Sub-Saharan Africa (Adejobi, *et al.*, 2003). Little attention has been devoted to the role of farm planning in the resolution of the food crisis which recent reports by FAO (2004) reveal that food supply has not kept pace with demand. The food deficit situation is exacerbated by declining farm productivity. Yields are low owing to inefficient production techniques manifested in technical and allocative inefficiencies, a shortage of capital for agricultural investments resulting in complete reliance on household resources, a poor resource base, use of inappropriate and labour-intensive agricultural technology, inconsistent agricultural policies, rapidly declining soil productivity, poor extension services and inadequate traditional management systems.

Achieving self-sufficiency in food crops and agro-industrial raw materials has become a more imperative task now than ever before. Quite a number of strategies have been advocated to this end, one of which is the effective combination of measures aimed at increasing the level of farm resources and making efficient use of the resources already committed to the food sub-sector. Nwosu (1981) advocated the combination of farm

enterprises while Tanko (2003) and Alam *et al* (1995) opined the optimum combination of enterprises by developing optimum farm plans. A typical farmer anywhere in the world has limited level of resources. He is faced with the problem of myriad of choices for allocating farm resources between not only crop but also animal enterprises to optimize production objectives. Consequently, greater emphasis is inevitable upon making efficient utilization of the existing resources and combining the enterprises in an optimal manner. Identifying the best farm plan is a difficult task for any farmer, but it is especially difficult for small-scale farmers with little or no formal education. Thus, if the limited resources available to the many small-scale farmers who produce the bulk of the food consumed in the country are to be used efficiently, optimum farm plans must be formulated for them by region or locality. Studies in optimum resource allocation in a regional framework using linear programming approach have largely been attempted in many countries (Alam *et al.*, 1995; Sama, 1997; Alam, 1994; Onyenweaku, 1980; Schipper *et al.*, 1995; Dipeolu *et al.*, 2000; Tanko, 2003 and Adejobi *et al.*, 2003). These plans could help policy-makers predict farmers' responses to policy alternatives, thereby sharpening the policy decision-making process. The paper aims at developing optimum enterprise combination patterns and resource allocation for farmers in Yauri agricultural zone of Kebbi State, Nigeria using the linear programming technique.

METHODOLOGY

Study Area

The study was carried out in Yauri Agricultural Zone in Kebbi State, located in the North Western part of Nigeria. The state occupies a land area of about 36,229 square kilometers with its administrative capital in Birnin Kebbi. The area falls within the dry savanna agro-ecological zone of Nigeria with an average annual rainfall of between 650mm and 1100mm. Soils are ferruginous on sandy parent materials evolving from sedentary weathering of sandstones. The vegetation largely comprises drought resistant grasses, legumes and shrubs. There are two distinct seasons: the rainy and the dry season. Over two thirds of the estimated population of about 2,951,831 people are engaged in agricultural production, majorly of arable crops, alongside few cash crops with aspects of animal husbandry (PLH, 1996). The animals provide energy for ploughing, while their droppings (faeces) are used for manuring the soil and also aid in mechanization and encourage intensification of land use. Islam is the dominant religion with most families being polygamous in nature and they reside in huts. Commonly cultivated crops include sorghum, millet, groundnut, maize, cowpea, vegetables and rice. Others include sweet potato, tobacco, ginger etc. Farmers utilize water from rivers for their irrigation activities during the dry season. There is a major inland port at Yelwa offering opportunities for fishing.

Sampling Design and Data Collection

The sampling procedure employed was the multi-stage stratified sampling technique. The Agricultural Development Zone was purposively selected because of the high concentration of farming communities in this zone. The zone formed the first stratum for sampling. Ten farming communities were then selected from the zone using the simple random sampling technique and these formed the second stratum. The last stratum was the farm household level, where a total of 60 representatives of households (6 from each community) were randomly selected. The

limited cost-route approach based on frequent interviews on forthnightly basis during the 2003 production season was adopted over a 5 months period for the collection of data which started in September, 2003 and lasted till January, 2004 after all the crops were harvested. The household livelihood, economic and demographic data constitute the bulk of the data collected.The Yield Plot Method which involved calculating the yields of 10, 100 square metre portions (i.e. 10 m x 10 m plots) on some of the sampled farms was used to estimate the yield of crops. For crop mixtures, the average number of stands of each crop in a particular mixture was determined and the crops were later on harvested and weighed to determine the per hectare yield of each crop in the mixture. Computed yield figures were then applied to the total hectarage of each mixture to obtain production estimates. These production estimates were then valued at the prevailing market prices to estimate potential gross returns.

Specification of the Empirical Model

The objective function is to maximize net farm income, which is total gross farm income minus the costs of human labour, bullock labour, tractor/power tiller hiring, marketing, capital borrowing, other variable costs, depreciation on fixed cost items and rent on land on each farm simultaneously in an annual cycle. The empirical model is of the form:

$$\text{Maximize } Z_o = \sum_{J=1}^{n} P_j X_j - \sum_{t=1}^{5} WhL_t - \sum_{t=1}^{2} WbK_t - \sum_{t=1}^{3} WdP_t - \sum_{t=1}^{n} P_t Y_t - \sum_{t=1}^{3} M_t - \sum_{t=1}^{n} Q_j \quad \text{D-R} \quad (1)$$

Subject to:

$$\sum_{J=1}^{n} ljs\, X_j \leq L_s \quad \text{(Land)} \quad (s = 1, 2, \ldots, 72) \quad \text{---} \quad (2)$$

$$\sum_{j=1}^{n} Aj_t\, X_j - L_t \leq H_t \text{ (Human labour)} \quad (t = 1, 2, 3, 4, 5) \quad \text{---} \quad (3)$$

$$\sum_{j=1}^{n} b_{jt}\, X_j - K_t \leq H_t \text{ (Bullock labour)} \quad (t = 1, 2, 3, 4, 5) \quad \text{---} \quad (4)$$

$$\sum_{j=1}^{n} d_{jt}\, X_j - P_t \leq S_t \text{ (Tractor/power tiller)} \quad (t = 1, 2) \quad \text{---} \quad (5)$$

$$\sum_{j=1}^{n} c_{jt}\, X_j - M_t \leq C_t \text{ (Capital)} \quad (t = 1, 2, 3) \quad \text{---} \quad (6)$$

$$\sum_{j=1}^{n} f_k\, X_j \geq F_{(min)} \text{ (Minimum subsistence farm-family cereal/legume requirement)} \quad \text{---} \quad (7)$$

$$X_j, L_t, K_t, P_t, R_t, M_t \geq 0 \quad \text{---} \quad (8)$$

Where

Z_o = Total Net farm income of the farm in Naira

X_j = Units of the j^{th} crop activity in hectares;

P_j = Gross value of output per ha of the j^{th} crop activity in Naira;

Wh = Wage rate per unit hire of human labour in Naira;

L_t = Number of hired human labour in t^{th} period;

Wb = Wage rate per unit of bullock labour in Naira;

K_t = Number of hired bullock labour in t^{th} period;

Wd = Wage rate per unit of tractor/power tiller;

R_t = Tractor/power tiller hired in t^{th} period;

P_t = Marketing expense per unit of the product sold in t^{th} period;

Y_t = Units of crop products sold in t^{th} period;

r = Rate of interest for six months;

M_t = Capital borrowed in Naira in t^{th} period;

f_k = Food production in tons/hectare of k^{th} cereal/legume activity;

L_s = Total available land in hectares for the crops with (s) restrictions;

H_t = Total man-days of family labour owned by the farmer in t^{th} period;

B_t = Total bullock labour owned in t^{th} period;

S_t = Total tractor/power tiller owned in t^{th} period;

C_t = Total working capital in Naira owned in t^{th} period;

D = Depreciation on fixed cost items such as equipment, implements and tools etc;

Q_j = other variable cost items e.g improved seeds, family labour, fertilizer, manures, agrochemicals etc.;

R = rent on land;

$F_{(min)}$ = Minimum quantity of cereal/legume required by the farm family per annum in tons;

I_{jt} = Input coefficient of land which is one hectare with s restrictions;

a_{jk} = Input coefficient of human labour (in mandays) for j^{th} crop activity in t^{th} period.

b_{jt} = Input coefficient of bullock labour for j^{th} crop activity in t^{th} period;

C_{jt} = Amount of capital used in producing one hectare of j^{th} crop activity in t^{th} period n

$\sum_{j=1}$ = Summation of j^{th} crop activities (j = 1 to n);

The constraints for land, labour (human, bullock), tractor/power tiller, capital require that the amount of a resource required to produce the n crop activities must not exceed the available.

Activities in the Model and the Price Coefficient "P_j"

The activities in the models can broadly be grouped into crop production activities, labour (human, bullock, tractor) hiring activities, capital borrowing and product selling activities. The crop production activities are broadly grouped into sole crops and crop mixtures. For each of the crop production activities the unit of activity is one hectare.

The price coefficient "Pj" of a production activity in the model is the gross value of output per hectare of all the crops. For a human labour hiring activity, the price coefficient is the ruling wage rate. The price coefficient of a bullock labour hiring activity is the wage rate per cattle day. The price coefficient of a tractor hiring activity is the wage rate per hour. For a capital borrowing activity, the price coefficient is the prevailing market rate of interest, while for a selling activity, the price coefficient is the marketing expense per unit of the product sold.

Input Coefficients

The input coefficients refer to the requirement of a crop activity is respect of the inputs of the different resources measured in terms of per

hectare basis (unit of land). The input coefficients for all the crop activities were calculated on the basis of the actual quantities of different resource used for those crop activities. For instance, the input-output coefficient for human labour are denoted by ajt's and they refer to the amount of human labour in mandays used in producing a hectare of the j^{th} crop activity in t^{th} period etc.

Resource Constraints/Restrictions In the Model

Six restrictions/ constraints were incorporated in the model. These are: Land (with 72 restrictions i.e three types of land namely: highland, medium highland and medium lowland, each further classified into with and without irrigation.. Twelve months of land restrictions were considered, Human labour (with five restriction periods namely: land preparation, planting first weeding, second weeding and harvesting), Bullock labour (with two restriction periods of first and second weeding), Tractor/power tiller (three restriction periods of May, June and July), Capital (three restriction periods namely: April-June, July-September and October-December), and Cereal/legume requirement constraints. Minimum Cereal/Legume Requirement refers to family food supply, another possible constraint in farm planning (Alam *et al.*, 1995). Subsistence farmers cultivate land area enough with cereal/legume crops needed to fulfill their home consumption requirement. Their production is less market oriented. It was estimated that a farm family would require a minimum of 1.97 tons of cereal/legume to meet up annual household requirement.

RESULTS AND DISCUSSION

Socio-economic Profile of Respondent Farm Household Heads The average farm household surveyed had six family members and the typical farmer interviewed was male, married, 49 years old and had at least quranic-level education. Mixed farming patterns accounted for a greater proportion of crop production activities. The average farm holding per household was 6.42 hectares comprising several plots, most fields being less than 2 hectares. Farm operations relied primarily on household labour and traditional farming practices. Operating capital averaged N9,500. Farmers that had access to capital borrowing received an average of N12,420.50 as farm credit, while the mean years of farming experience was 20.

Land Allocation Under Existing and Optimum Plans

The existing land use pattern together with the emerging optimum allocation of land under the limited and borrowed capital situations for the different tenurial groups of farms are presented in Table 1. Farmers devoted maximum area to sorghum/ cowpea/ groundnut, a three-crop mixture on highland under non-irrigated situation and sorghum/maize on medium lowland, non-irrigated situation which occupied 17.91% and 14.02% respectively of the total cropped area. Cassava, a commercial crop and maize were the next predominant enterprises which occupied about 13.40% each of total cropped area in the medium lowland, non-irrigated and highland non-irrigated situations respectively. Groundnut, which occupied 0.93% of total area, planted sole in the medium highland non-irrigated situation had the least hectarage allocation. Farmers also grew other cash crops namely vegetable and sugar cane in the medium lowland under irrigated situation.

The optimized plans are presented in Table 1. Results reveal that the land type namely highland, non-irrigated situation and medium lowland irrigated situation were not

utilized in the optimized plans. Due to optimization, sorghum/cowpea, a mixed crop found the prime place in the medium highland under non-irrigated situation which occupied about 38.07% and 35.70% of the total cropped area under the limited and borrowed capital situations respectively. The same land type, was utilized by other cropping patterns namely sorghum/groundnut which accounted for about 10.55% and 10.32% of the total cropped area under the limited and borrowed capital situations as well as sorghum/maize which accounted for only about 6.65% and 8.82% under the limited and borrowed capital situations respectively. The predominant cropping pattern under the borrowed capital situation was cassava on medium lowland under non-irrigated situation which accounted for about 36.13% of the total cropped area. Under the same land type, rice occupied 9.03% of the total cropped area. Limitation in resource endowment manifested in the disparity in land allocated to crops with profound dichotomy between farmers with access to capital borrowing and those without. The optimum plans prescribed a total of 4.65 hectares and 4.36 hectares respectively under borrowed and limited capital situations respectively and in order to optimize returns, a farm household in the survey area should allocate available land to five crop enterprises. Larger farm sizes, coupled with efficient utilization of resources and better management practices, should translate into increased outputs and/or farm income. Mechanization is also best suited and more cost-effective under larger farm sizes.

Utilization of Human Labour

The utilization of human labour for the existing and optimized plans under different capital situations in selected peak periods are presented in Table 2.

Table 1: Existing and Optimum Cropping Patterns (cropped area in hectares), Yauri Zone, Kebbi State 2003, (Programmes I and II).

Cropping Patterns		Optimum Plans	
	Existing Plan	With limited Capital	With bo Capi
Highland (Non-irrigated)	2.01 (31.31)	-	-
1. Sorghum /Cowpea/Groundnut	1.15 (17.91)	-	-
2. Maize	0.86 (13.40)	-	-
Medium highland (Non-irrigated)	2.15 (33.49)	2.41 (55.28)	2.55 (54.
3. Groundnut	0.06 (0.93)	-	-
4. Sorghum/Cowpea	0.20 (3.12)	1.66 (38.07)	1.66 (35.
5. Sorghum/Groundnut	0.31 (4.83)	0.46 (10.55)	0.48 (10.
6. Sorghum/Maize	0.90 (14.02)	0.29 (6.65)	0.41 (8.8
7. Sorghum	0.68 (10.59)	-	-
Medium lowland (Non-irrigated)	1.86 (28.97)	1.95 (44.72)	2.10 (45.
8. Cocoyam	0.50 (7.79)	-	-
9. Cassava	0.86 (13.40)	1.55 (35.55)	1.68 (36.
10. Rice	0.50 (7.79)	0.40 (9.17)	0.42 (9.0
Medium lowland (Irrigated)	0.40 (6.23)	-	-
11. Vegetable	0.18 (2.80)	-	-
12. Sugar cane	0.22 (3.12)	-	-
Total cropped area	6.42 (100.00)	4.36 (100.00)	4.65 (10
% sole crops	49.53	44.72	45.16
% crop mixtures	50.47	55.28	54.84

Note: figures in parentheses are percentages to total cropped area.

Table 2: Human Labour Days Utilization under Different Capital Situations in Yauri Zone, 2003.

Operation	Existing plan	Optimum Limited capital	Plans Borrowed capital	Increase/Decrease over Existing Plan			
				Limited capital	%	Borrowed capital	%
1.Land preparation	53.25	30.68	40.70	-22.57	-42.38	-12.55	-23.57
2. Planting	18.99	1.09	2.05	-17.90	-94.26	-16.94	-89.20
3. First weeding	54.20	33.80	41.08	-20.40	-37.64	-13.12	-24.21
4.Second weeding	47.15	26.75	84.33	-20.40	-43.27	+37.18	78.85
5. Harvesting	39.01	41.35	47.65	+2.34	6.00	+8.64	22.15
Total	173.59	133.67	215.81	-39.92	-23.00	+42.22	24.32

Source: Computed from survey data, 2003.

The results in Table 2 reveals that the optimized plans reduced labour requirement during land preparation, planting and first weeding operations by 23.57%, 89.20% and 24.21% but increased same during the second weeding and harvesting peak periods of farm operations under the borrowed capital situation. Overall, it increased labour requirement by 24.32% under the borrowed capital situation. Tightening the capital constraint reduced labour requirement by 23.00%. Due to capital scarcity, the farmers kept their lands fallow under the limited capital situation in the optimized plans. The farmers had to hire labour during the second weeding and harvesting operations under the borrowed capital situation. Increased labour utilization is paramount and justifiable during the harvesting operation so as to avoid spoilage and deterioration of agricultural produce in the fields.

Bullock Labour Utilization

The utilization of Bullock labour in the existing and optimum plans during selected peak periods are presented in Table 3

Table 3: Bullock Labour Utilization in Cattle days for the Different Capital Situation in Yauri Zone, Kebbi State, 2003.

Period	Existing Plan	Optimum Plans		Increase/Decrease over Existing Plan			
		Limited capital	Borrowed capital	Limited capital	%	Borrowed capital	%
1. June	5.50	6.15	8.18	+0.65	11.82	+2.68	48.73
2. August-Oct.	3.30	7.25	10.12	+3.95	119.70	+6.82	206.67
Total	8.80	13.40	18.30	+4.60	52.27	+9.50	107.95

Source: Computed from survey data, 2003.

Due to capital scarcity, the optimized plans increased bullock labour utilization more under the borrowed as compared to the limited capital situation. Bullock labour utilization increased by 52.27% and by an overwhelming 107.95% under the limited and borrowed capital situations respectively indicating the extent of resource disparity that prevailed in the survey area. Bullock labour hiring is a function of the ability of the farmer to pay for the service.

Utilization of Tractor/Power Tiller

Tractor/power tiller utilization for the existing and optimum plans in selected peak periods under borrowed and limited capital situations are presented in Table 4.

Table 4: Tractor Utilization in Hours under Different Capital Situations in Yauri Agricultural Zone, Kebbi State, 2003.

Period	Existing Plan	Optimum Plans		Increase/Decrease over Existing Plan			
		Limited capital	Borrowed capital	Limited capital	%	Borrowed capital	%
1. May	2.16	0.68	1.01	-1.48	-68.52	-1.15	-53.24
2. June	1.40	0.95	0.99	-0.45	-32.14	-0.41	-29.29
3. July	1.02	1.02	1.02	0.00	0.00	0.00	0.00
Total	4.58	2.65	3.02	-1.93	-42.14	-1.56	-34.06

Source: Computed from survey data, 2003.

Results in Table 4 show that the optimized plans reduced tractor utilization during the May and June peak periods of operations under the limited situation by 68.52% and 32.14% and by 53.24% and 29.29% under the borrowed capital situation, while tractor utilization in July peak period remained unchanged as compared to the existing plan. Farmers undertook this based on the cash-at-hand available to them.

Net Farm Income Under Existing and Optimum Plans

The net farm income realized and potentially derivable for the existing and optimum plans under different capital situations are presented in Table 5.

Table 5: Net Farm Income (in ₦) in the Existing and Optimum Plans

Existing Plan	Optimum Plans		Increase over		Existing Plan		Increase in borrowed over Limited capital situation	
	Limited capital	Borrowed capital	Limited capital	%	Borrowed capital	%	Amount	%
8,750.00	63,430.10	85,849.70	14,480.10	30.00	37,099.70	76.10	22,419.00	35.00

Source: Computed from survey data, 2003.

Table 5 reveals that the optimized plans increased net farm incomes by 30.00% and 76.10% under the limited and borrowed capital situations respectively. This implies that there was marked mal-allocation of existing resources and a considerable scope for increasing farm income by reallocating the existing resources in an optimal manner. The relaxation of the capital constraint by allowing the borrowing of capital raised incomes by 35.00%. Access to adequate and timely credit facility by farmers is likely to raise farm incomes. The informal credit sector of the financial market provides the bulk of the agricultural loan used by small holder farmers. However, loans from these sources are usually small and inadequate to meet the credit needs of small farmers. At the margin, N1.00 in borrowed capital could yield up to N1.80 in additional farm income.

Sensitivity Analysis

The formulated optimum plans were subjected to sensitivity analysis to

Table 6: Sensitivity Analysis of the plans under different scenarios

Optimum Income from Initial Programme (₦)		Optimum Income for the Present Model (₦)		Increase in farm Income (₦)		Percentage change (%)	
Limited capital	Borrowed capital	Limited capital	Borrowed capital	Limited capital	Borrowed capital	Limited capital	Borrowed capital
63,430.10	85.849.70	131,070.85	144,396.21	67,640.75	58,546.51	106.00	68.00
63.430.10	85.849.70	114,450.15	128,441.73	51,020.05	42,592.03	80.00	49.00

Source: Computed from survey data. 2003.

The results presented in Table 6 reveals that increasing the area under cultivation by 2 hectares resulted in optimum farm incomes increasing by N67,640.75 and N58,546.51 representing 106.00% and 68.00% under the limited and borrowed capital situations respectively. The increase in revenue was as a result of utilizing those resources that were idle when land posed as a constraint to production. In the second scenario where average real wage rates were equated with those institutionally determined, the optimized plans increased farm incomes by 80.00% and 49.00% under the limited and borrowed capital situations respectively. Labour supply is a positive function of real wage. Since wage rates offered in government owned farms are lower than what the farmers pay them, its supply will be high relative to demand, the only constraint being the farmer's ability to pay.

CONCLUSION AND RECOMMENDATIONS

The results reveal a divergence between the existing and optimum farm plans under both capital situations. Due to capital scarcity, more land was allocated to crops under borrowed as compared to the limited capital situation. Farm resources were not optimally allocated and thus, a considerable scope for increasing farm incomes by reallocating the existing resources in an optimal manner. Reduction in wages for human labour led to an increase in optimum farm income suggesting that the wages were high. Since farmers have limited cash to hire labour, agricultural productivity will be hampered so long as labour hiring is an indispensable component of small agriculture and thus the need to finance agricultural production. It is recommended that farmers should belong to organized farmer groups such as co-operatives. Increasing the area under cultivation resulted in an increase in optimum farm income. More land should be brought under cultivation to optimize returns. The vast agricultural land held in trust by the state should be leased out to practicing farmers. The prototype enterprise combinations emanating from this study could be found useful in the extension education package of the Kebbi State Agricultural Development Project (KADP) and Yauri Agricultural Zone in particular. It is also suggested that effective farm advisory services and extension programmes that will educate farmers on efficient allocation of their resources should be paramount in the quest for increased outputs and/or farm income.

REFERENCES

Adejobi, A. O.; Kormawa, P. M.; Manyong, V. M. and Olayemi, J. K. (2003). "Optimal Crop Combinations Under Limited Resource Conditions: Application of Linear Goal Programming (LGP) Model to Small holder farmers in the Drier Savannah zone of Nigeria". *Deutscher Tropentag, Cottingen, "Technological and Institutional Innovations for Sustainable Rural* Development. Oct. 8-10.

Alam, M. S. (1994). Optimum Cropping Patterns of the Small Farmers Under Risk: A Microlevel Study in Bangladesh. Unpublished Ph. D Thesis, Department of Agricultural Economics, Bangladesh Agricultural University Mymensingh.

Alam, M. S., Elias, S. M. and Rahman M. M. (1995). "Optimum Land Use Pattern and Resource Allocation in a Growing Economy:A Closed Model Approach". *Bangladesh Journal of Agric. Economics* XVIII, 2: 15 37.

Balogun, E. D. (1986). "Agricultural Development Strategies in Nigeria: Past, Present and Future", In: Nigeria Agricultural Outlook (with special reference to Budgets). Nigeria Association of Agricultural Economists. pp111 122.

Dipeolu, A., Adebayo, K. and Fabolude, O.(2000). "Optimal Farm Plans for Sustainable Environmental and Economic Resource use for Food Crop Farmers in University of Agriculture, Abeokuta, (UNAAB) Model Extension Villages". *Journal of Environmental Extension (Jext): Vol.1*, Dec.2000.

Food and Agricultural Organization (FAO) (1985). Production Yearbook vol. 40, FAO of the United Nations.

Norman, D. W. (1970)."*Methodology and Problems of Farm Management Investigations: Experience from Northern Nigeria*". African Rural Employment Paper No.8, Michigan State University, East Lansing MI, USA.

Nwosu, A. C. (1981). "Cropping Pattern and Resource Productivity: A Comparative Analysis of Profitability in Sole and Intercropping' *Nigerian Journal of Agricultural Science* 3 (1): 24-27.

Onyenweaku, C. E.; Ogunfowora O. and Falusi, A.O. "Spatial Equilibrium Analysis of Nigerian Agriculture" *Journal of Rural Economics and Development* 1978/79, 112(2): 1 14.

Political Leadership Handbook (PLH) (1986). "*Nigeria, A Viable Black Power: Resources, Potentials and Challenges*". Polcom Press, Lagos, 204-209 pp.

Sama, J. N. (1997). "Raising Income Level of Farmers on Swazi Nation Land: A Farm Planning and Extension Approach, *Uniswa Journal of Agriculture*, 6 (1): 5 14.

Schipper, R. A., Jansen, D. M. and Stoorvogel, J.J. (1995). "Sub-regional Linear Programming Models in Land Use Analysis: A Case Study of Neguev Settlement, Costa Rica", *Netherlands Journal of Agric. Science* 43: 83 109.

Tanko, L. (2003). "Optimum Combination of Farm Enterprises in Kebbi State, Nigeria: A Linear Programming Approach". An Ph.D. Dissertation, Department of Agric. Economics, Michael Okpara University of Agric. Umudike, Abia State, Nigeria.