# Farm Enterprise Combinations and Resource Use Among Smallholder Farmers in Bunza, Kebbi State, Nigeria.

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## Abstract

Survey Information obtained from a sample of 60 representatives of farm households in Bunza Agricultural Zone in Kebbi State, Nigeria, selected using the multi-stage stratified sampling technique, was used to develop optimum farm plans considering existing farm resource allocation, management practices and constraints during the 2003 cropping season. Using the cost-route approach to generate primary data, the linear programming model was used to formulate a farm plan with the information so collected for a representative farm household in the survey area. The resulting farm plans were subjected to sensitivity analysis to gauge the sensitivity of the plans to changes in some predetermined variable. Results revealed that farm resources were not optimally allocated and thus a divergence between the existing and optimum farm plans for the different tenure groups. There is a considerable scope for increasing gross margins by reallocating the existing resources in an optimal manner. Capital acted as a constraint. At the margin N1 of borrowed capital could yield up to ₦1.04 and ₦1.29 in additional income in the cases of owner and rented-in farms respectively. Legume based cropping patterns showed dominance in the existing and optimum plans. It is recommended that effective extension programs, strong financial support and educating farmers on efficient allocation of their meager resources would enhance the prospects of the small holder farmers in the survey area.

## Introduction

There is an ever increasing concern about the ever-worsening food crisis and the capability of Nigerian agriculture to satisfy the food requirements of a fast growing population with a declining Gross Domestic Products (GDP). Agriculture employs about three quarters of the Nigeria's working population (FAO, 2004), yet the performance of this sector has been on the decline. Food crop production comes under different agricultural systems, most commonly as mixed farming, mixed cropping or mono cropping. Activities in the food crop sub-sector have continued to dominate the category of farms variously referred to as smallholder farms, small scale farms, low resource farms or small farms (Adejobi, et al., 2003). Many regard the Nigerian food problem as a paradoxical situation because, Nigeria appear to have the human and physical resources necessary to provide ample food and fiber for its domestic population and the export market.

The complexity of the small farmer's production environment, objectives and decision variables is indicative of the need for caution in evaluating his performance for the purposes of micro-level planning. Faced with multi-dimensional objectives, some of which are competitive, the farmer's decision problem is that of picking the enterprise combinations which optimizes his overall achievement (Olayemi, 1970). Agricultural production planning, apart from shedding light on efficient utilization of resources in the farm makes possible the charting of those courses of action that help in the attainment of maximum net returns. Substantial body of literature on the application of linear programming to examine resource use pattern, optimum combination of enterprises and the potentialities for farm income and employment abound (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).

The food deficit situation in Nigeria 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, use of inappropriate and labor-intensive agricultural technology, inconsistent agricultural policy, rapidly declining soil productivity, poor extension services and inadequate traditional management systems. Food shortages and declining farm productivity have led to rapid increases in domestic food prices as well as to increased importation of food (Balogun, 1986), until the worsening position of the balance of payments position in recent years could no longer sustain the importation of food. Recent reports by FAO, (2004) reveal that cereal imports for instance have tended upwards in recent years, due mainly to high population growth and changing consumption pattern. Imports of cereals mostly wheat and rice are estimated at about 4.33 million tons in 2004, up from 4.07 million tons in 2003. The food import bill necessitated the Federal government imposition of drastic restrictions on food imports to check the rapid drain on foreign reserves, arrest the mounting burden of foreign debt and encourage domestic production.

The question that quickly comes to mind is: how can significant increases in food production be achieved given the prevailing socio-cultural and economic circumstance in Nigeria? Quite a number of strategies have been advocated including 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) and Tanko (2003) among others advocated the combination of farm enterprises. Given the multi-faceted nature of the food shortage problem, a multi-dimensional approach is required. Developing optimum farm plans for smallholder farmers could lead to the resolution of the

food crisis. To date, little attention has been devoted to the role of farm planning in the resolution of the food crisis. Consequently, farmers in sub-Saharan Africa over 60% of whom operate on a small scale, have had to rely on tradition, intuition or introspection to make farm planning decisions. Yet, Nigeria depends upon these small scale farmers for over 80% of its food production. If the limited resources available to the many small-scale farmers in Nigeria are to be used efficiently, optimum farm plans must be formulated for these farmers by region or locality.

The study is designed to develop optimum enterprise combination patterns and resources allocations for farmers in Bunza Agricultural zone of Kebbi State.

## Methodology

### Study Area

The survey was carried out in Bunza Agricultural Zone in Kebbi State. The State is located in the North-Western part of Nigeria and occupies a land area of about 36,229 square kilometers with its administrative headquarters in Birnin Kebbi. Kebbi State lies between latitudes $10^{o}$ and $13^{o}$N and between longitudes $3^{o}$ and $6^{o}$W, with a population of about 2,961,831 people. Agriculture is the predominant source of livelihood; 80% to 90% of the population resides in farm households. Mixed farming is widely practiced. The animals provide energy for ploughing, while their droppings are used for manuring the soil. Thus, the animals aid in mechanization and encourage intensification of land use. The major crops cultivated include sorghum, millet, groundnut, maize, cowpea, sweet potato, rice, vegetables and fruits. Cash crops grown include wheat, ginger, sugar cane, tobacco and gum Arabic. There is a major inland port at Yelwa where the great River Niger divided into tributaries terminating into such rivers as Rima, Zamfara, Gagare and Sokoto offering opportunities for fishing. Farmers utilize water from these rivers for their irrigation activities during the dry season.

Sources of Data

The analysis was based on survey information obtained from a sample of 60 representatives of farm households. Four farming communities in Bunza Agricultural Zone namely, Kaoje, Bagudo, Besse and Koko, were purposively selected for study. Representative farm households were selected using a multi-stage stratified random sampling technique. The farmers were stratified on the basis of the size of their holdings namely: small (2 hectares and under), medium (3–5 hectares) and large (over 5 hectares). Purposive selection of typical farming communities was ensured. The Cost-route approach to data collection from September, 2003 to January, 2004 (5 months period) during the 2003 cropping season was adopted. Information on household characteristics, farm size, management, and farm gate prices were solicited for using well structured questionnaire.

Crop yields were estimated by the Yield Plot Method, by calculating the yields of 16,100 square meters portions (that is 10m x 10m plots) on some of the sampled farms. In the case of crop mixtures, the average number of stands of each crop in a particular crop mixture was determined and the crops were later on harvested and weighed to determine the per hectare yield of each crop in the mixture. The computed yield figures were applied to the total hectare 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 general model framework is similar to Alam, *et al*., (1995) and its applications contain some features from Sama (1997), but it includes refinements

not found in the previous models. The model maximized total net farm income on each farm simultaneously in an annual cycle that is, the objective function is total gross income less the total variable costs of production which include the costs of human labor, bullock labor, tractor/power tiller hiring, marketing, capital borrowing, other variable costs depreciation on fixed cost items and rent on land.

$$\text{Maximize } Z_0 = \sum_{J=1}^{n} P_j X_j - \sum_{t=1}^{5} WhL_t - \sum_{t=1}^{2} WbK_t - \sum_{t=1}^{3} WdP_t - \sum_{t=1}^{n} P_t Y^{-}_t \sum_{r}^{3} M^{-}_t \sum_{j=1}^{n} O_j - D - R \quad (1)$$

Subject to:

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

$(s = 1, 2, \ldots, 72)$

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

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

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

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

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

$$X_j, L_t, K_t P_t, R_t, M_t \geq 0 \quad (8)$$

Where

Z = 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 in Naira;

Wh = Wage rate per unit of human labor in Naira;

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

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

$K_t$ = Number of hired bullock labor 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 labor owned by the farmer in $t^{th}$ period;

$B_t$ = Total bullock labor 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;

$\mathbf{Q_j}$ = other variable cost items e.g improved seeds, human labor, fertilizers family manures, agrochemicals etc.;

R = rent on land

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

$1_{js}$ = Input coefficient of land which is one hectare with s restrictions.

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

$b_{jt}$ = Input coefficient of bullock labor 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.

$\sum_{j=1}^{n}$ = Summation of $j^{th}$ crop activities

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

Price Coefficient "Pj"

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 labor hiring activity, the price coefficient is the ruling wage rate. The price coefficient of a bullock labor 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 in 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 labor are denoted by ajt's and they refer to the amount of human labor in man days 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), Human labor (with five restrictions), Bullock labor (with two restrictions), Tractor/power tiller (three restriction periods), Capital (three restriction periods), and Cereal/legume requirement constraints.

Land

Three types of land restrictions i.e. highland, medium high land and medium lowland were considered. Each land type was further classified into land with and without irrigation. Twelve months of land restrictions were also considered in the model. Thus, 72 land restrictions were considered in the model.

Human Labor

For setting up human labor restriction, seasonal operation-wise requirements of labor for different crops were considered. Labor requirement in the study area is characterized by certain peak operational periods which would require the hiring of casual labor to accomplish the required farm operations within time. Peak period hiring of labor is a common practice in the study area. The hiring in activity of labor was introduced for all the restriction periods. We conceptualized five restriction periods for labor. These periods are: land preparation, planting, first weeding, second weeding and harvesting.

Wage rate is the remuneration per man-day made to labor in cash and in kind. One man-day corresponds to 8 working hours.

Bullock Labor: Bullock labor restrictions were set in a similar way as for human labor. However, bullock labor hiring is restricted to only two periods. The periods are first weeding (June-July) and second weeding (August-October).

Cattle cultivation is found mainly in the Northern states of Nigeria where the present study was undertaken. Using a team of two bullocks, one cattle-day is six hours (usually 7:00 am to 10:30 am and 4:00 p.m. to 6.30 p.m.). One team-day is cattle working for six hours and two men working for eight hours, including attention to cattle.

Tractor/Power Tiller: The availability of tractor/power tiller in terms of hours spent was considered for May, June and July when its demand usually rises and peak. Tractor hiring is also a common practice in Kebbi State.

Capital: In this context and for the purpose of this study, capital was considered to be working capital required to meeting day to day farm or production expenses both in cash and kind. These consist of cost of hired human labor, bullock labor tractor/power tiller, purchased seeds, manures, fertilizers, insecticides and irrigation charges.

Capital coefficients included all the items listed above except hiring charges of human labor; bullock labor and tractor/power tiller because these items were taken as separate activities. Capital availability in terms of Naira required was considered for three periods in a year. The periods are: April, May and June: period for land preparation and planting of arable crops; July, August and September: period for weeding and other management practices; and October, November and December: period for harvesting cost of arable crops.

Minimum Cereal/Legume Requirement: This includes family food supply, another possible constraint in farm planning (Alam *et al*., 1995). It was also incorporated in the model. Subsistence farmers cultivate land area enough with cereal/legume crops such as maize, guinea corn, millet, rice, cowpea, etc 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 in the case of pure owner farm household and 1.86 tons for farm households that rented their farms to meet up annual household requirement.

Activities in the Model

The activities in the models can broadly be grouped into crop production activities, labor (human, bullock, and 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 sole crop production activities, the unit of activity is one hectare. Crops grown under irrigated and non-irrigated conditions have been treated as being a different activity. A crop grown on high, medium high and medium low land has been considered as being different activities.

The selling activities facilities the sale of the final output realized from the various cropping activities. Each production activity may have more than one selling activity depending on whether such activity is sole or mixed.

Transfer activities (rows) provide a vehicle whereby the services or output of one activity may be transferred in the model to another activity. Hence, to ensure fuller utilization of capital and labor, capital and labor transfer activities were incorporated in the model. These transfer activities ensures the transfer of capital and labor from one period to another period provided it is profitable.

## Results and Discussion

### Socio-economic Profile of Respondent Farm Households Heads

The average farm household had six family members and the typical farmer interviewed was male, married, 46 years old and had quranic-level education. Mixed cropping enterprises of usually cereal, laced with legumes accounted for a greater proportion of crop production activities. The average farm sizes were 7.21 and 5.82 hectares per household usually comprising of several plots; most fields were less than 2 hectares. Farm operations relied primarily on household labor and traditional farming practices. Operating expenses averaged N15,350; capital borrowing averaged N12,680.50. The mean years of farming experience was 23. Outright sale of land is not a common feature in the survey area. The average rent per hectare per production season was N950.

Table 1: Existing and Optimum Cropping Patterns for Owner Farms (cropped area in hectares), Programs I and II, Bunza Zone.

| Cropping Patterns | | Optimum | Plans |
|---|---|---|---|
| | Existing Plan | With limited Capital | With borrowed Capital |
| Highland (Non-irrigated | 2.18 | - | - |
| | (35.10) | - | - |
| 1. Maize | 1.08 | | - |
| | (17.39) | - | - |
| 2. Sorghum | 1.10 | - | - |
| | (17.71) | - | - |
| Medium highland (Non-irrigated) | 2.03 | 2.38 | 2.53 |
| | (32.69) | (83.80) | (83.22) |
| 3. Sorghum/Groundnut | 0.22 | - | - |
| | (3.54) | - | - |
| 4. Millet/Cowpea | 0.10 | - | - |
| | (1.61) | - | - |
| 5. Sorghum/Maize | 0.09 | - | - |
| | (1.45) | - | - |
| 6. Sorghum/Maize/Cowpea | 0.30 | 1.00 | 1.00 |
| | (4.83) | (35.21) | (32.89) |
| 7. Sorghum/Cowpea/Groundnut | 0.45 | - | - |
| | (.7.25) | - | - |
| 8. Sorghum/Millet/Cowpea | 0.87 | 1.38 | 1.53 |
| | (14.01) | (48.59) | (50.33) |
| Medium Lowland (Non-irrigated) | 2.00 | 0.46 | 0.51 |
| | (32.21) | (16.20) | (16.78) |
| 9. Rice | 0.50 | 0.28 | 0.33 |
| | (8.05) | (9.86) | (10.86 |
| 10. Sorghum/Cowpea | 1.00 | - | - |
| | (16.10) | - | - |
| 11. Maize/Groundnut\ | 0.50 | 0.18 | 0.18 |
| | (8.05) | (6.34) | (5.92) |
| Total Cropped area | 7.21 | 2.84 | 3.04 |
| | (100.00) | (100.00 | (100.00) |
| % Sole crop | 43.16 | 9.86 | 10.86 |
| % Crop mixture | 56.84 | 90.14 | 89.14 |

Note: Figures in parentheses are percentages to total cropped area
Source: Computed from Field Survey Data 2003.

Table 2: Existing and Optimum Cropping Patterns for Owner Farms (cropped area in hectares), Programs III and IV, Bunza Zone.

| Cropping Patterns | | Optimum | Plans |
|---|---|---|---|
| | Existing Plan | With limited Capital | With borrowed Capital |
| Highland (Non-irrigated | 1.75 | - | - |
| | (30.07) | - | - |
| 1. Maize | 0.70 | - | - |
| | (12.03) | - | - |
| 2. Sorghum | 1.05 | - | - |
| | (18.04) | - | - |
| Medium highland (Non-irrigated) | 3.00 | 2.30 | 2.46 |
| | (51.55) | (85.50) | (84.54) |
| 3. Sorghum/Groundnut | 0.40 | - | - |
| | (6.89) | - | - |
| 4. Millet/Cowpea | 0.10 | - | - |
| | (1.72) | - | - |
| 5. Sorghum/Maize | 0.08 | - | - |
| | (1.37) | - | - |
| 6. Sorghum/Maize/Cowpea | 0.52 | - | - |
| | (8.93) | - | - |
| 7. Sorghum/Cowpea/Groundnut | 1.48 | 1.00 | 1.00 |
| | (25.43) | (37.17) | (34.36) |
| 8. Sorghum/Millet/Cowpea | 0.42 | 1.30 | 1.46 |
| | (7.22) | (48.33) | (50.17) |
| Medium Lowland (Non-irrigated) | 1.07 | 0.39 | 0.45 |
| | (18.38) | (14.50) | (15.46) |
| 9. Rice | 0.40 | 0.15 | 0.15 |
| | (6.87) | (5.58) | (5.15) |
| 10. Sorghum/Cowpea | 0.50 | - | - |
| | (8.59) | - | - |
| 11. Maize/Groundnut\ | 0.17 | 0.24 | 0.30 |
| | (2.92) | (8.92) | (10.31) |
| Total Cropped area | 5.82 | 2.69 | 2.91 |
| | (100.00) | (100.00) | (100.00) |
| % Sole crop | 36.94 | 5.58 | 5.15 |
| % Crop mixture | 63.06 | 94.42 | 94.85 |

Note: Figures in parentheses are percentages to total cropped area
Source: Computed from Field Survey Data 2003.

## Land Allocation Under Existing and Optimum Plans

### Existing land use pattern

The existing land use pattern together with the emerging optimum allocation of land under the borrowed and limited capital situations for the pure owner and tenant farms are presented in Tables 1 and 2.

The basic crop production activities undertaken in Bunza zone in the existing land allocation are presented in Tables 1 and 2. The pure owner farms devoted a greater proportion of their cultivated land to sorghum which occupied about 17.71% of the total cropped area, under the highland, non-irrigated situation. Maize cropping pattern under the said land type as sole was the next predominant cropping pattern which occupied about 17.39% of the total cropped area. A greater proportion (56.84%) however, of the total cropped area was devoted to mixed crop enterprises.

In the case of rented-in farms (Table 2), more or less similar cropping patterns were followed. The most predominant cropping pattern for this category was sorghum/cowpea/groundnut on the medium highland type, non-irrigated situation which occupied about 25.43% of the total cropped area. Sorghum, planted as sole on non-irrigated highland was the next important cropping pattern which occupied 18.04% of the total cropped area. On a comparative note, pure owner farms allocated more land to crop production than the rented-in farms due to their resource endowment.

### Optimum Land Use Pattern

The emerging optimum farm plans for the different tenure groups are presented in Table 1 and 2. Results reveal that the optimization and reallocation of available resources resulted in significant changes in the existing land use pattern. Due to capital scarcity and tenure arrangement, more land was allocated to crops under the borrowed compared to the limited capital situation. Sorghum/millet/cowpea was the predominant cropping pattern in the case of

owner farms, in the medium highland under non-irrigated situation which accounted for an overwhelming 50.33% of the total cropped area. The same land type accommodated another cropping pattern, namely, sorghum/maize/cowpea which accounted for 32.89% of the total cropped area. Other prescribed cropping patterns in decreasing magnitude of importance are rice 0.33 hectares (10.86%) and maize/groundnut, 0.18ha. (5.92%) under the medium lowland non-irrigated situation. Due to optimization, the area under the cropping patterns decreased over the existing land allocation. Lesser allocation of land was observed the limited capital situation. Mixed cropping is more favorable in the survey area.

In the case of rented-in farms, sorghum/cowpea/groundnut dominated the cropping pattern under both limited and borrowed capital situations under the medium highland, non-irrigated situation, which occupied 37.17% and 34.36% of the total cropped area respectively. The optimum cropping patterns of the two tenure groups reveal that owner farms should allocate more land to crop production than the rented-in farms further revealing their land resource endowment. Thus, for an average farm household to optimize returns, a total of four crop enterprises should be undertaken according to the hectare allocations presented in Tables 1 and 2.

The optimum plans for owner farms prescribed 3.04 hectares and 2.84 hectares under the borrowed and limited capital situations respectively in order to maximize net return. Larger farm sizes are best suited for mechanization which is more cost-effective. Also, a total of four crop enterprises should be undertaken according to the hectare allocations prescribed in order to maximize net returns.

Utilization of Human Labor

The utilization of human labor for the different tenure groups under different capital situations for the existing and optimum production pans in different peak periods selected for the study are presented in Table 3:

Table 3: Human Labor Days Utilization by Different Tenure groups in Bunza Agricultural Zone, Kebbi State, 2003

| Operation | Existing Plan | Optimum Limited Capital | Plans Borrowed Capital | Increase Limited Capital | Decreased % | Over Borrowed Capital | Existing Plan % |
|---|---|---|---|---|---|---|---|
| Pure Owner Farms | | | | | | | |
| 1. Land Preparation | 51.00 | 18.28 | 43.39 | -37.72 | 64.16 | -7.61 | 14.92 |
| 2. Planting | 21.31 | 8.80 | 10.74 | -12.51 | 58.70 | -10.57 | 49.60 |
| 3. First Weeding | 87.42 | 93.00 | 160.55 | -5.88 | 6.75 | +73.43 | 84.39 |
| 4. Second Weeding | 86.00 | 86.78 | 104.58 | +0.78 | 0.91 | +18.58 | 21.60 |
| 5. Harvesting | 86.71 | 13.26 | 26.94 | -73.45 | 84.71 | -59.77 | 68.93 |
| Total | 332.44 | 220.12 | 346.20 | -112.02 | 33.73 | +14.06 | 4.23 |
| Rented-in Farms | | | | | | | |
| 1. Land Preparation | 48.00 | 14.68 | 49.78 | -33.32 | 69.42 | +1.78 | 3.71 |
| 2. Planting | 48.60 | 6.12 | 18.90 | -12.48 | 67.10 | +0.30 | 1.61 |
| 3 First Weeding | 92.37 | 68.05 | 95.83 | -24.32 | 26.33 | +3.46 | 3.75 |
| 4. Second Weeding | 86.18 | 72.08 | 92.70 | -14.10 | 16.36 | +6.32 | 7.57 |
| 5. Harvesting | 56.99 | 17.05 | 61.17 | -39.94 | 70.08 | +4.18 | 7.33 |
| Total | 302.14 | 177.98 | 318.38 | -124.16 | 41.09 | +16.24 | 5.37 |

Source: Computed from Survey Data, 2003

Table 3 reveals that overall, total human labor employment increased under the borrowed capital situation but decreased under the limited capital situation for both owner and tenant farms. Under the limited capital situation, human labor employment decreased by 33.73% in the optimum as compared to the existing plan for owner farms. However, the optimum plans increased human labor utilization during the first and second weeding operations by 6.75% and 0.91% respectively in the case of pure owner farms. Relaxation of the capital constraint by allowing capital borrowing increased labor requirement by 4.23% as compared to the existing plan for the aforementioned category of farms. This was

due to transfer of greater land area under particularly, cereal-legume-based mixed cropping enterprises. Besides, the cultivation of rice also increased labor demand. Human labor utilization also increased in the optimum plans for rented-in farms over the existing crop production farm plans under the borrowed, but decreased same under the limited capital situation by 5.37% and 41.09% respectively. One of the goals of small farmers is that of ensuring minimum usage of paid labor (Adejobi, 2003), which is necessitated by their financial handicap.

The utilization of bullock labor is presented in Table 4.

Table 4: Bullock Labor Utilization in Hours by Different Tenure Groups in Bunza Agricultural Zone, Kebbi State, 2003

| Operation | Existing Plan | Optimum Limited Capital | Plans Borrowed Capital | Increase Limited Capital | Decreased % | Over Borrowed Capital | Existing Plan % |
|---|---|---|---|---|---|---|---|
| Pure Owner Farms | | | | | | | |
| 1. June – July | 6.60 | 3.15 | 4.24 | -3.45 | 52.27 | -2.36 | 35.76 |
| 2. August-October | 5.65 | 5.65 | 5.65 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 12.25 | 8.80 | 9.89 | -3.45 | 28.16 | -2.36 | 19.27 |
| Rented-in Farms | | | | | | | |
| 1. June – July | 5.02 | 2.66 | 3.87 | -2.36 | 47.01 | -1.15 | 23.01 |
| 2. August – October | 3.05 | 3.78 | 4.15 | +0.73 | 23.93 | -1.10 | 36.07 |
| Total | 8.07 | 6.44 | 8.02 | -1.63 | 20.20 | -0.05 | 0.62 |

Source: Computed from Survey Data, 2003

Results in Table 4 reveals that bullock labor utilization decreased in the optimum plan with limited capital by 28.16% but decreased by only 19.27% under the borrowed capital situation as compared to the existing plan for pure owner farms. Bullock labor requirement in the optimized plans for rented-in farms for the period August – October was higher than in the existing plan because of greater weeding and ploughing requirements of the crops in the optimized plans.

Relaxation of the capital constraint increased the utilization of bullock labor due to the allocation of more land area to those crops that entered the plan.

Utilization of Tractor / Power Tiller

Tractor hiring is a function of the ability of the farmer to pay. Table 5 shows the utilization of tractor/power tiller by farmers in the existing and optimized plans.

Table 5: Tractor Utilization in Hours by Different Tenure Groups in Bunza Agricultural Zone, Kebbi State, 2003

| Operation | Existing Plan | Optimum Limited Capital | Plans Borrowed Capital | Increase Limited Capital | Decreased % | Over Borrowed Capital | Existing Plan % |
|---|---|---|---|---|---|---|---|
| Pure Owner Farms | | | | | | | |
| 1. May | 3.50 | 2.85 | 3.14 | -0.65 | 18.57 | -0.36 | 10.29 |
| 2. June | 2.35 | 1.62 | 1.59 | -0.73 | 31.06 | -0.76 | 32.34 |
| 3. July | 2.61 | 2.01 | 2.61 | -0.60 | 22.99 | 0.00 | 0.00 |
| Total | 8.46 | 6.48 | 7.34 | -1.98 | 23.40 | -1.12 | 13.24 |
| Rented-in Farms | | | | | | | |
| 1 May | 2.00 | 1.86 | 2.95 | -0.14 | 7.00 | +0.95 | 47.50 |
| 2. June | 1.50 | 1.00 | 1.03 | -0.50 | 33.33 | -0.47 | 31.33 |
| 3. July | 1.20 | 1.20 | 1.99 | 0.00 | 0.00 | +0.79 | 65.83 |
| Total | 4.70 | 4.06 | 5.97 | -0.64 | 13.62 | +1.27 | 27.02 |

Source: Computed from Survey Date, 2003

Table 5 reveals that tractor utilization decreased by 23.40% and 13.24% under the limited and borrowed capital situations respectively in the case of pure owner farms, during the May, June and July peak periods of tractor utilization. In the case of rented-in farms, tractor utilization increased by 27.02% but decreased by13.62% under the borrowed and limited capital situation respectively for the May, June and July peak periods of tractor utilization.

Table 6: Net Farm Income (In the Existing and Optimum Plans)

| | Existing Plan | Optimum Limited Capital | Plan Borrowed Capital | Increase Limited Capital | Over (%) | Existing Borrowed Capital | Plan % | Increase in Over Limited Amount (N) | Capital Plan % |
|---|---|---|---|---|---|---|---|---|---|
| Pure Owner | 49,320.50 | 64,300.86 | 77,546.99 | 14,980.36 | 30.37 | 28.226.49 | 57.23 | 13,246.13 | 20.50 |
| Rented-in | 54,050.80 | 70,150.00 | 86,591.83 | 16,100.00 | 29.79 | 32,541.83 | 41.71 | 16.441.00 | 23.00 |

Source: Computed from Survey Data, 2003

Net Farm Income under Existing and Optimum Plans

An examination of Table 6 reveals that optimum plans with limited capital resulted in an increase in net farm income by 30.37% and 29.79% for the pure owner and rented-in farms respectively.

This shows a marked mal allocation of existing resources on all tenure groups and a considerable scope for increasing farm incomes by reallocating the existing resources in an optimal manner. The provision f borrowed capital further raised the incomes by 20.60% and 23.00% over the optimum plans with limited capital in the case of pure owner and rented-in farms indicating that both groups of farms were cash starved. However, the informal credit sector of the financial market which provides the bulk of the agricultural loan used by smallholder farmers in Nigeria is limited. Its financial resources are inadequate and insufficient to meet the demand for rapid economic transformation. Loans obtained from these sources are relatively small. The result of the analysis suggests that provision of adequate and timely credit would go a long way in raising farm income. At the margin, ₦1 in borrowed capital could yield up to ₦1.04 and ₦1.29 in additional net income in the case of owner and rented-in farms respectively.

Table 7: Sensitivity Analysis of the Optimum Plans

| | Optimum Income From Initial Program (N) | | Optimum Income for the Present Model (N) | | Increase in Farm Income (N) | | Percentage Change (%) | |
|---|---|---|---|---|---|---|---|---|
| Pure Owner Scenario | Limited Capital | Borrowed Capital | Limited Capital | Borrowed Capital | Limited Capital | Borrowed Capital | Limited Capital | Borrowed Capital |
| I. Land Increased by 2 hectares | 64,300.86 | 77,546.99 | 83,640.70 | 112,823.75 | 19,339.84 | 35,276.76 | 30.00 | 45.00 |
| II. Wage Fixed at N200 per man day | 64,300.86 | 77,546.99 | 79.343.10 | 86,379.59 | 15,042.24 | 8,832.60 | 23.00 | 11.39 |
| Rented-in Farms | | | | | | | | |
| I. Land Increased by 2 hectares | 70,150.00 | 86,591.83 | 84,050.11 | 105,860.13 | 13,900.11 | 19,268.30 | 19.00 | 22.00 |
| II. Wage Fixed at N200 per man day | 70,150.00 | 86,591.83 | 77,749.72 | 97,480.20 | 7,599.72 | 10,888.37 | 10.00 | 12.00 |

Source: Computed from Survey Data, 2003

Sensitivity Analysis

The emerging optimum plans were subjected to sensitivity analysis to gauge the sensitivity of the plans to changes in some production variables. Two scenarios were considered. Firstly, land resource was increased by 2 hectares. This was done taking into account the endowment of this resource in the survey area. The average farm size for a representative farm household in this zone was 5.62 hectares per household comprising of one to several plots, the mode being two plots. Secondly, wage rates were equated with those institutionally determined, that is, as obtained in government-owned farms. In those farms, the average ruling wage rate was N200.00 per man-day. These wages were generally lower than those offered by individual farmers.

Table 7 reveals that optimum net farm income increased by 45.00% over the initial program in the case of pure owner farms under borrowed capital situation after cultivated land area was increased by 2 hectares. The total land

area allocated to crops by the optimized plans increased significantly. Larger farm sizes coupled with efficient utilization of production inputs and appropriate cultural and management practices should result in increased farm incomes. Under the same capital situation, net returns increased by 22.00% in the case of rented-in farms. In the second scenario, net returns increased by 23.00% and 11.39% under limited and borrowed capital situations respectively after wage rates for human labor were equated with those institutionally determined holding other variables constant. Real wage determines the amount of labor supplied. One of the goals of small farmers however, is ensuring minimum usage of paid labor. Given their meager resources, agricultural production will be constrained so long as labor hiring remains an indispensable component of small holder agriculture. Since the government cannot dictate wage rates or arbitrarily fix them in the private sector of the economy, making agricultural credit more accessible to small farmers becomes paramount in our quest for the resolution of the food crisis.

## Conclusion and Recommendations

The linear programming results revealed that only 4 out of the 11 cropping activities identified in the study area entered the optimum program. The 4 crop activities and their hectare allocations under the borrowed capital situation in the case of pure owner farms for instance, were sorghum/maize/cowpea (1.00), sorghum/millet/cowpea (1.53), rice (0.51) and sorghum/cowpea (0.33). The results also reveal that there is a divergence between the existing and optimum farm plans for the different tenure groups. Farm resources were not optimally allocated and there is a considerable scope for increasing farm incomes by reallocating the existing resources in an optimal manner.

Due to capital scarcity, more land was allocated to crops under borrowed as compared to the limited capital situation. Results of the sensitivity analysis revealed that reduction in wages for human labor led to an increase in optimum net farm income implying that the wages were high. Since farmers have limited cash to hire labor, the need to finance agricultural production thus become imminent. Farmers should belong to organized farmer groups so as to enhance their accessibility to agricultural credit. Increasing the area under cultivation also led to increase in net income of farms, implying that to optimize returns farmers should utilize more agricultural land. The prototype enterprise combinations emanating from this study could be found useful in the extension education package in addition to other extension programs that will educate the farmers on efficient allocation of their resources. These should be pivot points upon which policy thrust by the State for smallholder farmers should be hinged

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