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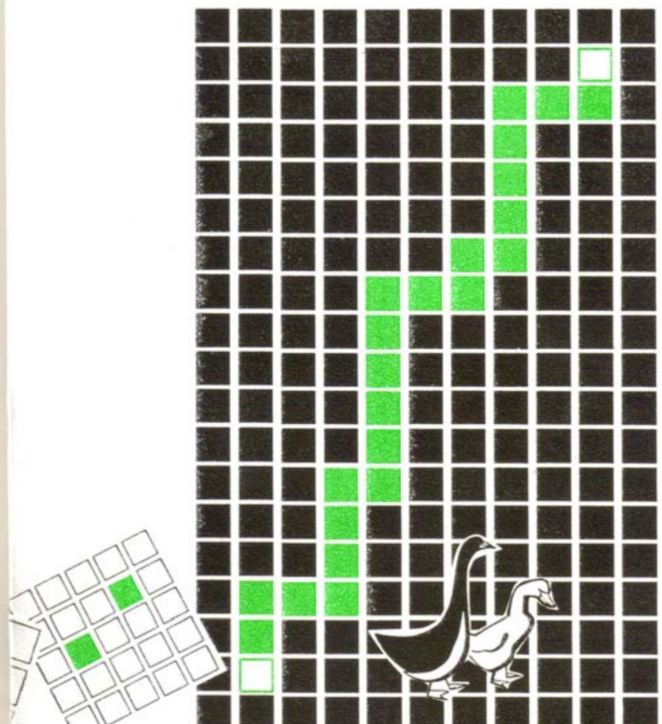

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EFFECTS OF RESOURCE CONSTRAINTS ON THE PRODUCTION SYSTEMS AND EARNINGS POTENTIAL OF SMALL FARM HOUSEHOLDS IN THE WEST PROVINCE OF CAMEROON

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INTRODUCTION

In the years following independence in 1961, Cameroon has experienced an average annual economic growth rate of 3.6 percent, which is almost three times higher than the Sub-Saharan African nations' average of 1.0 percent over the same period *(World Bank, 1987).* The country's agricultural sector grew at an average annual rate of 4.2 percent over the 1965-80 period. This was considerably better than the average growth rate of 1.9 percent of Sub-Saharan African countries over the same period. The growth rate of the agricultural sector has slowed substantially over the 1980-85 period, to about 1.3 per cent per annum. However, even at the reduced rate, the country's agricultural sector growth in the latter period was in excess of the Sub-Saharan African average of 0.9 percent *(World Bank, 1987).* For the most part, Cameroon is self-sufficient in supplying its food needs. In 1984-85 only 2.6 percent of the food consumed locally originated from net imports (the difference between exports and imports), and these imports were mainly cereals such as rice and wheat flour *(Ministry of the Plan & Regional Development, 1986).* The West Province of Cameroon is the smallest of the country's ten provinces, but is the third largest in population. The province has the highest population density of ,any of the provinces. For example, the population densities were 84..2, 95.7 and 107.7 persons per square kilometer in 1981, 1986 and 1991, respectively. In contrast, the population densities for the country as a whole were 18.9, 22.0 and 25.8 persons per square kilometer in 1981, 1986 and 1991, respectively *(Ministry of the Plan & Regional Development, 1986).* The Province is also an important producer of agricultural commodities. Agriculture accounted for over 65 percent of the province's GDP in 1977, which was more than twice the contribution of agriculture to the national GDP *(Nji, 1982).* The province is a primary producer of food crops and the main region for the production of Arabica coffee. In addition, Robusta coffee, cocoa and tobacco are produced in sizeable quantities. Given the land and other agricultural resource constraints associated with rural population pressures in Cameroon's West Province (and other regions), the purpose of this paper is to report on the results of the study to assess the effects of land and other resource constraints on the agricultural production systems and income generation potentials of small farm households in a sub-region of the West Province.

THE FARM PRODUCTION PROCESS: SOME CONCEPTUAL DIMENSIONS

In assessing the impact of land and other resource constraints on Cameroon small farm systems, it is *inter alia,* necessary to develop: (1) an understanding of the characteristics of the productive process and (2) identify and measure the key factors impacting the process. Economic theory and empirical studies provide the contextual framework for approaching the assessment. In other words, the behavioral assumptions underlying the form and the function of the production systems of small farmers are rooted in the tenets of traditional economic theory and the associated body of empirical findings relating to observable economic phenomena. Based on these tenets, we explicitly assume the following objectives as being typical of the small farmer population: (1) maximization of net returns, (2) attainment of a reasonable level of self-sufficiency in household food consumption and (3) minimization of risk in production activities.

The choice of an appropriate empirical model for assessing the behavioral characteristics of an economic system is subjective. As such, the choice process needs to be informed by a set of criteria. In the case of this study there are two overriding criteria for the selection of the model used. These are: (1) adaptability to the compositional theoretical framework which is providing guidance to the behavioral assumptions and characteristics of the system, and (2) "appropriateness" in meeting the general objective of the study. In this case, the objective is to evaluate the impact of land and other resource constraints on small farmer agricultural production systems and their income generation potential. A number of studies of these kind have used a production function approach in which regression analysis is used to determine the coefficients under which small farmers operate *(Wolgin, 1975; De Boer and Chandra, 1978; Dillon & Anderson, 1971; Yotopoulos, 1967; Hopper, 1965).* These types of studies have been primarily directed towards considerations of risk, allocative efficiency and the nature of constraints on farm production systems. Barnett *etal* (1982) used a linear programming (LP) model to test various objectives of Senegalese farmers. One study that is most closely related to our study in terms of objective is that by Heyer (1971) of small farmers in Kenya. Heyer used a linear programming model to estimate shadow prices for resources, thereby estimating the effective constraint of resources on the production process.

A Linear Programming Model: Rationalization and Specification

Based on the model selection criteria discussed above, a linear programming model was selected as being the most suitable empirical procedure for evaluation of the system. One advantage of a linear programming model within the context of traditional agricultural production system such as Cameroon's is that it avoids the question of allocative efficiency *(Heyer, 1971).* Although an LP model arrives at a solution by maximizing the model objectives, it avoids the assumption that technical maximization has already occurred *(Langham, 1968).* Instead, the existing (although possibly sub-optimal) allocative efficiency rates are determined and used in the model. The model solution then points to activities and levels of allocation that should be pursued if the objectives of the model are desirable.

Further, given the objectives of the LP model, the shadow prices of the resources are a measure of the constraining effect of those resources. The degree to which the objectives and constraints of an LP model match those of producers in the farm production system being represented, is a function of the specification of the actual model. Although an LP model must of necessity maximize or minimize some objective function, the model readily lends itself to attain other objectives through the use of the constraints (Langham, 1968). Empirical studies by Barnett *et al* (1982) indicate that the inclusion of other objectives besides profit maximization may not improve the performance of the model. In their study of Senegalese small farmers, a multiple objective model did not exhibit superiority over a profit maximization model with similarly-structured constraints. Also, a deterministic model requires fewer observations to structure the model, which in the context of the data limitation problems of developing countries, could be an important consideration. Finally, within a resource allocation LP model, the dual provides shadow prices or relative measures of the resource constraints of their associated resources. In this way such a model can show which constraints are the most seriously binding and which merit the most research.

The general algebraic notion, the primal form of the LP model specification, explicitly assumes the objectives of profit maximization, food self-sufficiency and risk minimization. The model is: Maximize:

Subject to: Land constraints

(2)

Labour constraints

(n=1...4) .... (3)

Purchased input identities

(/=1,.3) . . . .(4)

Consumption requirement constraints

• (5)

$X_{S)}, Y_k, Z_{,,} V_k > 0$ for all s,k,i,j.

Indices:

i) = 1...3 indexes purchased inputs, while i=4, 5 are male and female purchased labour

k) = 1...15 indexes the crops produced by the household. k=1,..l3 are crops which are considered household k=14,15 are crops which are considered monthly

s) = 1...4 indexes the land types available to household

j) = I,..8 indexes the activities, or crop mixes, for which land can be used. j=1,..5 are activities in the first season, while j=6,..8 are activities in the second planting season

n) = 1 ,..4 indexes the types of labour required.

Variables and coefficients:

P = market price of the i^{th} input

z = quantity of the i^{th} input purchased

$_{PR}$ = market price per bucket of the k^{*1} crop

Y_k = quantity sold of the k* crop, in buckets

X , = hectares of land of type s devoted to activity j

d_s = hectares of land of type s available

B , = hours of n^{th} labour type required for one hectare of land of type s devoted to activity j
hours of purchased labour to type n

b_n = hours of n^{th} labour type available
quantity of i^{th} input required for one hectare of land of type s devoted to activity j

$C_{s|k}$ = quantity of k^{*1} crop produced by one hectare of land of type s devoted to activity j in buckets

h_k = minimum quantity of k^{*1} crop required for household consumption, in buckets.

In the model, equation (1) represents the maximization of net returns to resources by the household. Net return is defined as the gross returns from farm products sold less the cost of inputs purchased. The amount of product sold is the amount produced less that reserved for home consumption. Equation (2) is the constraint allocating the household land resources to the various production alternatives or crop mixes. Equation (3) is the constraint allocating household labour, borrowed labour and hired labour, to the production alternatives. Equation (4) is condition guiding the allocation of purchased inputs to the production alternatives and equation (5) represents transfer constraint equations allocating the production of each output to either home consumption or sale.

THE LINEAR PROGRAMMING MODELS

The linear programming model was separately specified for each of the four household groups. Hyperlindo mathematical programming computer software was used to solve the model. Two detailed forms of the LP model were specified and these are referred to as Model 1 and Model 2. Model 1 has as its operational objective the determination of land and other resource constraints on income potential of farmers. The objective of Model 2 is to assess the relative value of alternative cropping activities of each group of farmers and predict their response to factor and product pricing policies. Each model was solved for a number of variations via a series of runs. Model 1 had 4 runs: run 1 = measured land values, without a binding capital constraint; run 2 = varying land availability constraint, without a binding capital constraint; run 3 = holding land fixed, and varying the capital constraint values; run 4 = varying both land availability constraint and capital constraint values. Model 2 had 3 runs: run 1 = measured coefficients, without a binding capital constraint; run 2 = varying price received for coffee, without a binding capital constraint; run 3 = varying price paid for fertilizer, without a binding capital constraint. The detailed forms of models 1 and 2 are presented below.

Model 1

Model 1 holds the proportion of land allocated to coffee and foodcrops fixed, based on the assumption that in the short run, land cannot be converted from one enterprise to the other.

Objective function:
Maximize:

(=1 (=4

/(-1

E £ P«Y» ..... (6)

price of one hour of i^{th} labour
during period t
hours of i^{th} labour purchased during period t
price of crop k during period t
quantity of crop k sold during period t

IN = average annual amount of income received from other agricultural sales, such as fruit, chickens, etc.

FC = average fixed cost of annual general agricultural purchases, including tools and equipment.

The objective function maximizes the revenue from crop sales less the out-of-pocket cost of crop production. The time periods represents the months during the period of the second phase survey (Nov. 1988 to April 1989) plus a single period representing the rest of the year. There are therefore 7 time periods.

Constraints:
Land allocation constraints, in hectares:

$$£X_{s/} < d. \ (s=1,..4) \ ...... \ (7)$$

There are four land types: 1 = land available for coffee production; 2 = land available for coffee - food crop associated cropping; 3 = land available for food crops in seasons 1 and 2; 4 = land available for food crop in season 2. Constraint (7) limits the amount of land of a specific type to the amount of that land available to the household. The eight cropping activities are: 1 = coffee production with land used throughout the year; 2 = food crops intercropped with coffee (first season); 3 = beans associated with potatoes (first season); 4 = corn associated with food crops (first season); *5* = cabbage (first season); 6 = beans with potatoes (second season); 7 = cabbage (second season); 8 = red cabbage (second season).

Labour allocation constraints, in hours:
Type 1 labour constraints (female and large child):

SO (M...7) .... (8)

Type 2 labour constraints (female and children):

s=1 /-1

$_2$, <0 (M...7) .... (9)

Type 3 labour constraints (all household members):

$_3$, - $(MT)_{3(}$<0 (M...7) .(10)

Type 4 labour constraints (male only):

(M...7) ...... (11)

(FT)nt = hours of female labour available to type n labour activities in period t

(CIT)nt = hours of large child labour available to type n labour activities in period n

(C2T)nt = hours of small child labour available to type n labour activities in period t

(MT)nt = hours of male labour available to type n labour activities in period t.

There are four labour types, differentiated by gender, age and task: 1 = tasks assigned to female or large child; 2 = tasks assigned to female, large child or small child; 3 = tasks assigned to general labour, including male, female or child; 4 = tasks assigned to males. A large child was considered to be older than 10 years, while a small child was one of 10 years or less. Based on discussions with local farmers, equivalencies were developed for adult and child labour inputs. One hour of large child labour was equivalent to one-half hour of adult labour, and one hour of small child labour was equivalent to one-third hour of adult labour. Constraints (8) through (11) allocate available labour to the 4 labour types.

Female labour constraints:

£$(FT)_{n(}$ -Z_4, <f, $_+$ /b,

(M...7) .... (12)

Large child labour constraints:

$E(C/T)_{n/}$< $C1_f$ (M...7) .... (13)
n-1

Small child labour constraints:

3
$E(C2T)_{n}$, < $C2_t$ (M...7) .... (14)
n-2

Male labour constraints:

* s *m, + mb,*

(M...7) .... (15)

f_t = hours of household female labour available in period t

fb_t = hours of borrowed female labour available in period t

$c1_t$ = hours of large child labour available in period t

$c2_t$ = hours of small child labour available in period t

m_t = hours of household male labour available in period t

mb_t = hours of borrowed male labour available in period t

$z4_t$ = hours of purchased female labour in period t

$z5_t$ = hours of purchased male labour in period t.

All of the labour constraints (8) through (1 5) limit the labour allocation to the respective labour types to that available either from household members, borrowed, or hired.

Purchased input identities:

-1 y-1 -f <0

(16)

Purchased input identity (16) allocate purchased inputs to cropping activities in the production process. The three types of purchased inputs are: 1 = fertilizer purchased from coffee cooperatives, assumed to be allocated to coffee production; 2 = fertilizer purchased on the open market, assumed to be allocated to foodcrops; 3 = other variable inputs, particularly seed and gasoline or irrigation pumps.

Household consumption constraints for crops considered annually:

s-1 /-((-1

(JM...13) .... (17)

Household consumption constraints for crops considered monthly:

(M...7) .... (18)

CSJK, = buckets[1] of crop k produced per hectare of activity j on land type s in period t

Y_k = buckets sold of crop k

Y_M = amount sold of crop k during time period t

h_k = household consumption requirement for crop k

h_w = household consumption required for crop k during time period t.

Constraints (17) are balance equations which move the production of crops to sales and home consumption. Constraints monthly to sales and home consumption.

Capital constraint:

(=1 ;-4 < C . . (19)

A capital constraint was introduced to test the effect of the availability of capital on the system. The terms of the left-hand side are the expenditure terms from the objective function, and represent the total out-of-pocket costs, in CFA,[2] of production. The coefficient e is the amount, in CFA, of capital available to the household.

Model 2

Model 2 allows land to be allocated freely to either coffee or foodcrop production. Further, households are able to purchase foodcrops on the local market to satisfy household consumption needs. This is assumed to free land and labour inputs from necessarily producing for subsistence, so that the highest level of income generation can be attained. Thus, the only difference between Model 1 and Model 2 are the constraints pertaining to land and foodcrop allocation.

Land constraints:

, <*d . . .* (20)

j is hectares of land devoted to activity

;. • • (21)

Constraint (20) allows the total household land to be available to planting by first-season crop mixes (j=1,..5). Coffee is considered as one of these. Constraint (21) requires that foodcrop land that is replanted during the second season (j=6,..8) cannot exceed a certain proportion (g:(0 g 1)) of the area planted during the first season.

Household consumption constraints for crops considered annually:

.... (22)

W_k is quantity purchased of crop k.
Household consumption constraints for crops considered monthly:

> />fc

(*=14,15),(M,..T) .... (23)

W_w is quantity purchased of crop k in period t.

The household consumption constraints are similar to Model 1 (constraints (17) and (18) except that in this case the purchase of food commodities to meet household consumption requirements is permitted. A number of coefficients had to be calculated to operationalize the linear programming models. These include: (1) hourly labour wages, (2) input prices, (3)-crop prices, (4) other agricultural income, (5) land availability, (6) labour availability, (7) input application rates, (8) yield rates, (9) labour application rates, (10) household consumption requirements, (11) household expenses. Details of these calculations are available from the authors.

THE STUDY AREA AND ELICITATION PROCEDURES

Study Area

The data used in the analysis were obtained from the chiefdom of Bafou in Cameroons' West Province. The chiefdom of Bafou is one of the largest and most important of the Bamileke chiefdoms. Bafou is located in the Department of Menoua,[3] on the western edge of the West Province, and is at its closest point, about 10 kilometers (km) from the city of Dschang, the departmental center. Dschang is also the location of the University Centre of Dschang, the national agricultural university; patterned after the Land Grant University System of the United States. The Bafou chiefdom is roughly rectangular shaped, with dimensions 28 km long and 8 km wide, with a surface area of 162 km2. A range of escarpments divides the terrain into rough highland and lowland areas. The highland area covers the northern 10 km length of the chiefdom with Elevations ranging from 1600 to 2740 meters. The lowland area occupy the southern 18 km length of the chiefdom, with elevations ranging from 1400 to just under 1600 meters *(Bergeret et al, 1988).* The climate is humid yet moderate, tempered by the relatively high elevation. Annual rainfall averages 1.9 meters, which is spread over an 8.5 month period, beginning in early March and ending around mid-November. The annual variation in rainfall pattern is considered the least varied in Cameroon. In a study of the rainfall pattern over a 30-year period, enough rain had fallen (25mm) to plant by March 31 in 9 years out of 10 *(Bergeret et al, 1988).*

The Bafou chiefdom is divided into more than 80 'quarters' (neighbourhoods), each traditionally governed by a sub-chief, whose authority is delegated by the chief. Favourable climate and fertile volcanic soils contributed to the development of a traditional agricultural system of associated cropping of corn, beans, plantain, bananas and rootcrops. During the colonial period, the plantation system of agriculture was introduced, with Arabica and Robusta coffee varieties as the major plantation crops. Coffee was rapidly adopted by small farmers between 1940 and 1960, such that at the present time coffee in association with food crops has become the dominant agricultural practice *(Bergeret et al, 1988).* The major food crops grown are corn, beans, cocoyams, yams, potatoes, cassava (manioc), bananas and plantain. Also grown, but in smaller quantities are peanuts, melons, onion, hot peppers and a variety of greens such as amaranth. There are two cropping seasons, the first beginning with the rains in March, and the second starting in August or September. The first rainy season is the most important in the production process, since the bulk of the annual plantings occur during this period. Plantings during the second rainy season is approximately one-quarter of the land planted during the first. Although there is wide variation in crop mixes among plots, the following three general cropping mixes are typical of the farming system.

(1) Coffee/Foodcrop Mix:

Coffee is planted at the usual density of 2500 plants/ha, or spaced 2 meters apart. Between these coffee trees are planted any and/or all of the major crops. However, very little is planted in this type of system during the second season. Responsibility for cropping decisions may be divided in cases where the cultivators of the coffee and foodcrops are different individuals. Chemical fertilizers are applied to coffee trees and are thus available to the other crops. Fungicides are also applied to coffee.

(2) Com Mix:

This is planted exclusively during the first season, and consists of corn and primarily beans, but often with some combination of cocoyams, potatoes, cassava and yams. Chemical fertilizers are sometimes applied.

(3) Bean/Potato Mix: Agricultural roles within the traditional farm households are generally differentiated along gender lines. The task for males are those associated with coffee, including planting, fertilizing, spraying, pruning, harvesting, depulping and drying. In the traditional system, among the food crop enterprises,' only plantains are cultivated and harvested by males. There are indications, however, that the traditional gender designated roles are in transition. Some males, particularly younger farmers, do plant and harvest their own food crops, particularly those produced for market. Also, women own and tend their own coffee plots. Women perform the bulk of agricultural labour, including participating in all of the coffee tasks, except pruning which is designated exclusively as a male task. For food crops, land preparation, planting, cultivating and harvesting are all performed by women and women process and market the food crops. Children in the farm household generally participate in most of these tasks. Young boys will assist women in their tasks, but with age both boys and girls assume their traditional roles.

Data Elicitation **Procedures**

Data relating to the production processes of typical small farm households were elicited in a structured format over an eight-month period from September 1988 to April 1989 in the Bafou chiefdom. To determine the characteristics of a typical farm, knowledge of the essential characteristics of each household type is essential. Sample survey procedures were used to acquire this type of information. Such survey procedures need not be random. A selection choice based on judgement will be at least as good and perhaps better than random choices in determining the typical characteristics. However, Mellor (1969) agrees that a beginning knowledge of the population to be studied is essential. In keeping with these considerations a two-phase data elicitation procedure was utilized to generate information required in the linear programming model. The first phase consisted of a rapid informal survey designed to provide: (1) descriptive analytical parameters of the agricultural system in the study area, (2) an overview of the general production and resource allocation patterns and (3) guidance to the nature of the constraints to be faced in conducting the formal survey. The second phase consisted of a formal sample survey of small farmer household. This phase was designed to generate data sets to be utilized in the linear programming model specified in the empirical procedures.

Phase I Survey

During the first phase informal survey, 24 farm households were identified through consultation with the area's agricultural extension posts, as representative of the farming system of the Bafou chiefdom. At each location, both small and large farm households are visited. Each household head was visited in plots for approximately 90 minutes, and attempts were made to talk to at least one female member of the household. The survey was conducted in an informal manner, and all questions and responses were recorded on voice tape. Questions were asked regarding number of women and children in the household, land available to the household, land sources, amount of land allocated to coffee and other crops. Coffee production and land allocation data were recorded from each farmer's coffee cooperative book.

General information was gathered on the production process, the agricultural cycle, labour role in agriculture, availability and use of inputs, markets for and sale of agricultural production, and land acquisition patterns.

Analysis of the informal survey data clarified a number of important points. It was made clear that much of the agricultural production, particularly rootcrop and banana/plantain, was harvested and sold on a day-to-day basis. Also, labour use was seasonal, and with the exception of coffee sales records, no records existed of either labour use or crop yields. Farmers, however, were able to recall the amounts harvested of crops such as corn and beans, which generally were harvested at one point in time, with the exception of those plots that were close to farm residences. Furthermore, the land holding size data are approximate since few farmers know the actual size of their holdings. Farmers, generally would have a rough idea of how much land was allocated to coffee, because a coffee cooperative extension worker would have made such a size determination at some point. These farmers generally had little idea, however, of the size of their food plots. All in all, one important conclusion derived from the first phase informal survey, was that important elements of the data concerning the production process (and the LP model) could not be elicited through single interviews of farmers or even over several visits.

Phase 2 Survey

The approach to the second phase formal survey was informed by the results of the first phase informal survey. Thus, the decision was made to select a small number of representative farm households and conduct repeated visits in order to obtain the daily data necessary for the estimation of labour allocation and certain crop production levels. Further, a small sample would allow all of the households' land holdings to be visited and measured in order to ascertain an accurate measurement of land and other factor allocations. It was recognized that a small sample survey would carry a much smaller probability of capturing representative households, compared to a statistically large sample. Budget and other constraints precluded the use of a large sample survey. It was therefore decided to use the large sample data base available for the study area, generated by the project known as *"Operation Bafou",** to select households most closely matching the typical households described by that data base. The use of this procedure facilitated the selection of farm households, which although not randomly generated, were representative, in that they matched known parameters of household size, holding size, and typical agricultural activities.

The second phase or primary survey was implemented via two separate questionnaires. One questionnaire was developed to record the daily activities of the household. The other questionnaire was developed to record data relating to a particular plot of land cultivated by the household. The two types of questionnaires were administered by trained interviewers who were proficient in the local dialect of the Bamileke language. A representative sample of 12 farm households we/e selected based on the *"Operation Bafoif* sample frame. This number of households was determined to be the largest that could be operationally accommodated, given the comprehensiveness of the data requirement and other constraints. However, because of certain data problems, only 10 farm households are included in the empirical analysis. Selected characteristics of these 10 farm households are presented in Table 1.

As shown in Table 1, three quartiers or neighbourhoods represent - the farm production variation found in Bafou, the study area. The three neighbourhoods are Tsinfou, Lefe and Loung. Tsinfou is located in lowland terrain and is considered an average quartier for the study area as a whole, with moderate population density and holding sizes. A total of 3 representative households were selected from Tsinfou neighbourhood, 1 large size household and 2 small size households. Lefe is also located in lowland terrain, where holding sizes are typically small, and population density is very high. A total of 3 households were selected from Lefe quartier, 1 large size and 2 small size. Loung is located in highland terrain, and is characterized by low population density, large size holdings and a high incident of market garden (non-traditional cash crop) cultivation. A total of 4 households were selected from the Loung neighbourhood, 2 large size and 2 small size. Summary characteristics of the 10 sample households reveal the following aggregates: 28 adults, 71 children, 13.03 ha of coffee land. The average hectares of coffee land was 1.3 (Table I). Summary characteristics of average size of crop land allocations and yields are presented in Table 2. These figures are the basis of the LP results.

Enumerators visited the sample households in each quartier twice each week on designated days of the week. Each of the adult members of the households were interviewed on each visit, at which time both types of survey questionnaires were administered. It was established earlier from the first phase survey that the standard unit of measurement for marketing most foodcrops in the area was a 15 litre bucket. Each household was provided with a similar bucket and instructed that all information gathered regarding yields, seed and even fertilizer use, would be expressed in bucket units. Other common units of measurement used were the coffee sack and fertilizer sack. Equivalencies in measurement units were established as 1 coffee sack = 8 buckets, and 1 fertilizer sack = 4 buckets. In administering the plot questionnaire, plot measurements were made with a 15 meter length of rope marked at 1 meter intervals.

RESULTS

Effects of Resource Constraints on Production Systems and Earnings Potential

Land: Results from run 1 of Model 1 indicate that the predicted optimum allocation of land to alternative crop mix is similar to the actual household land allocation as observed during the survey. In all cases, all of the available land was allocated by the model to cultivation. This result, however, does not especially underscore the constraints imposed by land availability, since in the model specification, land is the only effective constraint, since labour, and all other inputs can be purchased and capital was not binding. Table 3 compares the run 1 allocation of land to actual allocation. The primary difference between the model allocation and observed values is the amount of land left fallow. For example, in the case of the first season corn mix planting, large highland farmers only planted 0.78 ha in actuality, while the model allocates 3.9 ha to the mix. The model naturally allocated all land to production as long as net returns to labour and other inputs were positive. This difference could be a reflection of capital constraint which was assumed to be non-binding in the model. It could also, reflect a recognition on the part of the farmers of the limitations of land to sustained annual croppings. Those farmers who still choose to plant all of their land may simply be experiencing greater land constraint with respect to their household consumption needs. Recall that Model 1 does not allow for the purchase of foodcrops and that household consumption requirements were calculated based on observed production from existing crop mix allocation.

The allocation of all available land in the model does indicate clearly that there are positive returns to agricultural inputs in general, and that in the context of the existing constraints, larger land holdings are desirable for all groups. The model allocation could also reflect a response to yield uncertainty, whereby a large area is planted to ensure consumption needs. This is true even at relatively high levels of land availability (as shown in run 2) where the proportion of hired to household labour is high, indicating positive returns to hired labour. The model indicates that the cabbage crop is not a preferred crop mix in terms of land allocation to each particular crop mix, given the model constraints. As indicated in Table 3 only the two household groups in the highlands grow cabbage. In each of these household groups the model allocated only enough land to cabbage in the first season to meet household consumption requirement for that crop. Only in the large highland group does the model's land allocation solution include cabbage (red) produced for sale in the second season. The foodcrop mix most favoured by all of the groups was the first season corn mix. In all household groups, more of the corn mix was in the model solution than the actual plantings. The bean and potato crop mix for the first season was not selected by the model for any of the household groups, yet 3 of the 4 household groups actually planted this crop mix. In the cases of coffee production land and coffee/foodcrop land (the same land), only one mix is possible for each of these land categories. In all household groups, the model elected to plant all of the land available to these crop mixes, indicating positive net returns to coffee. Observation of actual foodcrop land plantings for the first and second seasons indicate significant reduction in plantings during the second seasons. On the average, the two highland groups planted about 26 percent of the first season foodcrop land, while the two lowland groups planted about 36 percent. This would suggest *inter alia,* that highland farmers are less pressured by land and are able to leave more land in fallow during the second season.

An interesting and informative dimension of the land constraint question has to do with the relative scarcity of land among household groups. As indicated earlier, the dual of the linear programming model produces the dual of the resource constraints and reflect the rate of change in the objective function, with respect to each associated constraints. These dual values are referred to as *"shadow prices"* or *"implied values"* for the limited resources that are causing the constraint. A resource whose availability poses no constraint to the model would carry an implied value of zero. The implied values of land can be taken to reflect the scarcity of land (and the value of the productive capacity), given the available resources and technology. Thus, the generation of implied land values for the four household groups would provide some indication of relative land scarcity among the groups. In general, it would be expected that households with smaller land holdings would have higher implied land values, under similar technology and farming practices, since they would have the available labour to make use of more land. This condition, however, would depend on the relative access to other resources, particularly labour. Survey data indicate that in the highland area, where land is generally considered to be less scarce, that the labour/land ratios are smaller than in the lowland area, reflecting a greater availability of land to labour.[5] It would be expected then that lowland households would reflect higher implied values for land.

Table 4 shows the calculated implied land values for each household type under run 1 of Model 1. Note that two types of implied land values are computed in the table. One set of implied land values in Table 4 are for coffee land, coffee/foodcrop land, first season foodcrop land and second season foodcrop land. A comparison of these values provide non-conclusive results, since there is no correlation of land value to household size. The relative values of coffee land, however, match closely the relative yield rates (Table 2) that were computed for coffee for each household groups. The coffee yield for both lowland groups is approximately 295 kg/ha, while small highland farms produce 491 kg/ha, and large highland farms 726 kg/ha. The implied values of the land used for that purpose rise with increased yield. As a general rule, implied land values were higher for first season foodcrop land than for coffee land. This finding is consistent with the model results reported in Table 3, where the corn mix was favoured and-the relatively high revenues available from the sale of corn, potatoes and beans. The second set of implied land values in Table 4 are estimates of total weighted average implied land values for coffee land and food crop land. These weighted average implied land values were calculated using a modified version of the formula used to compute the implied land values for the upper portion of the table. The total weighted average figures are the average value of all land to the farmer based on coffee and foodcrop holdings. The weighted average implied land values indicate as expected, that land values are higher for small farmers, and lower for large land holders, with the noted exception of large highland farmers.

Closer examination of the pattern of implied land values was conducted through the relaxation of the land constraints, allowing increasing land availability to each household group, and calculating implied land values (Model I, run 2). The land constraints for each land type were relaxed by equal percentages. In each household group implied land values were assessed under conditions of an increase in land availability to a maximum of 300 percent of existing land holdings. Land holdings beyond that point were considered unrealistic in light of the requirement for high proportions of hired labour. Table 5 shows total weighted average implied land values for all household groups under these conditions. Note that in Table 5 only land values for which the basis of the model is changed are presented, so that the incremental increases shown are not all equal. The implied land values for the small and large lowland farmers and the small highland farmers follow roughly the same trend. The results for the large highland farmers are significantly different. The patterns exhibited in the total weighted average implied land values are also reflected in the calculated implied land values for coffee land and foodcrop land. These results are interpreted as reflecting a fundamental difference in productivity of inputs, including land, labour and other factors, and could also reflect some economies of size. The large highland farmers are probably operating at a level of technology which is superior to the other groups. The lowland as well as the small highland farmers face generally the same land constraints, since their resource base, factor efficiency, activities productivity and available alternatives are not markedly different.

Although not presented here, it was observed that implied land value for coffee the traditional "cash crop", is not markedly different from that of foodcrop land. Indeed, there is strong evidence suggesting that the implied value of the coffee land, particularly for the two small farm household groups (lowland and highland) comes from the value of foodcrops planted in association with coffee. Examination of data collating increasing land availability with implied land value, shows that in 3 of the 4 household groups, foodcrop land exhibits a higher implied value. In all four household groups implied land value declines more slowly when available land is increased.

Labour: Results from run 1 of Model I indicate that labour is not generally a constraint at existing levels of land availability. Seasonally, however, some labour constraints occur in two of the household groups. Although the model allows for the hiring of labour, labour was only hired in two cases: (1) by the small lowland group during the month of March (94.3 female hours) and (2) by the large highland group during March (499.9 female hours). These household hired labour quantities represents 3.6 percent and 4.3 percent of total annual labour for small lowland and large highland groups, respectively. According to the results, as land is made available to households (run 2, Model 1), labour becomes increasingly more constraining. Table 6 shows the relationship of hired labour to total labour under increasing land availability. In the case of both large highland and small lowland farmers, the proportion of hired labour increases to approximately 11 percent with a 50 percent increase in available land. All of these increases come from female labour.[6] In the case of large highland households, although only a small percentage of labour is hired at existing levels of land availability, that percentage represents a large quantity of labour demanded from the local labour market. Local labour supply might not be available to meet that demand, or capital constraint might not permit the hiring of that quantity of labour. In either case, the net effect could be less than optimal allocation of land. This finding adds further insights into the earlier discussion regarding the relatively lower proportion of cropland planted to foodstuffs by the highland household group (26%) during the second season, compared to lowland household groups (36%).

Capital: Capital constraints may have significant impacts on the production systems. In all of the model results discussed so far, a solution was feasible as long as revenues exceed the out-of-pocket costs of production. In order to assess the impact of capital limitations the model was run over a range of capital constraint values (run 3, Model 1), and the calculated implied value of capital plotted against capital availability, reflecting actual land constraints and the other reflecting available land equal to 150 percent of actual land holdings. The results begin at the minimum amount of capital sufficient to arrive at a feasible solution, and continue until the implied value of capital goes to zero, in which case capital is no longer a binding constraint. In all cases, the implied value of capital is very large at the point of minimum feasibility. The largest implied value occurs for large highland households, where at a minimum feasible amount of capital (227,000 CFA per household), the implied value is more than 14 times the actual capital. This reflect the relatively high productive potential of these farmers. In all four household groups, however, the implied value of capital is initially large and remain positive for some time, as capital availability increases. With increased capital availability, at 150 percent of actual land holdings, the implied value is initially generally greater, and remains positive over an even wider range. Capital is therefore highly valued by the production system at levels close to minimum amount feasible. As such, a lack of capital availability would severely constrain the income generating potential of the production system.

Capital constraint effects at different levels of land availability are examined for a range of land holding levels (run 4, Model I). Result indicate that the minimum capital requirement is the same for any level of land holding for each group, reflecting the minimum requirement of meeting household consumption demands. With the exception of the large highland household group; the results show that at the smallest level of land holding (actual), the capital requirement range is quite small. We further computed the ratio of capital requirement to land used at the point where the implied value of capital goes to zero. Results indicate no markedly different ratios, with the least amount of capital required per hectare found among the large highland farmers. Similarities of these capital/ha ratios, combined with the proportion of land left fallow by the large highland farmers, suggest differences between these farmers and the other household groups in terms of adequacy of land holdings size, with respect to household consumption requirements.

Farm Earnings: Since off-farm employment activity was negligible in all four household groups, crop sales were the only means of income generation specified in the model. Coffee sales for each household group generated in the solution (run 1, Model 1) matches observed sales. In the case of foodcrop sales, the model solution had much higher sales than were actually observed, particularly with respect to corn, beans and potato. This was due to the allocation of land to those crops in the solution. Table 7 shows a comparison of the model's prediction of foodcrop sales to actual sales in terms of percentage of total production. As indicated in the table, not only are sales of corn, beans and potato higher in the model solution, but sale of cabbage is generally lower.

For the small highland household group the model produces only enough cabbage for household consumption. These results are supported by comparative data of model solution and actual gross revenues from all crop sales, as a percentage of total revenue (data not presented here). These data indicate that while coffee sales in actuality make up the majority of gross revenue in all household groups, in percent terms, gross revenue from coffee sales were smaller than those from foodcrop sales in model solutions.

Table 8 shows a comparison between the objective function value (earnings) result and estimated average annual family expenses. Of the four household groups, only in the case of the large highland group was the net returns from farming expressed in the objective function, enough to meet the estimated living expenses of the household. Although it is likely that some income was unreported, the consistency and magnitudes of these outcomes are consistent with those of Fouda (1988) in her study of farm households in the Western Province. She found that the average household's net revenue of 1,106,014 CFA did not cover family living expenses (1,222,447 CFA). The implication is that the available resource base, particularly land, is not large enough to support the households. In the case of the large highland households, it would appear that the level of land holding is sufficiently large to provide for the household's need. However, in light of the relatively large amount of land actually devoted to fallow by this household group, it is expected that their income will not match the income level in the objective function of the model solution. In fact, as shown in Table 8 their reported gross revenue of 1,133,201 CFA does not meet their estimated annual living expenses (1,450,523 CFA).

Crop Land Production Mix and Earnings Potential: Under specifications of Model 2, complete flexibility of land use is permitted, as well as purchase of food for household consumption. Run 1 of Model 2 was used to examine the long run optimality in land allocation to alternative crop mix. Table 9 shows the crop land allocation results as predicted by the model. Of some note is the finding that during the first season, the only period when non-irrigated cultivation of cabbage is possible, no cabbage crop was planted by either of the highland household groups. This result contrasts strongly with the tendency of most highland farmers to allocate land to cabbage during this season, as indicated earlier in Table 7. During the survey, farmers complained of lower prices received for cabbage. The model results indicate that at least for the first season, prices are such that cabbage production might be unattractive. The location of Douala and Yaounde (the two largest and rapidly growing urban areas), adjacent to the West Province, might be creating transitional trends in the demand for cabbage. There is evidence that the supply of cabbage has increased significantly as farmers seek alternatives to the perceived low returns to coffee. Nevertheless, the rate of growth in this demand might not be significant. All the results indicate is, however, that of the various food crops, corn and to some extent potatoes, generate large positive returns. Under Model 2, the solution for both of the large household groups included exclusively, the first season corn cropping mix.

The optimality of land allocation to coffee production shows mixed results from Model 2. Large household groups chose not to plant coffee, even though there are indications that the rate of yield is higher among the large highland farms. This tendency can be understood in terms of the weighted average implied values for coffee land and foodcrop land shown earlier in Table 4. Recall that in that table, the weighted average value of foodcrop land is greater than that of coffee land in both of the large household groups. Also, the value of both cropland types are virtually the same for the two lowland household groups, suggesting that there might be a high degree of sensitivity to coffee prices. As such, reduction in the price of coffee could quickly shift the basis of the solution to reflect greater allocation of land to foodcrop production.

Results of run 2 of Model 2 show the effects of changes in coffee price on optimal land allocation. Table 10 shows the results for the small and large highland household groups and Table 11 shows the results for the small and large lowland groups. Results are shown for only those prices at which a change in the basis of the model occur. Since at the existing prices, neither of the large household models chose to plant coffee, the results were determined for rising coffee prices. In the large highland group, a moderate 16 percent increase in coffee price (550 CFA/kg) resulted in the model allocating land to coffee. However, a 68 percent increase in coffee prices (800 CFA/kg) was required to induce the model to abandon food entirely and produce only coffee. This is further indiction of the attractiveness of food crops in the production system. It has been estimated that the implicit tax on Arabica coffee production was about 71 percent at the time of the study. The 68 percentage required increase in coffee prices is thus less than the implicit tax, so even if farmers received the world market price for coffee, foodcrop production would still be an attractive alternative.

In the large lowland household group, the optimal model solution also did not include coffee planting at the existing price level. It took an 89 percent increase in the price of coffee (900 CRA/kg) to induce the model solution to allocate land to coffee production (Table 11). However, even at that price level, the model solution included some corn cropping mix. Since food purchasing is permitted in the solution, the corn cropping mix is most likely for sale, rather than household consumption. In the case of both small household groups the optimal model solution included coffee production at the existing price level (475 CFA/kg). However, in the small highland household group, a 21 percent decrease in coffee price to 375 CFA/kg, leads to a decrease of more than one-half of the land allocated to coffee production, and 31 percent decrease leads to a complete shift away from coffee. In the case of the small lowland household group, a 16 percent decrease in coffee price to 400 CFA/kg leads to a decrease in coffee land allocation by more than one-half. Ths general results of the optimal model solution indicates that under even moderate decreases in coffee prices, the tendency is to shift away from coffee production to foodcrops. Thus, at prices existing at the time of the study, coffee production appears to be at best marginally attractive to some of the household groups.

Model 2 also generated an optimal solution for cropping mix, over a range of fertilizer prices (run 3). The results indicate some resistance in optimal land allocation to changes in the price of fertilizer. In the small highland and large lowland groups, an increase in fertilizer price by more than 100 percent effected no change in the model's basis. In the large highland household group, the rise in fertilizer price led to a shift away from cabbage in the second season, but this allocation represented a small portion of total land. In the small lowland group, a rise in fertilizer price[7] to 4500 CFA/sack for both coffee and foodcrops led to a significant shift away from coffee production and towards the corn cropping mix. The general implication is that, assuming that the removal of subsidies increases the price of fertilizer to the farmer, the implication of such a policy would have minimal differential effect on cropping patterns. The exception might be cabbage production, which like other non-traditional cash crops, heavy fertilizer use would put them at a disadvantage when fertilizer prices rise. The small lowland household group model gave results suggesting that an increase in the price of fertilizer could have an additional negative impact on coffee production. The model indicates that in the other three household groups, the effect of capital is neutral with respect to fertilizer price increases. Thus, in terms of the small lowland household, fertilizer price increase in combination with a capital constraint, could make the outlook for coffee production even less attractive.

CONCLUSIONS

The farmers of the Bafou study area can be categorized into four representative farm household groups: (1) small lowland households, (2) large lowland households, (3) small highland households and (4) large highland households. The households can be further categorized into two groups with respect to the effects of land constraints. Group 1 consists of both lowland household groups and the small highland household group. The implied values of land to the households in Group 1, show that smaller land holders generally face higher land values than do larger land holders. That is, other things being equal, additional land is of more value to those with less to begin with. As such, the effects of land constraints on income generation are more severe for those farmers with smaller holdings. However, all members of Group 1 share similar levels of productivity and efficiency, in terms of rates of yield of labour and other factor use. Also, results indicate that for all members of this group, returns from agricultural production are not enough to meet household living expenses. The conclusion is that for this group of householders, their resource base is too small to support the household size.

Group 2, the large highland farmers, display greater resource productivity and allocative efficiency than Group 1 farmers, resulting in slightly higher implied land values. Thus, due to simply technical differences, land scarcity has a greater impact on the income generation of Group 2 households, in spite of the relatively large size of their holdings. Further, Group 2 farmers have enough land to be able to generate enough income to meet household living expenses, and they do not allocate all of their land to productive activities. All households have a strong need for capital, and the lack of access to capital might be as large a factor in their behaviour as are land constraints. Under existing levels of farm technology, most households, even most large households, do not have enough land to generate sufficient income to meet household needs. As population increases, so will population densities. Unless off-farm employment opportunities become available, holding sizes will become even less adequate to sustain households.

In terms of optimal crop land allocation, the results indicate that the future for the continued widespread cultivation of Arabica coffee in the West Province is at risk. At existing prices, two of the four household optimization models selected coffee over foodcrop production. However, each of the four household group models showed sensitivity to coffee prices. As such, even moderate reduction in coffee prices caused the profit maximization model solution to indicate a near complete shift from coffee to foodcrop production. Any shift away from coffee production may not necessarily take the form of clear-cutting coffee plants. Farmers were observed to be increasing the spacing between plants when replanting their coffee, and thereby increasing the area available for alley-cropping with cabbage, beans and other foodcrops in association with the coffee.

Cabbage (including red cabbage) is the most widely planted non-traditional cash crop. Recent years have witnessed its increasing cultivation, as farmers search for alternatives to coffee production. Results indicate, however, that cabbage as a non-traditional (or market garden) cash crop might not be as financially attractive an alternative as is believed. Of the two household groups who cultivated cabbage, only one household group selected the crop in the optimal allocation solution, and the selection occurred only during the second season. During the second (dry) season cabbage must be irrigated, and the resulting small supply assures higher prices. In the aggregate, however, the demand side of the market is small and prices have declined in recent years as supply increased. The implied land value results of the model indicate that in general, a higher land value exists for land allocated to foodcrops than for coffee production. It was found that even on land allocated to coffee, much of the land value comes from foodcrops planted in association with coffee. In the optimal land allocation model, two of the four household groups chose to plant only the corn crop mix during the first planting season, consisting of corn, beans and potatoes. In one of these household groups (the large highland farmers), the corn mix was selected in spite of the highest coffee yield rate. In this household group, nearly all land is reallocated to the corn, bean and potato crop mix when there is a moderate decline in coffee prices.

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NOTES:

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[4]*'Operation Bafou' is data gathering project that has been in operation for several years. The project is administered and conducted by the Interdisciplinary Farming System Research Team from the University Center of Dschang.*

[5]*The ratio of total annual household labour to total land holding for all households are: small lowland = 8,482 hours/ha; large lowland = 5,011 hours/ha; small highland = 4,213 hours/ha; large lowland = 3,195 hours/ha.*

[s]*Model solutions include hired male labour after a 90% increase in land availability in the case of large highland Two data sets are generated, one farm households, and after a 120% increase for small lowland households, fertilizer prices at the time of the study were measured at an average of 3500 CFAJsack when purchased on the open market, and 2500 CFAJsack when obtained from the coffee cooperative.*

TABLE 1. **SELECTED CHARACTERISTICS OF REPRESENTATIVE SAMPLE OF SMALL FARM HOLDINGS**

Area Quartler (Neighbourhood)	No. of Households	No. of Adults Households	No. of Children In Households	Total Ha. of In Coffee Land	Av. Ha. of Coffee Land
		Large Size* Lowland Household Group			
Tsinfou	1	4	11	2.62	2.62
Lefe	1	4	11	2.28	2.28
Sub-total	2	8	22	4.90	2.45
		Small Size' Lowland Household Group			
Tsinfou	2 2	4 5	5 8	1.47	0.73
Lefe				1.37	0.69
Sub-total	4	9	13	2.84	0.71
		Large Size Highland Household Group			
Loung	2	8	29	4.49	2.46
Sub-total	2	8	29	4.49	2.46
		Small Size Highland Household Group			
Loung	2	3	7	0.80	0.40
Sub-total	2	3	7	0.80	0.40
GRAND TOTAL	10	28	71	13.03	1.30

Source: Second Phase Formal Survey.

'Household size is based on the number of adults in the household and the amount of land allocated to coffee production. A small size household is one with 1 or 2 adults and less than 1.00 hectare of coffee land, while a large size household is one with 4 or more adults and more than 1.5 hectares of coffee land.

TABLE 2. LP MODEL LAND ALLOCATION AND ACTUAL LAND ALLOCATION, ALL HOUSEHOLD GROUPS

Land Type	Household Group							
	Small Lowland		**Large Lowland**		**Small Highland**		**Large Highland**	
	Model	**Actual**	**Model**	**Actual**	**Model**	**Actual**	**Model**	**Actual**
	(..				, *Hectare ...*			*....)*
Coffee Production								
Land Coffee	**0.498**	**0.498**	1.796	1.796	0.342	0.342	2.246	2.246
Coffee! Foodcrop Land								
Foodcrop intercropped w/coffee	0.586	0.586	1.580	1.580	0.351	0.337	1.873	1.873
Foodcrop Land, Season 1								
Com Mix	0.193	0.188	0.831	0.780	0.391	0.340	3.904	0.778
Bean & Potato Mix	NA*	NA	0.000	0.048	0.000	0.047	0.000	0.154
Cabbage	NA	NA	NA	NA	0.010	0.014	0.041	0.339
Fallow	0.000	0.005	0.000	0.003	0.000	0.000	0.000	2.674
Foodcrop Land, Season 2								
Bean & Potato Mix	0.070	0.070	0.296	0.287	0.104	0.029	0.597	0.523
Cabbage	NA	NA	NA	NA	0.010	0.022	0.253	0.264
Red Cabbage	NA	NA	NA	NA	NA	NA	0.067	0.069
Fallow	0.000	0.061						

*Not applicable.

TABLE 3. IMPUED AND WEIGHTED AVERAGE IMPLIED LAND VALUES, ALL HOUSEHOLDS

Land Type	Household Group			
	Lowland			Highland
	Small	Large	Small	Large
	(.................................. Implied Land Values (CFAI Hectare).....................................			
Coffee Land	105,200	128,400	213,100	333,200
Coffee/Foodcrop Land	262,200	77.400	162,400	67,400
Foodcrop Land, 1st Season	370,100	305,400	200,800	379,800
Foodcrop Land, 2nd Season	27,200	72,700	420,100	207,400
	Total Weighted Average Implied Land Values (CFA/Hectare)			
Coffee Land	367,400	205,790	376,510	400.570
Foodcrop Land	379,990	331,270	320,140	427,990
Weighted Average	370,520	245,490	345,990	418,050

TABLE 4. TOTAL WEIGHTED AVERAGE IMPLIED LAND VALUES, ALL HOUSEHOLDS

Total Land *(Hectares)*	Household Group			
	Large Lowland	Small Lowland	Large Highland	Small Highland
	/ *1000 of CFAI Hectare** \			
0.8	370.5	INF[a]	346.0	INF
0.9	363.7	iNF	346.0	INF
1.0	363.7	INF	327.0	INF
1.1	363.7	INF	327.0	INF
1.2	325.9	INF	327.0	INF
1.3	325.9	!NF	327.0	INF
1.4	284.4	INF	293.9	INF
1.5	284.4	INF	263.7	INF
16	259.3	INF	263.7	INF
1.7	255.7	INF	263.4	INF
1.8	255.7	INF	260.8	INF
1.9	233.0	INF	260.8	INF
2.0	220.0	INF	260.4	INF
2 1	220.0	;NF	259.5	INF
2.4	NA"	INF	259.5	INF
2.5	NA	INF	259.5	INF
26	NA	245.5	199.6	INF
29	NA	245.5	199.6	INF
3.2	NA	220.7	NA"	INF
3.4	NA	195.1	NA	INF
4.0	NA	195.1	NA	INF
5.0	NA	195.1	NA	INF
5.8	NA	149.4	NA	INF
6.1	NA	142.0	NA	418.1
68	NA	140.8	NA	418.1
7.1	NA	138.0	NA	418.1
7.4	NA	138.0	NA	415.3
8.0	NA	NA	NA	403.7
8.6	NA	NA	NA	384.9
9.0	NA	NA	NA	384.9
10.0	NA	NA	NA	384.9
11.0	NA	NA	NA	362.0

"Indicates infeasible solution due to constraints of household consumption requirements.
"Indicates solutions are no longer applicable because of unrealistic land availability.

TABLE 5. HIRED LABOUR AS PERCENTAGE OF TOTAL LABOUR WITH PERCENTAGE INCREASE IN LAND AVAILABLE, ALL HOUSEHOLDS

Increase In Total	Household Group			
	Small Lowland	Large Lowland	Small Highland	Large Highland
	f............		Percent ..	....
			0,0	4.3
	3.6	0,0	0.0	5.8
	5.2	00	0.0	6,6
	6.5	0.7	0,5	6.9
	7.9 9.1	2.0 4	1.4	8.5
00 10	10.9	15.9	2.2	11.0
20 30	13.0	7.6	2.3	13.3
40 50	14.9	9,1	3.5	15.5
60 70	16.6	10.5	4.3	17.8
80 90	19.0	11.7	5.6	21.1
100	21.8	12.9	7,7	24.3
150	36.1	22.9	21.3	38.0
200	51.5	34.0	32.4	46.5

TABLE 6. PERCENT OF CROP PRODUCTION SOLD, MODEL RESULTS AND OBSERVED VALUES, ALL HOUSEHOLDS

Crop	Household Group							
	Small Lowland		Large Lowland		Small Highland		Large Highland	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model
	,				Percent			)
Banana	22.2	22.8	15.6	18.1	00	0.0	2.8	12.6
Beans	0.0	9,2	12.4	47.8	0.0	77.9	3.7	45.4
Cabbage	NA'	NA	NA	NA	70.7	0.0	90.7	85.3
Cocoyam	0.0	0,5	0.4	2.3	0.0	0.3	5.1	23.2
Com	3.6	89.5	29.6	49.3	0.0	28.2	31.7	83.2
Manioc	0.0	0,0	62.9	62.2	00	0.0	0.0	2.0
Plantain	38.9	39.1	8.3	12.0	0.0	0,0	3.0	21.2
Potato	0.0	49.0	9.2	68.7	27.4	66.6	27.5	86.3
Red Cabbage					NA	NA	100.0	100.0
Yam	24	3.1	0.0	3,3	0.0	0.0	0.0	39.2

'Not applicable

TABLE 7. COMPARISON OF OBJECTIVE FUNCTION VALUES AND GROSS ANNUAL REVENUES AND ANNUAL LIVING EXPENSES

Household Group	Objective Function Value (Earnings)	Av. Annual Gross Revenues	Av. Annual Living Expenses
	(•.. CM	.... ;	
Small Lowland	220,299	73,182	414,915
Large Lowland	245,969	74,395	1,231,250
Small Highland	151,268	111,171	219,375
Large Highland	2,154,097	1,133,201	1,450,573

TABLE 8. OPTIMAL LAND ALLOCATION.MODEL **2, ALL HOUSEHOLDS**

Cropmlx	**Household Group**			
	Highland		**Lowland**	
	Large	**Small**	**Large**	**Small**
	(.. Hectares	*..;*		
Coffee	0.00	0.75	0.00	0.58
Season *1:*				
Foodcrops intercropped with w/coffee	0.00	0.75	0.00	0.58
Commix	6.19	0.00	2.63	0.20
Bean and potato mix	0.00	0.00	0.00	0.00
Cabbage	0.00	0.00	NA	NA[a]
Season 2:				
Bean and Potato mix	1.54	0.00	0.78	0.07
Cabbage	0.25	0.00	NA	NA
Red Cabbage	0.07	NA	NA	NA

"Not applicable.

TABLE 9. OPTIMAL LAND ALLOCATION UNDER CHANGING COFFEE PRICES, HIGHLAND HOUSEHOLD GROUPS

Cropmlx	Price of Coffee									
	Small Highland Household Group					Large Highland Household Group				
	CFA/Kg									
	325	375	400	475"	475	550	600	625	650	ao
	,		.... *Hectares*							.i
Coffee	0.00	0.34	0.61	0.75	0.00	2,9	30	31	4.3	6.2
Season 1:										
Foodcrops with coffee	0.00	0.34	0.61	0.75	0.0	2.9	3.0	3.1	4.3	0,0
Commix	0.75	0.41	0.15	0.00	6.2	3.3	3.2	3.1	1.9	0,0
Cabbage	0.00	0.00	0.00	0.00	0.0	0.0	00	0.0	00	0,0
Season 2:										
Beans & Potatoes	0.23	0.12	0.05	0.00	1.5	0.8	0.9	09	0.5	0.0
Cabbage	0.00	0.00	0.00	0.00	0.3	0.1	0.0	00	0,0	0,0
Red Cabbage					0.1	0.1	0.1	0.1	0.1	0.0

"Price of coffee at time of study.

TABLE 10. OPTIMAL LAND ALLOCATION UNDER CHANGING COFFEE PRICES, LOWLAND HOUSEHOLD GROUPS

Cropmix	Price of Coffee									
	Small Lowland Household Group						Large Lowland Household Group			
	CFA/Kg									
	100	**250**	**400**	**450**	**500**	**550**	**800**	**475***	**900**	**1000**
	(........ Hectares ....)									
Coffee	00	0.07	0.23	0.53	0.58	0.68	0.78	0.00	2.21	2.63
Season 1:										
Foodcrops w/coffee	0.07	0.07	0.23	0.53	0.58	0.68	0.78	0.00	2.21	2.63
Commix	0.71	0.71	0.55	0.25	0.20	0.09	0.00	2.63	0.41	0.00
Cabbage							0.00	0.00	0.00	
Season 2:										
Beans & Potatoes	0.26	0.26	0.20	0.09	0.07	0.04	0.00	0.79	0.12	0.00

"Price of coffee received by farmer at time of study.