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Bean Production and the Relationship with Recommendation Domains in the Rwandan Highlands

An executive summary of the Masters Thesis submitted by Marcie Brewster

Prepared by Malcolm R. Mayfield, Lucas D. Parsch, Donald E. Voth and Eric J. Wailes

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INTRODUCTION

This paper presents results of an economic analysis of traditional bean production in the context of the Farming Systems Research Program (FSRP), a USAID-funded FSR project in the Buberuka Highlands of Rwanda. The study described here was undertaken to identify a set of variables that meaningfully differentiate farmers into distinct groups in terms of important bean production variables. A classification scheme based on this set of variables may be used by researchers at several stages. Research and extension personnel may use the classification scheme, in combination with other data, to define groups of farmers to whom an intervention may be recommended. Such groups are termed recommendation domains.

A recommendation domain may be as specific as, for instance, the smallest fields on steep slopes with acid soils. On the other hand, a recommendation domain might include all farms within a given region. The definition of the recommendation domain depends ultimately on the distribution of farmers under consideration. If farmers are sufficiently homogeneous in terms of the criteria that determine the appropriateness of an intervention, then one uniform recommendation will suffice.

The principle findings of this research are: a) Farms in the Buberuka Highlands[1] are relatively uniform in terms of size: 90% are less than 2 ha; b) The number of family laborers (persons age 15 to 64) is concentrated around 2/farm; c) Farms depend minimally on outside labor for growing crops, with 76% hiring less than 6 labor days/season; d) Although a third of the farms have no animals, animal ownership is not highly concentrated; e) Low levels of correlation among these four classification variables further indicate that the study area does not appear to be highly stratified; f) In terms of bean production variables, differences among farmers do not appear to be clearly associated with the above socio-economic variables, at least as these were defined in this study[2]; g) Variation in the same production variables is associated with location (commune level), the degree to which beans are intercropped (usually with maize or bananas) and the type of bean grown (bush or pole); h) An examination of costs and returns in bean production reveals that the economic advantage of higher-yielding pole beans is largely nullified by the cost of stakes and greater labor requirements.

The tentative implication of this study is that agro-ecological differences (implicit in the location variable) show the most promise as guides in distinguishing among groups of farmers.

The results point out the need for further research on soil and climatic differences, the role of animals in the farming system, the determinants of the degree of intercropping, choice of bean type and respecified socio-economic variables.

Description of Project and Agriculture in the Project Area.

The Farming Systems Research Program is based at the Rwerere research station of the Rwandan Agronomic Research Institute (ISAR) in Ruhengeri prefecture. The FSRP project was established by a decision of the Rwandan government after a December 1983 ISNAR (International Service for National Agricultural Research) Seminar. At this seminar the entire Rwandan agricultural research system was evaluated, and recommendations were made for improvement. Adoption of a Farming Systems Research (FSR) approach was strongly recommended.

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[1]About 20% of the farms in the study were not in the Buberuka Highlands but were in the Central Plateau region.

[2]The socio-economic variables were defined as "stock" or wealth variables in order to examine the social structure. In terms of bean production, more appropriate socio-economic variables should be defined and tested (e.g., by converting to a per-hectare basis).

The FSRP is funded by USAID (U.S. Agency for International Development) and administered cooperatively by the University of Arkansas and ISAR. The FSRP's research zone covers four communes, about 603 km^2. Average altitude in the zone is 2000 m. The range is between 1600 and 2600 m.

Farms in the project area are very small, averaging about 1 ha. Seventy-four percent of the farms are 1.5 ha or smaller, compared with 85% for Rwanda as a whole.

These small farms have, on the average, seven non-contiguous parcels of land, averaging 0.14 ha each. These parcels of land are further divided into fields--an average of two fields/parcel, for 14 to 15 fields/1-ha farm.

Until recently, agricultural production in the Highlands had expanded slowly by bringing new lands under cultivation as the population has grown. There are now no new lands available. Cultivation is taking place on steeper slopes and in wetlands that were formerly reserved for grazing animals. Fallow periods have been shortened or eliminated. Recent evidence of declining yields has confirmed long-held fears that soil fertility is being mined (Jones and Egli, 1984).

When the FSRP began work in the project area in the fall of 1985, the first task was to identify the most important problems facing farmers. The team that designed the FSRP had performed a preliminary diagnostic survey in the spring of 1984 (Franzel et al., 1985). Later, in 1985, the FSRP project team carried out additional diagnostic surveys of FSRP zone farmers through which they identified a list of common problems. Working from the list of farmer-identified problems, the team chose two crops, beans and sweet potatoes, as the focus of their first research efforts.

Table 1 shows the average production by major crops for the two cropping seasons and for the year.[3]

The production system centers on beans and sweet potatoes in terms of their importance in the diet. Farmers complained of low yields of both crops and of some problems of disease and mildew with beans.[4] The FSRP team moved quickly to select farmers to participate with them through on-farm trials.

The first bean variety trials were installed for the second cropping season of 1986. At the same time, the team commissioned an economic study of traditional beans[5] to be carried out to complement the agronomic trials. This paper presents results of that economic study.

Research Objectives

The general goal of the study was to provide the FSRP team with useful information about the socio-economic characteristics and production practices of farmers in the project area. Diagnostic surveys had been useful in developing the initial research program. The team was concerned, however, that recommendations for extendable technologies (improved inputs and cultural practices) be made to those groups of farmers capable of adopting and benefitting from them. Differences in farmers' circumstances, production practices and performance (e.g., yield) were recognized, but it was not known which variables should be used to differentiate farmers in terms of the appropriateness of particular recommendations. Thus, the need was to search for social, economic and agro-ecological variables useful in categorizing groups of farmers prior to extending improved technologies. A meaningful classification of farmers would facilitate in the definition of "recommendation domains"--groups of approximately homogeneous farmers for whom a given recommendation is appropriate. Such a classification scheme would also serve as a guide to future research needs by helping to rank farmer-identified problems. Identifying relevant "target groups," in short, helps to insure that the returns to limited project resources are maximized.

There were three specific research objectives. The first objective was to perform a socio-economic characterization of farms in the project area. This was essentially limited to an examination of the distribution of productive resources for evidence of economic stratification.

The second objective was to document the costs and returns of traditional bean cultivation practices and examine how inputs, outputs, returns to labor and profits are influenced by socio-economic, agro-ecological and other variables. This documentation required extensive interviewing of a random sample of farmers from throughout the FSRP zone to collect input and output data for crop production. The information obtained was used to prepare separate crop enterprise budgets for major groups of farmers.

[3] As is true of most of the Highlands region of Central Africa, the project area has two cropping seasons during the year. The first lasts from about September to February, the second from about March to August.

[4] As is evident from Table 1, sweet potatoes are the dominant crop by weight at 982 kg/year. Bananas follow at 766 kg. Around two-thirds of the banana crop is used for the production of banana beer, which is a highly commercialized product among Rwandan farmers. Beans, at 177 kg/year, are third by weight.

[5] Farmers in the project area grow two main types of beans: pole beans (also called climbing beans) and bush beans (semi-climbing and dwarf mixed) beans. Pole beans generally require stakes.

The third research objective was to analyze the input/output relationships implied by the cost of production data. A yield response model was estimated. This model is used to describe the effects of important inputs on yields and to assess the economic value of those inputs in the production process.[6] The first two objectives and the research results are presented in this paper.

SOCIO-ECONOMIC CLASSIFICATION OF FARMERS

Data and Methods

Two separate sources of data are used. Secondary data (MINAGRI/SESA, 1985) were used for creation and analysis of a socio-economic classification scheme of area farmers. Primary data on bean production gathered during 1986 and 1987 were used both separately and in combination with the secondary socio-economic data to analyze differences between farms. The primary data were also used to develop bean enterprise budgets.

The secondary data for socio-economic classification of farmers came from the 1983/84 national agricultural survey of the Agricultural Statistic and Survey Service (SESA). The goal of SESA is to establish an agricultural information system using list-frame sampling procedures (MINAGRI/SESA, 1985). This data set contains a multi-stage, cluster sample of about 2000 observations, with estimates at three different levels and aggregations: (1) nationwide, (2) each of 10 prefectures, and (3) each of 12 agricultural regions. The 12 agricultural regions are defined by the Rwandan Ministry of Agriculture based upon agro-climatic homogeneity (see Delepierre, 1974).

The analysis of socio-economic variables reported here was performed using SESA's samples in the entire "Buberuka Highlands" region, though this region is substantially larger than the FSRP project area. It was chosen because it covers about 80% of the FSRP's four commune zone of action. The sample included 223 cases, each case representing one farm.

The classification of the farmers entailed four distinct operations. First, in consultation with the project research team, several key socio-economic variables were chosen based on the data available in the SESA records: (1) farm size, measured in hectares, (2) number of animal units,[7] (3) outside labor use[8] and (4) family labor (persons age 15 to 64). Second, the sample distribution of each of these variables was examined. Third, the correlations among these variables were examined in order to determine whether any clear patterns might emerge characterizing, for example, the typical large farm, the typical small farm, etc. Finally, the association of these socio-economic variables with key aspects of traditional bean production was examined.

Two general sets of hypotheses were tested. 1) The null hypothesis of no association between the socio-economic variables. The basis of this hypothesis is to identify the degree of correlation between the structural variables. This provides a means to identify the extent of socio-economic stratification. 2) The null hypothesis of no significant differences between population means of production variables by sub-groups of socio-economic variables. These variables were specified in a one-way analysis of variance (ANOVA) model to test this hypothesis.

Distribution of Project Area Farmers by Socio-economic Variables

Farm Size. Table 2 shows the distribution of both farms and land by size of farm. Perhaps the most important feature is the relatively even distribution of land: Only 24% of the farms have less than 0.5 ha, and less than 10% had more than 2.

Animals. The distribution of total animal units is shown in Table 3. This distribution ranged from zero animal units on 76 farms to a slightly more than 7 animal units on one farm. Only about 5% of the population has more than 2 animal units. This distribution is similar to that of farm size in that ownership is not highly concentrated.[9]

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[6] Preliminary results are described in Brewster, 1987.

[7] One cow equals one unit. Goats and sheep were defined as one-fifteenth of a cow based on the assumption that a cow produces about fifteen times as much manure as a goat or sheep.

[8] Defined as days of non-family labor used during the past 3 months. It includes all outside labor whether it was remunerated in cash, commodities, or by exchange of labor.

[9] Recent analysis indicates that the physical location of farms on the terrain may be a significant factor in the ownership pattern. It was found, for instance, that fields located on peaks or plateaus were associated with farms that had significantly more animals (88% more) than those with fields located on medium or steep slopes or in valleys. The former group had larger farms and more family laborers as well.

Use of Outside Labor. These data are presented in Table 4. The distribution of outside labor use in the SESA data ranged from less than 1 day for 32% of the population, to a high of 62 days. Forty-one percent used from 1 to 4 days, and only 25% used 7 days or more.

Family Labor. The frequency distribution of the number of family laborers ranged from 0 for 3.6% of households to 6 for less than 1% and is presented in Table 5. This distribution is very heavily clustered around the mean (2.2), with nearly 84% having from 1 to 3 laborers. Again, the sample is surprisingly homogeneous, with relatively few families at the extremes.[10]

Inter-Correlation Among Characterization Variables

Table 6 shows the correlation coefficients among the four socio-economic characterization variables used. The relatively low, though statistically significant, correlations imply that the system is not highly stratified. Larger farms, for example, do not strongly imply greater use of outside labor or more animals.

Table 7 shows the association of the other socio-economic classification variables with farm size. A contingency table format is used to give a more detailed sense of the different types of farms that actually occur. Table 7 further illustrates the relative lack of economic stratification among farms in the area. In a stratified system, farm size relative to other resources would likely be one of the most important variables associated with production practices. Labor availability, use of hired labor and number of animals, since they are associated with relative wealth, would be highly associated with farm size.

None of the associations in Table 7 are high. Thus, farm size does not by itself reveal any distinct typology of farms in terms of resources other than land. Among small farms, there are those that have many animals and a relatively large amount of labor available and use relatively large amounts of outside labor. Among large farms, one finds significant numbers that have few animals, use little outside labor and have relatively small amounts of labor available.

BEAN PRODUCTION INPUTS AND RETURNS

Characterizing Production Differences by Socio-Economic and Agro-Ecological Variables

From the point of view of Farming Systems Research, cultural practices and economic performance are influenced by both agro-ecological and socio-economic characteristics. Any of these variables can serve as potential constraints. To the extent that farms in the project area differ significantly according to these variables, these differences must be taken into consideration in identifying and selecting appropriate target groups.

In view of this, a preliminary series of analyses were performed to determine the extent to which major factors in bean production inputs and returns varied among categories of these socio-economic and agro-ecological characteristics.

Procedures.

The analysis combines the primary data on inputs and yields (production variables) collected for this study with the socio-economic data obtained from the 1983-84 SESA survey. One-way analysis of variance was used.

Data Collection. Inputs into the production of beans are few. Data were collected on yields, seed, composts, labor, field size and plant densities.[11] Primary data for the analysis of production inputs and returns were collected during the period from July 1986 to February 1987, which covered the dominant of the two growing seasons for beans in the project area. Input data were collected through farmer interviews. These were performed by nine enumerators, each of whom was responsible for 5 farmers. To minimize recall errors, each enumerator visited the five farmers twice weekly to collect the labor, seed and compost input data.

Observations on farm size, animal units and family labor were based on secondary data supplemented with primary data for the farms that were not in the SESA sample.

Farmer Selection. The SESA sample of farmers was simultaneously stratified by farm size and ecological region within the project area, and five farmers were selected within each of nine size/region

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10 This variable excluded children below age 15. Since the labor contribution of children can be substantial, child labor availability might provide a basis for differentiating farms.

11 The data collection forms used, together with descriptions of field measurement and plant density count methodologies, may be found in the appendices of Brewster (1987).

strata (three size groups x three regions). Following SESA, the farm size categories used at the farmer selection stage were:

Size Category	Percent of Farmers in Sample
Less than 0.75 ha	48
0.75 ha to 1.5 ha	32
More than 1.5 ha	20

Where the total farm size was not known with certainty, other criteria, such as numbers of animals or use of hired labor, were used for selection.

The three geographical regions selected were (1) Nyarutovu Commune, (2) Nyamugali Commune and (3) Cyeru-Butaro: one northern sector of Cyeru Commune combined with a southern sector of Butaro Commune. These regions are known to differ significantly in their agro-ecological conditions (i.e., altitude, soils and rainfall).

Farmers from both the 1983-84 SESA survey lists and current FSRP collaborators were chosen for the study, as well as supplemental farmers who were included in order to give a minimum of 5 farmers per stratum. When farms had two or more fields, two fields were chosen for the sample. For those who had only one field, this field was chosen. Thus, the final unit of analysis was the field. A total of 81 fields were monitored.

Production Variables Used and Their Measurement. The bean production data were collected in the 81 fields monitored by the FSRP project and include: 1) yield, kg/ha; 2) seed, kg/ha; 3) compost, tons/ha; 4) land preparation labor, hrs/ha; 5) weeding labor, hrs/ha; and 6) harvest/post harvest labor, hrs/ha. Based on these data, 7) total labor, hrs/ha;[12] 8) returns to factors (other than seed), FRw/hour of labor; 9) accounting profits, FRw/ha; and 10) economic profits, FRw/ha, were calculated.

In order to be able to analyze yields appropriately, the area of each field was measured at the beginning of the production season, and plant density counts were taken once on each field.

At harvest time, farmers were given storage sacks and asked to keep the harvest from the two sample fields separate from their other beans and from each other. They were also given a bucket to measure any beans that they removed from their fields before the harvest was weighed. When the beans were ready for storage, the farm was visited, and the yield was weighed.[13]

All seed is valued at 30 FRw/kilo since that was the price of beans at planting time. Yield is valued at 25 FRw/kilo, which is close to the 1987 average price.

Family labor information was obtained concerning who had worked in the field, what tasks were done and how many hours were spent on each task. The data were collected for four categories of persons as follows: (1) men from 15 to 64 years of age, (2) women from 15 to 64 years of age, (3) children from 10 to 14 years of age and (4) persons younger than 10 and older than 65.

Outside labor data was not broken down by sex or age, but exchange labor was separated from hired labor. Hired labor is paid for in FRw (Rwandan francs, $1.00 = 85 FRw), usually a flat daily sum rather than by the hour. Exchange labor, which is used mostly for tilling, planting or weeding, is returned in kind, sometimes supplemented with a meal or some sorghum beer.

The return to factors was estimated by subtracting the cost of seed, at a constant rate of 30 FRw/kilo of seed sown, from the value of the yield, at the rate of 25 FRw/kilo of yield, and dividing this by the number of hours of labor spent:

$$\text{Return to Factors} = [(25 \times \text{Yield}) - (30 \times \text{Seed})]/\text{Total Labor}$$

This calculation includes neither the costs for stakes used in pole bean production nor the value of land and composts used. Most farmers grow pole beans only if they have access to stakes from their own farm, either from the cane (Pennisetum, purpurium) planted for erosion control or from their own small woodlot. While there is a limited market for stakes, lack of staking material may be an important constraint to some farmers wishing to grow pole beans. Compost, too, generally comes from the farmers'

[12]Includes labor devoted to spreading composts and staking pole beans.

[13]The farmers all said that they had a comparatively poor harvest during the season studied because of excessive rainfall.

own compounds. Farmers recognize the importance of compost but there is no commercial production nor established market for it. No monetary value was placed on land since the sale of land is politically controlled and sales are uncommon.

Accounting profits are calculated by subtracting all actual cash expenditures on labor and seed from the value of the yield:

$$\text{Acct. Profit} = (25 \times \text{Yield}) - \text{Actual Cash Expenditures}$$

Since most farmers did not sell any of their bean harvest from the September-February 1987 crop, these are hypothetical rather than actual accounting profits.

For the calculation of economic profits, all seed and labor, including family labor, is assigned a monetary value whether or not any expenditure was made for them. All labor is valued at 10 FRw per hour, the average wage rate observed in the FSRP zone during the season. All seed and yield were valued as described above:

$$\text{Econ. Profit} = (25 \times \text{Yield}) - (30 \times \text{Seed}) - (10 \times \text{Total Labor})$$

The cost of equipment and stakes was not included in calculating economic profits.

Except for returns to labor, all variables are calculated on a per-hectare basis, but this was complicated by the fact that most of the fields were not in pure stand. For fields of beans grown in association with other crops, the equation used to convert from actual field size to a pure equivalent (PE) field size was:

$$\text{PE Field Size} = \text{Actual Field Size} \times [BD/(BD + OD)],$$

where BD = Bean Density = average number of bean plants/square meter counted at three randomly chosen spots on each field, and OD = Other Density = average number of all plants/square meter counted in the same 3 square meters. The ratio (in brackets) is interpreted as the portion of the field actually occupied by bean culture.

Results: Production Differences by Socio-Economic Variables

The means and standard deviations of the 10 production variables are provided in Table 8. There is considerable variability in the data as indicated by the magnitudes of the standard deviations relative to the means.

One-way analysis of variance was used to test the null hypothesis that there were no significant differences between subgroups by socio-economic variables. Tables 9 through 12 present the subsample means, F-values and significance levels of these tests.

Farm Size. One classification variable, farm size (Table 9), showed no significant association with any of the production variables at the 0.1 level of significance (i.e., 90% confidence level). This may be due in part to the smaller sample size for this category (16 observations were missing on farm size).

Animal Units. The number of animal units on the farm was associated with two production variables (Table 10); the hours per hectare of harvest/post harvest labor and the returns to factors. Harvest labor increased with number of animals held. Returns to factors were significantly higher in the category with the greatest number of animals but decreased slightly from the no animal to the few animal category. Farmers with the most animals had higher returns to labor than farmers having no or only a few animals.

Family Labor. Total labor hours increased according to the number of laborers in the family (Table 11), corroborating findings from a preliminary report of the SESA/Michigan State project (SESA/MSU, 1987). The results indicate that additional family labor tends to go mostly toward increased weeding and compost application. The fact that total labor hours, weeding labor hours and the amount of compost used per hectare of beans all increase significantly with increased family labor while yields do not suggests that larger families increase farming intensity with mixed results.[14]

[14] An analysis performed after the completion of the thesis found no evidence that returns to labor are declining at higher levels of labor inputs. When active family members per hectare is used to divide farms into high (3 or more persons/ha) and low (less than 3) groups, yields, prep. labor, weeding labor, total labor and accounting profits all are significantly higher (90% confidence level) in the high group, although the number of observations was limited to 65. Returns to factors are not lower in the high group.

Outside Labor. Both accounting and economic profits showed a significant negative relationship to outside labor use (Table 12). Increasing use of outside labor seems to be clearly associated with higher levels of land preparation. This could indicate a labor bottleneck during land preparation periods.

The particular socio-economic characteristics analyzed above do not provide a definitive basis for describing bean production input and output variables. Additional analysis of these variables, redefined on a per-hectare basis and using Duncan Multiple Range and regression analysis, would be expected to provide a clearer assessment of the relationship between these variables and bean production. This extended analysis would logically include differences in agro-ecological environment as well.

Results: Production Differences by Agro-Ecological Variables

Agro-ecological variables (location, bean type and degree of intercropping) appear to be important. This follows from the analysis of variance presented in Tables 13 through 15 below.

At the 90% confidence level, seven production variables varied significantly by location, six varied significantly by bean type and five variables were significantly different by degree of intercropping. Bean type contained two categories, bush and pole, with 58 fields in bush bean and 23 fields in pole beans.

The exclusion of any cost for stakes in pole bean production in the tables presents a misleading picture. Including a cost for stakes eliminates whatever economic advantage pole beans may appear to have because of their higher yield. To a lesser extent, including stake costs also decreases the relative advantages of Cyeru-Butaro and of growing beans in pure stands.

Location. Seed rate per hectare varied by location and was significantly higher in Cyeru-Butaro (Table 13). Tons of compost varied by location as well. Compost in Cyeru-Butaro averaged 7.75 tons/ha compared to 6.63 tons/ha in Nyarutovu and only 1.44 tons/ha in Nyamugali. Nyamugali farmers spent the most time weeding and preparing the land, while Nyarutovu farmers had above-average harvest/post-harvest labor. Returns to factors (except seed) varied by location, as did profits, but this is considerably biased by the exclusion of stake costs. The higher returns in the Cyeru-Butaro region, however, confirmed an observed higher wage paid by farmers in Butaro. In Nyarutovu and Nyamugali, labor was generally paid 50 or 60 FRw/day for a standard 6-hr work day. In the Cyeru-Butaro region, the observed wage was 70 FRw/day. For post-harvest work in Butaro, one farmer paid 100 FRw for only 3 hrs of labor. The returns to factors (primarily labor) calculated here are consistently lower than the observed wage rates, possibly due to the poor season.[15]

Type of Bean. Yields were significantly higher for the pole beans (Table 14). The bush beans averaged 600 kg/ha while the pole beans averaged almost 1100 kg/ha. It should be noted that there is interaction between location and type of bean. Of the 23 fields planted to pole beans in the sample, 12 were in Cyeru-Butaro. This sub-sample of 12 fields had an average yield of 1247 kg/ha.

The weight of seed used per hectare was found to be greater for pole beans. The amount of compost applied per hectare was also higher for pole beans than for bush beans. Since Cyeru-Butaro had the greatest percentage of pole bean fields, the high yields of pole beans in Cyeru-Butaro is likely due to the higher levels of compost applied on those fields.

Total labor hours per hectare increased significantly from bush beans to pole beans.

Degree of Intercropping. Yields varied by degree of intercropping (Table 15). Yields decreased from pure fields to moderately intercropped fields and again to highly intercropped fields. A deficiency in the field adjustment measure could partly account for the yield variation. The bean yield reduction could also be due to a negative effect on the beans from the plant with which the beans were associated.

Weeding and land preparation labor hours per hectare varied by degree of intercropping. Highly intercropped fields were weeded the most, and pure fields were weeded the least. Intercropped fields received more weeding due to the fact that many were weeded a third time just before or during the harvesting of the beans. The extra weeding hours that were picked up in these fields were intended not for the beans but for the corn that remained in the fields for another month after the beans were harvested.

The Nyamugali region has the greatest proportion of intercropped fields. In Nyamugali only 3 of the 26 fields were in pure stand, whereas in Nyarutovu and Cyeru-Butaro there were almost equal numbers of pure and intercropped fields.

[15] The different wage rates in each area suggest that the defined regions represent distinct labor markets. In retrospect, using the different regional wage rates, rather than a single average wage rate, would have improved the 'realism' of the returns to factors and economic profit variables. Using the single average (10 FRw/hr) overestimates the cost of labor and lowers economic profits for most fields.

Bean Production Budgets

Following the results of previous sections, separate enterprise budgets were prepared for each commune for the two bean types. Thus, there are six budgets: budgets for each of the three regions, and, within each region, a separate budget for pole beans and bush beans.[16] It is assumed in all of these budgets that land is hand hoed twice before planting, that no commercial fertilizer is used, that some composts are tilled in during land preparation and that hand weeding is done twice.

The value of equipment is almost zero. A hoe costs 300 FRw in the FSRP zone and lasts approximately two years or four cultivation seasons. Since the hoe would also be used on other crops, the price of a hoe for one season was estimated at 25 FRw.

The FSRP agronomist counted stakes on farmer plots of pole beans to determine that about 35,000 are needed per hectare. Although these stakes are usually not purchased, a lack of stakes could be a constraint to growing pole beans. They can be purchased at about 100 francs per bundle of 100 and will last at least two seasons. The cost per stake is therefore estimated to be 0.5 FRw/season.

The budgets, summarized in Table 16, confirm that labor is the largest input. This accounts for the fact that all six of the budgets presented show negative returns when all labor is valued at the observed wage rate of 10 FRw/hr and the cost of stakes is included. The subsequent sensitivity analysis in Table 16 shows that excluding the cost of stakes and valuing labor at 5 FRw/hr decreases losses in all six budgets and results in positive returns for the Cyeru-Butaro region.

The return to labor is also the break-even value of labor. These values are presented in Table 17 for each bean type and region. Under the base assumptions (labor at 10 FRw/hr, cost of stakes included) returns to labor were lower than the observed wage rate in all cases. However, when the cost of stakes is excluded, returns to labor in Cyeru-Butaro for pole beans exceeds the observed wage rate (Table 17, column 3).

These budgets confirm that accounting for the cost of stakes causes pole bean production to appear less profitable than that of bush beans, despite the higher yields of the former. This cost of stakes is in addition to higher labor inputs for pole beans.

The six detailed budgets for each bean type and region are found in Tables 18a through 18f.[17]

SUMMARY AND CONCLUSIONS

The results indicate that the four socio-economic classification variables obtained from secondary sources are not sufficiently correlated to indicate a complex, multi-dimensional structure defining different types of farms. Large farms are found with small families that use little outside labor and have few animals. Small farms are sometimes found with large families that use larger amounts of outside labor and have many animals.

The results also indicate that the major categories of resources--land, labor and animals--are not highly concentrated in the project area.[18] There is little evidence that the "wealth" characteristics examined can be used to define a meaningful stratification system.

In the analysis of production variables, three important factors were identified: agro-ecological areas within the project (i.e., the three locations specified in the study), degree of association and type of bean grown. These factors formed the basis for grouping farmers and preparing budgets.

The crop enterprise budgets demonstrate clearly the effect of including the cost of stakes in pole bean production. The analysis of the decision to grow pole beans must consider the substantially higher resource requirements involved under traditional cultural methods.

In the future, a more detailed, focused examination of these three factors would improve our understanding of the determinants of the costs, returns and profitability of bean production in the project area. Differences in soil fertility between locations or between different crop associations, for example, may explain much of the variation mentioned above. In comparing beans grown in pure versus mixed

[16] More budgets may be warranted to analyze the significant differences in five of the production variables according to the degree of intercropping, though these may be due to shortcomings in the estimation of true area under beans or inclusion of some labor hours not actually devoted to beans in intercropped fields.

[17] The discrepancy between the values in the budgets and those presented in the ANOVA tables is due to the different methods used to calculate means. The means in the ANOVA tables are the simple averages over all fields in the subsample. The means in the budgets are obtained by summing the values in the subsample and then dividing by the number of observations.

[18] This is not surprising since East African agriculture tends not to suffer from severe concentration of land ownership or wealth.

stands, the interaction between beans and other crops (e.g. corn and sweet potatoes), needs to be assessed. Refinements in the method of estimating the area given to bean production in an intercropped system should be an important part of such a study.

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Table 1. Average Production of Various Commodities per Farm by Commodity and by Season (in kgs).

Total Commodity	First Season	Second Season	Yearly
Sweet Potatoes	555.3	426.7	982.0
Bananas	408.9	357.1	766.0
Beans	127.1	50.3	177.4
Sorghum	6.7	119.1	125.8
Potatoes	55.5	37.8	93.3
Maize (corn)	60.6	29.0	89.5
Manioc	21.7	19.6	41.4
Peas	26.0	7.0	33.0
Wheat	3.1	11.0	14.1
Coffee	0.8	4.3	5.1

Source: MINAGRI/SESA, vol. 1, Tables 4.1.4, 4.2.4, and 4.3.4 (Buberuka Highlands).

Table 2. Percentage Distribution of Farms and Land by Size of Farm in Project Area.

Farm Size Category	Percent of Farms	Percent of Land
Less than 0.25 ha	5.9	1.1
0.25 to 0.50	17.8	6.8
0.50 to 0.75	24.5	15.9
0.75 to 1.00	11.6	10.6
1.00 to 1.50	20.2	24.9
1.50 to 2.00	10.2	18.0
More than 2.00	9.7	22.6
Total	100.0	100.0

Source: MINAGRI/SESA, 1985, vol. 1, Table 3.1.1 (Buberuka Highlands Region).

Table 3. Frequency Distribution of Total Animal Units on Farms Surveyed in the Buberuka Highlands Region.

Number of Animals	Number of Farms	Percent of Farms
Zero	76	34
0.07 to 0.53	107	48
More Than 0.53	40	18
Total Households Surveyed	223	100

Source: MINAGRI/SESA, 1985, vol. 1, Buberuka Highlands, 1983-84.

Table 4. Frequency Distribution of Outside Labor Use Per Season by Farmers Surveyed in the Buberuka Highlands.

Days of Outside Labor Use	Number of Farmers	Percent of Farmers
Zero	57	26
One	23	10
Two	22	10
Three	22	10
Four	22	10
Five and six	21	10
Seven to ten	19	8
11 to 20	20	9
21 to 30	11	5
More than 30	7	3
Total Households Surveyed	223	100

Source: MINAGRI/SESA, 1985, vol. 3 (Buberuka Highlands Region).

Table 5. Frequency Distribution of the Number of Family Laborers per Household in the Buberuka Highlands.

Number of Family Laborers	Number of Households	Percent of Households
Zero	8	3.6
One	35	15.7
Two	124	55.6
Three	28	12.6
Four	23	10.3
Five	4	1.8
Six	1	0.4
Total Households Surveyed	223	100.0

Source: MINAGRI/SESA, 1985, vol. 1 (Buberuka Highlands Region).

Table 6. Correlation Matrix of Farm Size, Animals, Outside Labor and Number of Family Laborers.

	Farm Size	Family Labor	Outside Labor	Total Animals
Farm Size	1.00	.3719	.1870	.2995
		(.00)[1]	(.003)	(.00)
Family Labor		1.00	.0618	.1185
			(.179)	(.039)
Outside Labor			1.00	.1310
				(.025)
Total Animals				1.00

[1]Numbers in parentheses equal the probability that the correlation coefficient is zero.

Table 7. Cross Classification of Farm Size with Number of Animal Units, Hired Labor and Family Laborers.

Item	Farm Size: Less than .61 ha	.61 to 1.1 ha	More than 1.1 ha	Total
	No. observations/cell			
Animal Units:				
None	37	19	20	76
.07 to .5	30	43	32	105
.5 or More	7	13	22	42
Total	74	75	74	223
Chi-square = 25.01 w/ 4 d.f.	Contingency coefficient[1] = .32			
Days of Hired Labor Used:				
Less than One	27	31	14	72
One to Six	32	27	33	92
Six or More	15	17	27	59
Total	74	75	74	223
Chi-square = 33.56 w/ 4 d.f.	Contingency coefficient[1] = .36			
Family Laborers				
Up to One	17	16	10	43
Two	49	44	31	124
Three or More	8	15	33	56
Total	74	75	74	223
Chi-square = 35.27 w/ 4 d.f.	Contingency coefficient[1] = .37			

[1]Maximum Value = .82

Table 8. Means and Standard Deviations of Production Variables.

Production Variable	Mean	Standard Deviation	n
Yield (kg/ha)	738.82	559.0	81
Seed (kg/ha)	189.68	184.2	79
Compost (tons/ha)	5.06	10.9	79
Prep. Labor (hrs/ha)	1106.17	1057.8	81
Weed. Labor (hrs/ha)	681.21	573.5	81
Harv. Labor (hrs/ha)	295.48	316.4	81
Total Labor (hrs/ha)	2435.46	1692.0	81
Return to Factors (FRw/hr)	5.80	6.5	79
Acct. Profit (FRw/ha)	13,264.87	14,149.3	81
Econ. Profit (FRw/ha)	-11,658.45	15,543.2	79

Table 9. Means of Production Variables by Farm Size (In Hectares).[1]

n=65 Production Variables	Less than .61	Between .61-1.1	More than 1.1	Sig. of F-test	Value of F
Yield (kg/ha)	847	786	688	0.655	0.43
Seed (kg/ha)	158	181	159	0.803	0.22
Compost (tons/ha)	5.30	3.24	6.05	0.723	0.33
Prep. Labor (hrs/ha)	1397	1032	1043	0.534	0.63
Weed. Labor (hrs/ha)	675	966	612	0.147	1.98
Harv. Labor (hrs/ha)	262	263	370	0.463	0.78
Total Labor (hrs/ha)	2681	2634	2372	0.824	0.19
Return to Factors (FRw/hr)	6.08	6.01	6.21	0.992	0.01
Acct. Profit (FRw/ha)	17,364	15,755	9,823	0.168	1.84
Econ. Profit (FRw/ha)	-10,364	-12,125	-11,300	0.940	0.06

[1]Break points were redefined for the analysis of production variables to achieve nearly equal numbers of observations in each category.

Table 10. Means of Production Variables by Total Animal Units.

n=81 Production Variables	Zero	.07 to .5	.6 or More	Sig. of F-test	Value of F
Yield (kg/ha)	597	707	828	0.413	0.89
Seed (kg/ha)	167	177	165	0.912	0.09
Compost (tons/ha)	1.35	4.75	6.97	0.291	1.26
Prep. Labor (hrs/ha)	986	1324	922	0.268	1.34
Weed. Labor (hrs/ha)	578	702	700	0.784	0.24
Harv. Labor (hrs/ha)	201	246	386	0.093	2.45
Total Labor (hrs/ha)	2052	2652	2356	0.524	0.65
Return to Factors (FRw/hr)	5.19	4.83	7.82	0.090	2.48
Acct. Profit (FRw/ha)	10,338	12,557	15,169	0.543	0.62
Econ. Profit (FRw/ha)	-10,610	-14,160	-7,810	0.218	1.56

Table 11. Means of Production Variables by Number of Family Laborers.

n=81 Production variables	Zero Or One	Two	Three Or More	Sig. of F-test	Value of F
Yield (kg/ha)	545	692	855	0.223	1.53
Seed (kg/ha)	196	169	164	0.755	0.28
Compost (tons/ha)	0.54	3.33	8.48	0.053	3.05
Prep. Labor (hrs/ha)	841	1024	1287	0.395	0.94
Weed. Labor (hrs/ha)	347	606	876	0.015	4.45
Harv. Labor (hrs/ha)	225	236	386	0.102	2.35
Total Labor (hrs/ha)	1565	2156	3039	0.015	4.41
Return to Factors (FRw/hr)	5.71	6.09	6.25	0.967	0.03
Acct. Profit (FRw/ha)	8,295	13,205	14,989	0.402	0.92
Econ. Profit (FRw/ha)	-5,868	-6,865	-9,642	0.729	0.32

Table 12. Means of Production Variables by Outside Labor Use (in 8-hr days).

n=81 Production variables	0.0 to 3.63	3.75 to 9.0	9.0 or More	Sig. of F-test	Value of F
Yield (kg/ha)	904	599	710	0.130	2.09
Seed (kg/ha)	207	153	152	0.162	1.87
Compost (tons/ha)	7.18	4.02	4.03	0.488	0.72
Prep. Labor (hrs/ha)	746	1147	1416	0.060	2.92
Weed. Labor (hrs/ha)	670	630	740	0.779	0.25
Harv. Labor (hrs/ha)	317	281	288	0.911	0.09
Total Labor (hrs/ha)	2034	2381	2873	0.182	1.74
Return to Factors (FRw/hr)	8.89	4.46	4.75	0.009	5.00
Acct. Profit (FRw/ha)	21,525	11,713	6741	0.000	9.35
Econ. Profit (FRw/ha)	-3,942	-13,446	-15,544	0.008	5.12

Table 13. Means of Production Variables by Location.[1]

Production variables	Nyarutovu Commune	Nyamugali Commune	Cyeru- Butaro	Sig. of F-test	Value of F
Yield (kg/ha)	671	624	911	0.125	2.14
Seed (kg/ha)	134	164	212	0.051	3.09
Compost (tons/ha)	5.97	1.44	7.75	0.097	2.41
Prep. Labor (hrs/ha)	1465	738	1103	0.041	3.32
Weed. Labor (hrs/ha)	630	892	536	0.062	2.89
Harv. Labor (hrs/ha)	280	414	200	0.043	3.29
Total Labor (hrs/ha)	2812	2281	2215	0.367	1.02
Return to Factors (FRw/hr)	5.26	4.91	8.03	0.097	2.01
Acct. Profit (FRw/ha)	12,294	10,215	17,032	0.192	1.69
Econ. Profit (FRw/ha)	-15,382	-12,123	-5,742	0.050	3.12

[1]The cost of stakes was excluded in the calculation of economic returns. Since Cyeru-Butaro had a high percentage of pole beans, returns to labor and economic profits would be particularly lower in that region if the cost of stakes were included.

Table 14. Means of Production Variables by Type of Bean.[1]

Production variables	Bush	Pole	Sig. of F-test	Value of F
Yield (kg/ha)	600	1089	0.000	14.82
Seed (kg/ha)	153	216	0.033	4.73
Compost (tons/ha)	3.34	9.51	0.023	5.37
Prep. Labor (hrs/ha)	930	1551	0.016	6.04
Weed. Labor (hrs/ha)	664	724	0.676	0.18
Harv. Labor (hrs/ha)	268	364	0.219	1.54
Total Labor (hrs/ha)	2151	3154	0.015	6.16
Return to Factors (FRw/hr)	5.53	7.56	0.161	2.42
Acct. Profit (FRw/ha)	9,804	21,993	0.000	14.24
Econ. Profit (FRw/ha)	-11,094	-10,776	0.932	0.01

[1]Including the cost of stakes at a rate of 0.5 FRw/stake/season results in economic losses of 28,266 FRw/ha for pole beans.

Table 15. Means of Production Variables by Degree of Intercropping.[1]

Production variables	Pure	≤ 5 Other Plants/m²	More than 5 Plants/m²	Sig. of F-test	Value of F
Yield (kg/ha, Pure Equi.)	958	638	508	0.011	4.79
Seed (kg/ha)	185	164	157	0.697	0.36
Compost (tons/ha)	7.78	3.10	4.00	0.216	1.56
Prep. Labor (hrs/ha)	1459	863	901	0.050	3.12
Weed. Labor (hrs/ha)	564	647	986	0.048	3.15
Harv. Labor (hrs/ha)	281	277	362	0.646	0.44
Total Labor (hrs/ha)	2729	2073	2595	0.273	1.32
Return to Factors (FRw/hr)	7.68	6.05	3.07	0.035	3.50
Acct. Profit (FRw/ha)	17,550	12,737	5,784	0.022	4.01
Econ. Profit (FRw/ha)	-8,866	-9,701	-17,965	0.112	2.25

[1]The pure category is dominated by pole beans. Since the cost of stakes is excluded, the cost of pure bean production is highly underestimated.

Table 16. Summary of Bean Enterprise Budgets.

	Region/Beantype[1]					
	1Bush	1Pole	2Bush	2Pole	3Bush	3Pole
RESOURCE:	Cost (FRw/ha)					
Labor	17,010	33,850	17,520	23,130	15,580	19,520
Equipment	25	25	25	25	25	25
Seed	3,720	3,360	5,010	4,800	4,140	7,860
Stakes	N.A.	17,500	N.A.	17,500	N.A.	17,500
Total	20,755	55,005	22,555	45,455	19,745	44,905
Value of Yield (25 FRw/kg):						
FRw	11,700	18,025	11,425	14,300	12,775	31,175
Returns Above Total Costs:						
FRw	-9,055	-36,980	-11,130	-31,155	-6,970	-13,730
SENSITIVITY ANALYSIS:						
Returns, Excluding Stakes, Labor 10 FRw/hr						
FRw	-9,055	-19,480	-11,130	-13,655	-6,970	3,770
Returns, Including Stakes, Labor 5 FRw/hr						
FRw	-550	-20,055	-2,370	-19,590	820	-3,970
Returns, Excluding Stakes, Labor 5 FRw/hr						
FRw	-550	-2,555	-2,370	-2,090	820	13,530
Returns, Excluding Stakes, Labor 0 FRw/hr						
FRw	7,955	14,370	6,390	9,475	8,610	23,290

[1]Region 1 = Nyarutovu, 2 = Nyamugali, 3 = Cyeru-Butaro

Table 17. Break Even Value of Labor by Commune and Bean Type, @ 25 FRw/Kg.

		Pole	
Cost of Stakes	Bush	Included	Excluded
Nyarutovu	4.68 FRw	-0.92 FRw	4.24 FRw
Nyamugali	3.65 FRw	-3.47 FRw	4.10 FRw
Cyeru-Butaro	5.53 FRw	2.97 FRw	11.93 FRw

Table 18a. Traditional Bean Enterprise Budget Nyarutovu Commune.
Bean Type: Bush. Average Yield = 468 kg/ha.

	Tasks	Quantity/Units	Unit Cost	Cost
I.	Land Preparation			
	Labor	851 hrs	10 FRw	8510
	Hoe	one season	25 FRw	25
	Subtotal			8535
II.	Planting			
	Labor	222 hrs	10 FRw	2220
	Seed	124 kg	30 FRw	3720
	Subtotal			5940
III.	Weeding			
	Labor	443 hrs	10 FRw	4430
	Subtotal			4430
IV.	Harvest & Threshing			
	Labor	161 hrs	10 FRw	1610
	Subtotal			1610
V.	Manuring			
	Spreading Labor	24 hrs	10 FRw	240
	Compost	2.2 tons	(no cost)	0
	Subtotal			240
VI.	Total			20755

Summary of Costs of Production:

By Task:		By Resource:	
1. Land Preparation	8535	1. Labor	17010
2. Planting	5940	2. Equipment	25
3. Weeding	4430	3. Seed	3720
4. Harvest	1610		
5. Manuring	240		
6. Total	20755	4. Total	20755

Sensitivity Analysis:

Bean Price	Value of Yield	Returns Above Specified Costs
25 FRw/kg	11,700	-9,055
30 FRw/kg	14,040	-6,715
35 FRw/kg	16,380	-4,375

Table 18b. Traditional Bean Enterprise Budget Nyarutovu Commune.
Bean Type: Pole. Average Yield = 721 kg/ha.

	Tasks	Quantity/Units	Unit Cost	Cost
I.	Land Preparation			
	Labor	1,755 hrs	10 FRw	17550
	Hoe	one season	25 FRw	25
	Subtotal			17575
II.	Planting			
	Labor	481 hrs	10 FRw	4810
	Seed	121 kg	30 FRw	3630
	Subtotal			8440
III.	Weeding			
	Labor	550 hrs	10 FRw	5500
	Subtotal			5500
IV.	Harvest & Threshing			
	Labor	454 hrs	10 FRw	4540
	Subtotal			4540
V.	Manuring			
	Spreading Labor	44 hrs	10 FRw	440
	Compost	5.9 tons	(no cost)	0
	Subtotal			440
VI.	Staking			
	Labor	101 hrs	10 FRw	1010
	Stakes	35,000	0.5 FRw	17500
	Subtotal			18510
VII.	Total			55005

Summary of Costs of Production:

By Task:		By Resource:	
1. Land Preparation	17575	1. Labor	33850
2. Planting	8440	2. Equipment	25
3. Weeding	5500	3. Seed	3630
4. Harvest	4540	4. Stakes	17500
5. Other	18950		
6. Total	55005	5. Total	55005

Sensitivity Analysis:

Bean Price	Value of Yield	Returns Above Specified Costs
25 FRw/kg	18,025	-36,980
30 FRw/kg	21,630	-33,375
35 FRw/kg	25,235	-29,770

Table 18c. Traditional Bean Enterprise Budget Nyamugali Commune.
Bean Type: Bush. Average Yield = 457 kg/ha.

	Tasks	Quantity/Units	Unit Cost	Cost
I.	Land Preparation			
	Labor	652 hrs	10 FRw	6520
	Hoe		25 FRw	25
	Subtotal			6545
II.	Planting			
	Labor	165 hrs	10 FRw	1650
	Seed	167 kg	30 FRw	5010
	Subtotal			6660
III.	Weeding			
	Labor	643 hrs	10 FRw	6430
	Subtotal			6430
IV.	Harvest & Threshing			
	Labor	278 hrs	10 FRw	2780
	Subtotal			2780
V.	Manuring			
	Spreading Labor	14 hrs	10 FRw	140
	Compost	0.9 tons	(no cost)	0
	Subtotal			140
VI.	Total			22555

Summary of costs of Production:

By Task:

1. Land Preparation	6545
2. Planting	6660
3. Weeding	6430
4. Harvest	2780
5. Manuring	140
6. Total	22555

By Resource:

1. Labor	17520
2. Equipment	25
3. Seed	5010
4. Total	22555

Sensitivity Analysis:

Bean Price	Value of Yield	Returns Above Specified Costs
25 FRw/kg	11,425	-11,130
30 FRw/kg	13,710	-8,845
35 FRw/kg	15,995	-6,560

Table 18d. Traditional Bean Enterprise Budget Nyamugali Commune.
Bean Type: Pole. Average Yield = 571 kg/ha.

	Tasks	Quantity/Units	Unit Cost	Cost
I.	Land Preparation			
	Labor	633 hrs	10 FRw	6330
	Hoe	one season	25 FRw	25
	Subtotal			6355
II.	Planting			
	Labor	184 hrs	10 FRw	1840
	Seed	160 kg	30 FRw	4800
	Subtotal			6640
III.	Weeding			
	Labor	883 hrs	10 FRw	8830
	Subtotal			8830
IV.	Harvest & Threshing			
	Labor	502 hrs	10 FRw	5020
	Subtotal			5020
V.	Manuring			
	Spreading Labor	22 hrs	10 FRw	220
	Compost	2.1 tons	(no cost)	0
	Subtotal			220
VI.	Staking			
	Labor	89 hrs	10 FRw	890
	Stakes	35,000	0.5 FRw	17500
	Subtotal			18390
VII.	Total			45455

Summary of Costs of Production:

By Task:		By Resource:	
1.Land Preparation	6355	1. Labor	23130
2. Planting	6640	2. Equipment	25
3. Weeding	8830	3. Seed	4800
4. Harvest	5020	4. Stakes	17500
5. Other	18610		
6. Total	45455	5. Total	45455

Sensitivity Analysis:

Bean Price	Value of Yield	Returns Above Specified Costs
25 FRw/kg	14,300	-31,155
30 FRw/kg	17,160	-28,295
35 FRw/kg	20,020	-25,435

Table 18e. Traditional Bean Enterprise Budget Cyeru-Butaro Commune.
Bean Type: Bush. Average Yield = 511 kg/ha.

	Tasks	Quantity/Units	Unit Cost	Cost
I.	Land Preparation			
	Labor	767 hrs	10 FRw	7670
	Hoe	one season	25 FRw	25
	Subtotal			7695
II.	Planting			
	Labor	225 hrs	10 FRw	2250
	Seed	138 kg	30 FRw	4140
	Subtotal			6390
III.	Weeding			
	Labor	330 hrs	10 FRw	3300
	Subtotal			3300
IV.	Harvest & Threshing			
	Labor	194 hrs	10 FRw	1940
	Subtotal			1940
V.	Manuring			
	Spreading Labor	42 hrs	10 FRw	420
	Compost	3.8 tons	(no cost)	0
	Subtotal			420
VI.	Total			19745

Summary of Costs of Production:

By Task:		By Resource:	
1. Land Preparation	7695	1. Labor	15580
2. Planting	6390	2. Equipment	25
3. Weeding	3300	3. Seed	4140
4. Harvest	1940		
5. Other	420		
6. Total	19745	4. Total	19745

Sensitivity Analysis:

Bean Price	Value of Yield	Returns Above Specified Costs
25 FRw/kg	12,775	-6,970
30 FRw/kg	15,330	-4,415
35 FRw/kg	17,885	-1,860

Table 18f. Traditional Bean Enterprise Budget Cyeru-Butaro Commune.
Bean Type: Pole. Average Yield = 1247 kg/ha.

	Tasks	Quantity/Units	Unit Cost	Cost
I.	Land Preparation			
	Labor	754 hrs	10 FRw	7540
	Hoe	One Season	25 FRw	25
	Subtotal			7565
II.	Planting			
	Labor	241 hrs	10 FRw	2410
	Seed	262 kg	30 FRw	7860
	Subtotal			10270
III.	Weeding			
	Labor	577 hrs	10 FRw	5770
	Subtotal			5770
IV.	Harvest & Threshing			
	Labor	247 hrs	10 FRw	2470
	Subtotal			2470
V.	Manuring			
	Spreading Labor	56 hrs	10 FRw	560
	Compost	8.2 tons	(no cost)	0
	Subtotal			560
VI.	Staking			
	Labor	77 hrs	10 FRw	770
	Stakes	35,000	0.5 FRw	17500
	Subtotal			18270
VII.	Total			44905

Summary of Costs of Production:

By Task:		By Resource:	
1. Land Preparation	7565	1. Labor	19520
2. Planting	10270	2. Equipment	25
3. Weeding	5770	3. Seed	7860
4. Harvest	2470	4. Stakes	17500
5. Other	18830		
6. Total	44905	5. Total	44905

Sensitivity Analysis:

Bean Price	Value of Yield	Returns Above Specified Costs
25 FRw/kg	31,175	-13,730
30 FRw/kg	37,410	-7,495
35 FRw/kg	43,645	-1,260