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Rwanda Farming Systems Research Program
Technical Paper Series

Farming Systems Research Program
(FSRP), Rwanda

TDY REPORT

Eric Wailes and Lucas Parsch
July 4-24, 1988

Report # 60

USAID Contract #696-0110
between
The University of Arkansas, Fayetteville
(International Agricultural Programs)
and
The Rwandan Ministry of Agriculture
Rwandan Institute for Agricultural Sciences (ISAR)

Farming Systems Research Program (FSRP), Rwanda

TDY REPORT

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TERMS OF REFERENCE

1. Initiate revitalization of agricultural economics component of FSRP.

2. Report on the executive summary of BREWSTER'S M.S. thesis and submit to FSRP Technical Paper Series of project.

3. Assist in finalizing formal linkages between FSRP/ISAR, U of A and UNR to facilitate special academic opportunities. Develop arrangements for special project funding to integrate UNR faculty and students with economic research. Integrate M.S. thesis research proposal for Malcolm MAYFIELD into this linkage.

4. Meet Participant Training Students in Rwanda to discuss graduate study in the U.S. and report on agricultural economic analysis of the project.

5. Develop recommendations for the economic analysis of the 1989 workplan in concert with Rwandan counterpart, MUNYEMANA Augustin.

6. Review agronomic trials completed and in progress to identify the appropriate economic analysis required.

PROGRESS OF ACTIVITIES

July 4: Arrived Kigali 10:30 a.m. Checked into hotel by 1:00 p.m. Met with team at Kigali office from 3:00 to 5:00 p.m.

July 5-8: Finalized executive summary paper on BREWSTER'S thesis, "Traditional Bean Production in the Buberuka Highlands." Reviewed recent TDY reports (ZALLA, SWANSON, BROWN) and technical reports by the team (diagnostic and analyses). Met with Minister NTEZILYAYO Anastase to discuss invitation to the U.S. in August. Met with AID Director MELAVEN to report on planned activities and discuss proposed visit of the Minister to the U.S. Met with officials at Enquete Nationale and ASPAP/AID project. Reviewed work on data sources, survey research and price analysis and policy.

July 9: Travel to RWERERE. Discussed participant training work with Ashoka PAUL and bean research with K. B. PAUL and met the Rwandan socio-economist, MUNYEMANA Augustin.

July 10: Met with FSRP team members, BIZIMANA, BURLEIGH, PAUL K., YAMOAH, PAUL A. and MUNYEMANA to discuss our terms of reference. Visited agro-forestry trials with YAMOAH.

July 11: Final review of executive summary bean study and review of Enquete Nationale data. Initiated proposal for an extension of the bean study that will serve as the basis of Malcolm MAYFIELD'S M.S. thesis research.

July 12: Participated as representatives of the University of Arkansas in the inauguration of the Rwerere Research Office Building. Continued discussions with Yamoah on agroforestry and research and potential economic analysis.

July 13: With the coordination by Ashoka PAUL, we met with eight Participant Training Students to discuss issues relating to graduate study and opportunities to conduct collaborative research with FSRP project. Continued discussions on proposed economic research.

July 14: Held seminar with Participant Training Students to discuss results of BREWSTER'S M.S. thesis, economic analysis of traditional bean production. Met with PAUL to visit on-station and on-farm bean and wheat research trials. Continued discussions on major achievements of bean research and potential for economic analysis of agronomic trials.

July 15: Met with BURLEIGH to visit on-farm integrated agroforestry trials. Discussed productivity index measure, which is proposed to better characterize farming potential in the project region. Met with MUNYEMANA to introduce economic methods of analysis for the traditional bean production research.

July 16-17: Report writing. Travel to Gisenyi for overnight stay.

July 18: Report writing. Visit with BIZIMANA Ignace, potato variety, fungicide and rotation on-farm and demonstration trials. Continued discussions with MUNYEMANA Augustin on bean production study.

July 19: Report writing. Review of studies proposed by MUNYEMANA. Assisted YAMOAH and UNR students PIOUS, ANECLET and LEONARD in developing questionnaire for long-term farmer survey of alley cropping management study. Completed review of bean study with MUNYEMANA.

July 20: Travel to Butare with Ashoka PAUL to meet KAMANZI Abdul, former Dean of the Faculty of Agronomy, to finalize the formal linkages between FSRP/ISAR and UNR to facilitate special academic opportunities. Formally invited NDINDABAHIZI Innocent, professor of socio-economics, to join the socio-economic research effort of the FSRP/ISAR project. Also met with Paul HANEGREEFS of the Minnesota/UNR project to share information regarding our objective of adaptive research linkage with UNR. Return to Rwerere.

July 21: Attended Farmer/Monagri Field-Day and Workshop at Rwerere hosted by FSRP/ISAR. Continued report writing. Arranged for exit interview with Dr. Valens NDOREYAHO for Saturday, July 23.

July 22: Report writing. Review of executive summary of BREWSTER'S M.S. thesis with K. B. PAUL. Review of proposed studies by MUNYEMANA. Review of TDY report with team members.

July 23: Exit interview with Team leaders, BIZIMANA AND BURLEIGH. Exit interview with USAID, Dr. Valens NDOREYAHO. Departure from Kigali.

GENERAL OBSERVATIONS

FSRP Team Accomplishments to Date

A substantial amount of research and participant training has been accomplished and administered by the team. The workplan for 1989 reflects an aggressive set of scientific studies and pre-extension activities. We were impressed with the number of trials with an increasing emphasis on on-farm sites. It was a delight to meet the Participant Training Students, who were very well coordinated by Ashoka PAUL. The particular groups that we met are outstanding students, and much should be expected of them in the future.

While the level of frustration of the team regarding logistics, i.e. access to vehicles, is a real constraint to accomplishing more, their achievements to date are excellent. We were greatly impressed with the overwhelming attendance and active participation by approximately 130 farmers, 9 agronomes and 11 monagris at the field-day/workshop. This activity clearly demonstrated the achievements of the team

and the great interest by the farmers in the new technologies that address constraints such as soil fertility/erosion, varietal improvement and higher levels of land and labor productivity.

FSRP Needs

In our discussions with the team and based on our own observations. we were impressed with the need for the project to do the following:

a) develop a documentation and publications center;
b) complete and control use of the laboratory such that it meets minimum scientific standards (under FSRP);
c) ensure availability of vehicle and chauffeur for the researchers; this should be done by assigning vehicles to each expatriate team member;
d) give particular attention to the development of technical documents and scientific papers as well as educational materials on the adaptive technologies for farmers, moniteur agricoles and agronomes. The latter materials should include both pamphlets and audio-visuals so that the pre-extension activities can be conducted and demonstrated to more individuals without requiring major interruptions in the on-going research efforts of the team.

FSRP Team Cooperation with TDY Visit

Our primary responsibility in developing a set of economic studies and responsibilities for the socio-economic component of the research program was greatly facilitated by the assistance of many people, especially the present team members: BIZIMANA Ignace, James BURLEIGH, MUNYEMANA Augustin, K.B. PAUL and Charles YAMOAH. They provided their time readily despite the fact that they were extremely busy with their current research trials, hosting the research center inauguration and a major workshop for farmers and agronomes while we were on the station.

We especially benefitted from the generosity of team members in inviting us to visit on-farm research sites.

Needs for FSRP/ISAR and UNR Collaboration

A memorandum of understanding of general intent for collaboration of FSRP/ISAR and UNR should be developed as soon as possible. This would provide the framework for particular special studies, which would be developed by the collaborators. The special study proposal on "Integration of Research Planning of the Farming Systems Research Program with the Rwandan National Agricultural Research Plans" submitted last December is the basis for the proposed intermediate-term study discussed in this report. A memorandum of understanding for collaboration on this project has been signed by FSRP and ISAR; unfortunately, it has not been signed by UNR. Agreement on this specific research should be followed up by the socio-economists on the team as soon as possible. The general memorandum of understanding should be developed and signed by ISAR Director, UNR Dean and FSRP Director and Senior Advisor.

Needs for Economic Analysis

The following factors provide the context within which we pursued our ideas for an economic research program. First, we noted that a substantial amount of agronomic data has been collected. Much of it has been analyzed without the benefit of any economic consideration. Only one trial explicitly considered the costs and benefits of the tested intervention, i.e. Bean Seed Treatment by K.B. PAUL and Peter TRUTMANN. With this wealth of data, we believe that it is important to provide partial budgeting analysis comparing the costs and benefits of the intervention against the traditional (control) practice for as many trials as possible. We have identified below a set of trials completed and planned for the next year that should be considered by the socio-economists.

Second, we were accompanied by Mr. Malcolm MAYFIELD, an M.S. candidate in agricultural economics at the University of Arkansas. We had assigned him, prior to arriving in Rwanda, the responsibility of developing an executive summary of Ms. Marcie BREWSTER's M.S. thesis on the economic analysis of traditional bean production in the project area. This summary has been submitted for translation into French and should be considered as a technical research paper of the research program. It served as a discussion paper for the Participant Training Students and as a prototype analysis for discussions with

the Rwandan socio-economist, MUNYEMANA Augustin.

While we believe the paper is a useful contribution, there are a number of important analyses (elaborated below) that were not pursued by BREWSTER. She collected a rich data base, especially dealing with the labor input for traditional bean production. We believe that this study provides a foundation for collecting data on additional variables so that a definitive micro-economic analysis of traditional bean production can be completed. Such a study would provide for a badly needed understanding of the interaction of agro-ecological and socio-economic variables that characterize traditional bean production in the project area.

In general, there is a dearth of micro-level studies in the country that is even more pronounced in comparison to the far greater macro orientation of the economic analyses we were able to review. Such micro-level studies must be done before there is an adequate basis to assess impacts of new technologies on farmers, as well as national agricultural policies such as regional specialization, research priorities, pricing policies, etc.

Third, while the bean enterprise is of obvious importance not only in the project region but throughout the nation, the farming systems of the region are far more complex than suggested by a focus on a single important crop. The economic component of the research program must, therefore, be broadened to include an assessment of the major products produced in the region with an explicit recognition of the crop interactions/associations. We believe this can be accomplished with the talented and enthusiastic socio-economic team members.

Proposed Economic Research Program

Agricultural research is the primary development tool that can directly increase the well-being and ability of the small farmers in the project area by increasing land productivity. The dominant resource limitations are land and, increasingly, the deterioration in the quality of the soil. Farmers in this area place a tremendous priority upon producing enough food for their daily consumption. There is little surplus produced. Consequently, market activities appear to be very limited with regard to inputs. Products are restricted to bananas for beer, wheat and barley, small amounts of tobacco and coffee and post-harvest surpluses of the staples, beans and potatoes.

Only after research interventions have been successful in helping to generate surpluses will the current farming systems change to respond to market considerations such as specialization in production of cash crops and reliance on the market for food consumption needs. Such a market development, away from the subsistence system, will require not only the technical improvements from the research program but an accompanying development of market infrastructure including improved transportation, increased numbers of commercants (trader/merchants), and market information.

The research priorities must not lose sight that the subsistence priority of farmers will continue to dominate the immediate future. The implication of this is that continuing to improve an understanding of the traditional system is necessary. Cost of production under traditional cultivation as well as knowledge of factors associated with yield variation are not well understood and are virtually undocumented. Variations in the farming systems organization and level of productivity in the region appear to be related to sets of agro-ecological and socio-economic variables. The agro-ecological variables include altitude, rainfall, slope and soil type. Socio-economic variables include farm size in relation to family size and composition (labor availability), livestock component (manure availability), access to market (purchased inputs, e.g. chemical fertilizers, hand tools) and non-market resources (e.g. stakes for pole bean production).

The economic component of the farming systems research program thus should include the following:

a) determination of resource costs under traditional cultural practices for major crops produced in the region (beans-pole/bush, wheat/triticale/barley, irish potatoes, sweet potatoes, bananas, sorghum, maize, peas);
b) analysis of agro-ecological and socio-economic variables that are associated with variation in yields of these crops on farms and compared to potential yields, i.e. yield gaps;
c) analysis of costs and benefits associated with output-increasing technologies being tested under on-farm conditions.

In order to achieve these objectives, we view the activities of the research team to have short-, intermediate- and longer-term dimensions.

Short-run studies include those identified under item c) above. They include essentially partial budgeting analyses that are logically a component of most applied research trials. These studies will require the collaboration of the socio-economist with the other team members, and the benefit-cost analysis should be considered a part of the trial evaluation. As noted above there are a large number of trials already completed, especially for beans, wheat and alley cropping. These studies should commence immediately and will be a major on-going responsibility of the socio-economists. A list of trials, completed and proposed, for the 1989 workplan that fall into this type of analysis is given in Appendix 1. Major responsibility for these studies will be the socio-economics counterparts NDIAYE Serigne and MUNYEMANA with assistance from UNR faculty, NDINDABAHIZI Innocent and students and MAYFIELD. PARSCH and WAILES will provide technical support for these analyses.

One intermediate-run study is proposed that will extend the traditional bean production study initiated by BREWSTER. The protocol for this study is detailed in Appendix 2. The value of this study in addition to the valuable information it will provide on the economics of bean production is that it will serve as the prototype for the studies proposed for the longer run, which will characterize the traditional cultural practices of other crops as they complete an understanding of the farming systems in the region. Major responsibility for this study will be MAYFIELD, MUNYEMANA and NDIAYE with collaboration of PARSCH and WAILES. Technical support will rely upon enqueteurs to assist with data collection. This study will help train enqueteurs for the longer-run study.

One longer-run study is proposed for the research team. This will be a year-long study including seasons A and B of a sample of farmers in the region. The objective will be to characterize production and consumption practices for all crops and major household items. The primary focus will be to establish confident estimates and enterprise budgets for crops by characteristics considered important for recommendation domains. Thus farmers will be characterized by appropriate agro-ecological and socio-ecological variables using multivariate techniques such as cluster analysis or other appropriate classification methods. Analysis of factor productivity, especially for labor by crop and region, will be an important analysis that falls out of the cost of production data. This analysis will be based upon yield response estimation procedures. Details of this study are developed in greater detail in Appendix 3. Major responsibility for this study will be the socio-economists, NDIAYE AND MUNYEMANA with technical backstopping support from PARSCH, WAILES, MAYFIELD and UNR faculty NDINDABAHIZI and students. The study will require enqueteurs to visit sample farms several times per week during the year.

Follow-up and Economic Training Needs

The U of A is committed to providing the technical support necessary to conduct the proposed economic research. We believe that Malcolm MAYFIELD will be a useful resource for the long-term socio-economists. We propose that Lucas PARSCH return for approximately two weeks at the end of September, after NDIAYE and MUNYEMANA have had an opportunity to develop their program and react to the proposals of this TDY report. We believe that PARSCH'S visit will provide a timely assessment of the economic studies that will necessarily have begun for the 1989 A cropping season. It will also be important to assess the progress of Malcolm MAYFIELD with regard to his thesis study.

We propose that MUNYEMANA Augustin be sent for a one- to two-month training course in economic analysis of on-farm research trials at one of the international research institutes. An ideal time period for this would be after the A season, once NDIAYE has had an opportunity to establish the research program in collaboration with MUNYEMANA.

We are very hopeful for the productivity of this research in contributing to the team effort in meeting the objectives of the Farming Systems Research Program. We thank the team for their gracious hospitality and certainly look forward to providing any support that is necessary.

Appendix 1:
Short-Term Studies

Title: Socio-economic analyses of agronomic trials

Principal Investigators: MUNYEMANA Augustin, Serigne NDIAYE with backstop support from Malcolm MAYFIELD, Lucas PARSCH and Eric WAILES

Justification: One primary role of the socio-economists is to participate in the collaborative, multidisciplinary research of the project. This is recognized in the terms of references of the socio-economists' positions and is explicit in the workplan activities. The contribution of the socio-economist is to aid in the design, implementation and evaluation of the agronomic trials. Typically, the unique contribution in evaluation of agronomic trials is the assessment of costs and benefits of a particular intervention in comparison to the control, normally a proxy for the traditional farmer method.

The objective of these trials will be to determine differences in agronomic performance variables such as yields and the costs and benefits of the different treatments. The standard approach is partial budgeting that sums over the four potential changes: a) added costs, b) added revenue, c) reduced costs and d) reduced revenue. Yield response analysis using multiple regression, a standard tool for socio-economists, is becoming increasingly popular in agronomic studies. This method is particularly important to estimate the relative contribution of various factors as well as to determine the marginal productivity estimates of inputs on output.

From a farming systems perspective, interventions that require changes in timing, rate of input use, etc., alter more than the particular costs and revenue of the specific crop being studied. In a limited resource environment as found in the Buberuka Highlands, interventions for one crop imply changes in the availability of resources for other crops. Understanding of the interactions and associations among crop costs and returns requires a whole-farm analysis. Whole-farm analysis can be done using linear programming (LP) models based on input and output coefficients for the full set of farm activities. This type of analysis is one year away from being possible pending the achievement of the study proposed in Appendix 3. Useful LP modeling depends upon accurate micro-level input and output coefficients.

Methodology: Analysis of variance, partial budgeting and multiple regression will be appropriate analytical tools for the economic analysis of the agronomic studies. These methods are well known and are presented in an extremely valuable review and set of training exercises in Volume III of the Farming Systems Support Project Participant Manual, ANALYSIS and INTERPRETATION of ON-FARM EXPERIMENTATION. We recommend that the socio-economists MUNYEMANA and NDIAYE with MAYFIELD review the material to determine the most appropriate approaches for each trial.

Results: A substantial number of agronomic trials have been completed during the 1987 and 1988 workplans that lend themselves to economic analysis. We recommend that the socio-economists work with the team scientists responsible for those trials to obtain the data, develop the economic analysis and write a collaborative paper or amend the earlier trial evaluation as submitted by the scientists.

Analyses for the 1989 Workplan (PLAN DU TRAVAIL FSRP/ISAR, 1989) that are indicated for participation of the socio-economists include Etudes 2, 6, 7, 8, 9, 10 and 11. While not explicitly noted in the protocol, we recommend the involvement of the socio-economists for Etudes 1, 3, 4 and 5.

Appendix 2:
Intermediate-Term Study

Title: Analysis of traditional bean production in the Buberuka Highlands.

Principal Investigator: Malcolm MAYFIELD
Co-Investigators: Augustin MUNYEMANA, Serigne NDIAYE with backstopping support from Lucas PARSCH, Eric WAILES.

Justification: During season 1987A, special studies research was conducted by Marcie BREWSTER in the four-commune area of the FSRP project. Results of that study are described in an executive summary, "Traditional Bean Production and the Relationship with Recommendation Domains in the Rwandan Highlands" by MAYFIELD et al. The data set collected by BREWSTER in an 81-field, 45-farm survey over the 27-week cropping season was unique in that it described weekly producer-resource use at the micro-level in the production of a major food crop. Data of this nature has not been previously collected in Rwanda. Examination of the results of the BREWSTER study by MAYFIELD et al. indicates that greater confidence in its conclusions would be forthcoming if the original study could be extended. This extension includes the following: collection of additional data from the same sample of farmers to supplement the original data set; redefining of selected socio-ecological classification categories and selected production variables; testing of alternative and more appropriate hypotheses relevant to recommendation domains and production practices; and the use of more discriminating statistical tests that will provide additional information of value to the project. The extension of the original study will serve as the M.S. thesis for MAYFIELD. The completed MAYFIELD thesis and supporting documents will serve as a prototype for future studies that attempt to analyze resource use, costs and returns at the whole-farm (exploitation) multi-crop level of analysis.

Objectives:

1. To describe traditional bean production practices (pole and bush) in the four-commune area by developing coefficients for major inputs (labor by field operation, compost use, equipment) and outputs.
2. To determine whether bean production practices vary significantly according to socio-economic and/or agro-ecological classifications.
3. To develop individual enterprise budgets (costs and returns) for bean production in the four-commune area for relevant socio-economic and/or agro-ecological classifications.
4. To determine the magnitude and sign of the relationship between bean yields and relevant agro-economic and socio-economic factors.

Procedures: During a 3- to 4-month stay at the Rwerere ISAR station, MAYFIELD's primary task relevant to this study will be to supplement the original BREWSTER data set and to do the follow-up analysis. Each of the 45 farms (81 pole bean and bush bean fields) initially surveyed in 1986 will be given a one-time interview in August 1988 during which additional socio-economic and agro-economic data will be collected. The supplemental data to be collected and other issues relevant to identifying the original sample are detailed in the section "Mayfield Study Data Collection" below. Visits to each farm will result in questions asked from a developed questionnaire in addition to measurements of field size, elevation, aspect, total farm size, etc. Data collected from this survey will be combined with the original BREWSTER data set and analyzed using either SAS or SPSS. Statistical analysis will include the use of correlation analysis, contingency table development, Duncan Multiple Range Testing and multiple regression. Enqueteurs originally employed in the BREWSTER survey will be utilized to conduct the farmer survey under the direction of MAYFIELD, MUNYEMANA and NDIAYE. This one-time interview will serve as a training session for enqueteurs to do the year-long, two-season study described in Appendix 3. Organization of the data set, definition of variables, the survey instrument used (BREWSTER and MAYFIELD) and the subsequent follow-up analysis for this study on bean production will serve as the prototype for the multi-crop, whole-farm analysis described in Appendix 3.

MAYFIELD Study Data Collection: Issues, Variables, Definitions

Farmer Identification:
It is essential to identify all 45 farms and 81 fields from the BREWSTER study. Of the 45 farms, 16 were "new" farms, and 29 had been used in the 1984 SESA study. Verify either through the enqueteurs or SESA sources that these 29 farms of the Brewster study are identical with those of SESA. This verification may have to take place with a visit to the Enquete Nationale headquarters in Kigali to talk with LASSITER (Michigan State agricultural economist) of ASPAP. If this is verified, farm size, family labor, outside labor and number of animals from Brewster can be accepted as valid. For example, it will be important to determine whether the names of the 29 Brewster farmers can be cross-referenced with farmer names in some SESA documentation.

Of the 16 remaining "new" farmers, all of the state variables for farm size and family labor must be collected in this survey. This permits an increase from the original sample size of 65 fields on 32 farms to 81 fields on 45 farms.

A. Essential Data to extend BREWSTER analysis. Data to be collected in a one-time survey in August 1988.
   1. Elevation in meters for each field, measured at mid-point of each parcel using Yamoah's altimeter. Consult with YAMOAH on use of altimeter.
   2. Aspect in degrees if compasses available. Stand in field facing down slope. This approximates a measure of whether field faces sunshine. Compass measurements can be indexed later to a more general 180-degree or 90-degree orientation (e.g. east-west, north-south; east, west, etc.) as yet to be determined in consultation with FSRP team.
   3. Family labor. For all families not in the original SESA data set, get age and sex of all family members so that they can be classified into the same four labor categories as BREWSTER. Also, find out if there have been any deaths (age/sex) in the past two years so that relevant members can be extrapolated backwards to July 1986 when BREWSTER surveyed.
   4. Farm size. For same subsample as in no. 3 above, find total area under cultivation, in fallow and not being cultivated (i.e., pasture and woodlands) consistent with "farm size" definition of SESA. For all the farms not in the SESA set, this will have to be done by measuring all parcels on that farm using either YAMOAH's measuring wheel or the technique described by BREWSTER in the appendix of thesis.
   5. Other. Additional agro-ecological measures that may optionally be collected for each of the 81 bean fields include (a) terraced field, y/n; (b) distance of field from rugo measured in the number of minutes to walk to the field; and (c) width of field top and bottom or drawings of shape.

B. Supplemental Data. These data are collected at same time as "essential" data in A above and can also be obtained in a one-time survey. These data are not essential to completing the BREWSTER extended study but provide a potential additional dimension to the study regarding diffusion of new interventions of the FSRP project.
   1. Was the farmer a FSRP collaborator in 1986 at time of BREWSTER survey in season 87A? Farmer recall on this may be hazy, and definition of "collaborator" may be unclear as well. BREWSTER claims that many of the farmers selected were FSRP-collaborating farmers and the actual survey forms used indicate "semence selectionee" for both beans and sweet potatoes. K. B. PAUL may be able to help on this since collaboration during that season probably referred to his on-farm trials, which had begun in season 86B. It may be necessary to distinguish between FSRP varieties and varieties introduced by other agencies (CIAT or MINIPLAN) if we want to measure FSRP impacts on agriculture in the four-commune area.
      a. If yes, what is the intervention (variety) or technology? Most likely, new varieties of beans were the only interventions being tried at that time. Have other adjacent farmers asked for the seed, or has this farmer offered the seed to other farmers, and to how many?
         Does the farmer still use the technology (seed)?
      b. If no, go on.

2. Is the farmer an FSRP collaborator at present?
   a. If yes, since when and by what medium did he become a collaborator (e.g., monagri, FSRP team member, workshop)?
      What is the intervention or technology that makes him a collaborator (fungicide, variety, agro-forestry, etc.)?
3. Location of rugo by cellule so that we can determine if diffusion of FSRP technology is a function of distance from FSRP, monagri, proximity to roads, proximity to extension personnel, etc. It will be desirable to develop maps of the study sample so that the geographic distribution of farms (fields) in the study is readily apparent. Additional "distance" questions may include distance to water and notation of whether rugo is located on a road.

C. Original data of BREWSTER's (to be maintained).
1. Farm size (ha) where appropriate from SESA.
2. Hired labor days per season from SESA.
3. Family labor persons/farm by age-sex category as defined by BREWSTER and SESA (e.g. four categories). This variable defines labor availability.
4. Animal units/farm where base unit is 1 goat and where 1 cow = 15 base units. (I am suggesting we switch from cow as base unit to goat for ease of units as per below). This variable defines manure availability.

Possible redefinition of the above variables in the following manner is suggested:

Family labor: Since family labor is defined as 15-64 age group, and since other categories were also collected, i.e., 10-15 year group and 10>age>65, could the whole variable of family labor be re-defined to include these other groups (esp. 10-15) or to place different weights on each category to come up with a measure more truly reflecting family labor? Especially important is that most people agree that children beyond age 7 or 8 years become important elements of the farm labor force. One question to be answered: Does SESA data contain other categories (i.e., 10-15)?

Animal units/farm: Why not go to goat as basic unit redefining cows in terms of goats (e.g., 1 cow=15 animal units). Easier to work with and possibly to reclassify animal unit categories more meaningfully. In addition, check again with FSRP team whether 1 cow= 15 goats in terms of manure. ZALLA TDY report indicates 7-8 or 12 goats per cow unit is more appropriate.

D. Original Data of BREWSTER's collected in field on 45 farms during season 1987A using 9 enqueteurs, i.e., basic data set. All of these variables are to be maintained.
State variables: one observation per field.
1. field size, ha. Also field density of beans if inter-cropped used to calculate pure equivalent field size, and actual field size of inter-cropped parcels.
2. yield, kg/ha or kg/pure equivalent ha if inter-cropped. Note: It is our understanding that all variables measured on a per hectare basis represent a per pure field equivalent hectare.
3. seed, kg/ha. Note: Seeding date could most likely be derived from the original data set since week of seeding was noted on the survey form for seed used. This may be an important agronomic variable reflecting difference in management that could be used as a regressor explanatory variable in the yield response equations.
4. compost, t/ha. Note: Originally four categories were collected and entered, but these were later aggregated into one variable for purpose of analysis in BREWSTER. These could be disaggregated into manure, compost vegetale, etc. especially in the Cyeru-Butaro region where much fumier was used and where we might have enough observations to distinguish if there was a differential impact of quality of manure for this subsample.
5. location, commune Nyatorovou, Nyamugali or Cyeru-Butaro. Note: We need to find out why BREWSTER combined the two communes into one for only three regions in all. Was it for convenience, population distribution, distance, hypothesized similarity of Cyeru-Butaro, or simply due to limited resources? It would also be nice to have a map included in the study showing the geographical distribution of fields in the sample. Evidently, ZALLA was able to incorporate a graph in his TDY report, so the technology must be available to do this here at the station.

6. bean type, pole or bush (1 or 2). Note: The survey forms for semis included designation of whether the beans were improved or not (selectionee, non-selectionee). This is a potentially important variable as a regressor if the sample size is large enough of those farmers using the former.
7. index of inter-cropping= [bean density/(bean + other)density], decimal. This is an intermediate variable for calculation of pure field equivalent size for intercropped fields. We need to think whether this should be recalculated based on discussion with FSRP team members. The issue is whether BREWSTER's method is satisfactory to accommodate the range of "other" crops in her sample, which included, among others, bananas. The data set contains data on what the intercropped crop was, so this recalculation should be possible if it is deemed worthwhile.
8. slope index, integers 1, 2, 3, 4 and 5 representing different regimes from hilltop to valley and, hence, also serving as a proxy for erosion and perhaps fertility.
9. chemical fertilizer, kg/ha. Note: Although this is in the original data set, no reference is made to it in the analysis. It is likely that no farmers used it, so it is inactive. However, we need to check this out.
10. wage rate, FRw/hr for each of three communes. We need to look more closely to see if there is any potential in differentiating wages by region since BREWSTER recognizes that e.g., Cyeru-Butaro typically paid higher wages than other regions.

Rate variables. Collected once weekly over a 27-week period for season 87A, 25 August 86-22 February 87.

Labor, by field operation, by sex (m or f), by age (15-64; 10-15; 15>age>65) all in hours.

1. clearing
2. tilling 1
3. tilling 2
4. seeding
5. weeding 1
6. weeding 2
7. harvest
8. post harvest
9. compost (combined with staking labor in analysis)
10. staking poles

11.-20. Same as 1-10 except for outside labor exchanged, but not referenced by sex or age category.

21.-30. Same as 11-20 except for outside labor salaried, but not referenced by sex or age category.

Mayfield Study: Analysis.

Agro-ecological aspects. The primary rationale for the MAYFIELD extension of the original bean study is that, whereas BREWSTER developed a rich database on farmer resource use, there were important analyses that were not pursued. This became evident after BREWSTER's results were analyzed by MAYFIELD et al. Although BREWSTER demonstrated that there were significant differences in bean production variables (yield, labor use, compost use, returns, etc.) by commune location, bean type and degree of inter-cropping, it became readily apparent that high correlation between these three classifications may be concealing more fundamental agro-ecological impacts on bean production. For example, pole bean yields were significantly different from bush bean yields in the sample. However, the majority of pole beans in the sample were located in the Cyeru-Butaro commune, and most pole beans were pure-cropped as opposed to bush beans, which were for the most part intercropped. Hence, one important question is, how much of the yield difference can be separately attributed to type of bean, how much to the degree of inter-cropping, and how much to location?

An additional question is, what does the classification variable "commune location" serve as a proxy for? In her conclusions, BREWSTER suggests that more fundamental agro-ecological differences such as soil type and field slope differ from one commune to another. Two additional variables, field aspect and altitude, have subsequently been suggested by FSRP team scientists as potentially influencing crop productivity.

The extended MAYFIELD study, in collecting and analyzing additional data, will be more discriminating in separating out the effects these variables have on crop productivity and resource use. The Duncan Multiple Range Test will be used to test for significant differences in production variables by agro-ecological classification. More importantly, production response surfaces will be developed using multiple regression techniques to estimate the magnitude and sign of the relationship between yield, resource inputs and agro-ecological factors. This permits an assessment of marginal value productivity of each of the resources found to significantly contribute to crop productivity.

Socio-economic aspects. In addition to the collection of agro-ecological data described above, the MAYFIELD study will collect supplemental socio-economic data from the original sample of farms in the BREWSTER survey. This data will include measures of labor availability (family composition) and whole farm size of a subsample of farms not collected by BREWSTER. By collecting this additional data, sample size will be increased, thus permitting retesting of hypotheses relating to recommendation domain and variability of crop productivity and resource use by socio-economic classification.

Equally important, however, is the fact that new hypotheses will be tested based on a re-definition of the basic socio-economic classifications described by BREWSTER. BREWSTER found that the correlation among farm size, labor availability, hired labor and manure availability was, for the most part, low but highly significant. This led to the conclusion that farms in the four-commune area are largely uniform in their resource base and not highly stratified and lent weak support to the suggestion that recommendation domains could be clearly identified for the study area.

The MAYFIELD study will suggest that a more appropriate measure of socio-economic influence on crop productivity and resource use is labor availability and manure availability per unit area of farmland. Redefining these state variables of farmer resources into rate variables reflecting intensity of resource use on the most limiting resource--land--is hypothesized to more appropriately serve as a socio-economic classification scheme. Correlation analysis and contingency tables will be developed using the redefined classification variables. Subsequently, statistical analysis (DMRT and regression) will be used to test whether variability of crop productivity, resource use and returns is related to socio-economic characteristics based on the new hypotheses.

Results.

1. Documented survey report and database of traditional bean production from the study.
2. At least one technical report for submission to the FSRP report series.
3. A M.S. thesis with at least one copy sent back to FSRP documentation center/library.
4. At least one seminar in Rwanda regarding the study findings.
5. Trained enqueteurs in data collection of agro-ecological and socio-ecological survey data.

Appendix 3:
Longer-Term Study

Title: Farm-level investigation of the production and consumption systems of the Buberuka Highlands.

Principal Investigators: MUNYEMANA Augustin, Serigne NDIAYE

Collaborators: UNR faculty (NDINDABAHIZI Innocent) and students, U of A Faculty (PARSCH AND WAILES) and student (MAYFIELD), FSRP TEAM MEMBERS

Justification: Few micro-level studies exist that systematically describe and analyze the traditional production/consumption systems of farmers in the Buberuka Highlands. Knowledge of variation in yields, costs and returns of major crops produced under traditional systems is essential to evaluate consequences of and prospects for adaptive technologies. Variations in yields, costs and returns of major crops are influenced by agro-ecological and socio-economic variables. The degree of association among these variables is not well understood for the project area. Yet the design, acceptability and consequences of adaptive technologies will be dependent upon such knowledge. This study will provide a fundamental analysis of the variation in yields, costs and returns of traditional production systems and identify the effects of socio-economic and agro-ecological variables. Future market and policy studies will benefit from this study of fundamental relationships and documentation of micro-economic coefficients.

This is the most important investigation that the long-term socio-economists could undertake. This study will provide a data set that is not by the self-selection of farmers in the on-farm agronomic trials. To restrict the economic analysis to farmers who are cooperating in the agronomic, on-farm trials would be to miss the scientific requirement for unbiased, quality data. This study is clearly feasible based on the training and enthusiasm of the team and the availability of 10 enqueteurs. Details are not established here to provide the principal investigators the discretion and flexibility to design the study based on their expertise.

Objectives:

1. Determine the yield, costs and returns for major crops produced under traditional farm conditions in the project region for two continuous cropping seasons (1989 A and B).
2. Estimate the effect/association between yields, costs and returns with selected agro-ecological and socio-economic variables.
3. Develop enterprise budgets for major crops and crop associations, identifying input/output relationships, costs and returns.
4. Use estimated coefficients to evaluate impacts of new technologies on resource constraints and factor productivities.

Methodology:

1) Conduct a year-long survey of approximately 50 farmers selected from a stratified (by farm size and commune) random sample. Farms will be enumerated at least twice each week to collect data on all production (input and output) activities for all crops and non-farm activities. Data will also be collected on consumption of major household items. The BREWSTER study and methods discussed in Appendix 2 will serve as a prototype for this study.
2) Develop multiple regression models of yield response based on data collected from the survey.
3) Based on observed input and output relationships for distinctly different farming systems, estimate crop enterprise budgets (for crops in association as well) for major crops in the region.
4) Use partial budgeting, linear regression, sensitivity analysis and, ultimately, linear programming models to evaluate the impacts of new technologies.

Results:

1. A descriptive characterization of production and consumption activities of farmers in the Buberuka Highlands.
2. An identification of agro-ecological and socio-economic variables that give rise to distinctly different cropping systems in the Buberuka Highlands.
3. A set of enterprise budgets for major crops and cropping systems for the Buberuka Highlands.
4. A generalized framework for complete analysis of impacts of technology change on the production and consumption patterns of the Buberuka Highlands, ultimately including timely and accurate linear programming analyses of whole-farm impacts on resource use and farmer welfare.