ECONOMIC ANALYSIS OF NEW TECHNOLOGY IN THE BEAN AND CASSAVA FARM TRIALS OF CIAT

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Over the last three years, the role of the economists in the crop programs at CIAT has been the implementation and analysis of farm level testing of new technology. There are three basic stages of technology evaluation in the research process. These evaluations take place at the experiment station, in regional trials, and finally on farms (Figure 1).

The principal product of international centers is new varieties. Farm trials help identify the region specific performance of these varieties with different production practices in different farming systems. Can the farm trials be bypassed so that regional trials will then lead directly to diffusion by farmers as has occurred with irrigated rice and wheat? If this happens, the research center will have substantially reduced costs. If regional variety trials do <u>not</u> lead to diffusion, the assumption should first be made that the lack of diffusion results from a failure of the technology to be adequately tailored to the environment rather than a lack of information, a problem in public policy, or inadequacies in the extension service. If the economic evaluation of the technology in the farm trials indicates that the variety is adequate for farm level conditions, then the evaluation process of research has been completed. The research data and the variety pass on to the national organization for further testing or extension purposes. The objective of this paper is to define and illustrate the process of economic evaluation of new technology in the farm trials of CIAT.

The Economic Component in the Design and Evaluation of Farm Trials:

On the experiment station and in regional trials higher yields than the farmers' check generally indicate successful performance. Occasionally, economic analysis of experiment station or regional trials is done especially of traditional agronomic research such as the response to fertilizer or herbicide. However, in the production of new varieties the agronomic tool of the statistical significance of yield differences predominates in the first two stages of research evaluation (Figure 1).

The farm trials differ from traditional agronomic research as carried out at the experiment station and regional level in both design and evaluation. In design little effort is made to separate individual input effects. The basic research problem is the profitability of the synergistic effects of input complementarity rather than compartmentalizing yield increases into one input changes as in traditional agronomic research. Complete factorial trials may be carried out in which direct yield effect and interaction effects are measured, but plot size, the number of factors to be tested, and the different levels of factor use must be weighed in trial design. Moreover, the objective of the trials is not to resolve all the production problems of variety, inputs, density, and association. The more limited goal is to evaluate the farm level effect of new technology, which has been agronomically successful (higher yields than some proxy for farmers' practices) at the experiment station and/or regional trials. Secondly, a large number of trials are needed to evaluate the variance in treatment performance result

FIGURE 1

STAGES OF THE RESEARCH PROCESS

	I	II	III
TYPE OF PRODUCT	BASIC OR LESS SITE SPECIFIC RESEARCH	REGIONAL ADAPTATION: MORE SITE-SPECIFIC RESEARCH	FARM LEVEL ADAPTATION
LOCATION	EXPERIMENT STATION	REGIONAL EXPERIMENTAL SITES	FARMS IN TARGET AREAS
OUTPUT	PRODUCTION OF NEW GERMPLASM AND BASIC INFORMATION FOR FUTURE GERMPLASM PRODUCTION	SITE SPECIFIC WORK PRINCIPALLY ON ADAPTATION TO SPECIFIC CONDITIONS, FERTILIZER AND HERBICIDE RESPONSE	IS THE NEW TECHNOLOGY PROFITABLE, RISKY? DOES IT FIT INTO THE FARMERS' PRODUCTION SYSTEM? OTHER FARM LEVEL CONSTRAINTS?

INFORMATION FLOWS OF FARM LEVEL TESTING

FEEDBACK PRINCIPALLY TO THE VARIOUS SITES OF BEAN PROGRAM EXPERIMENTATION

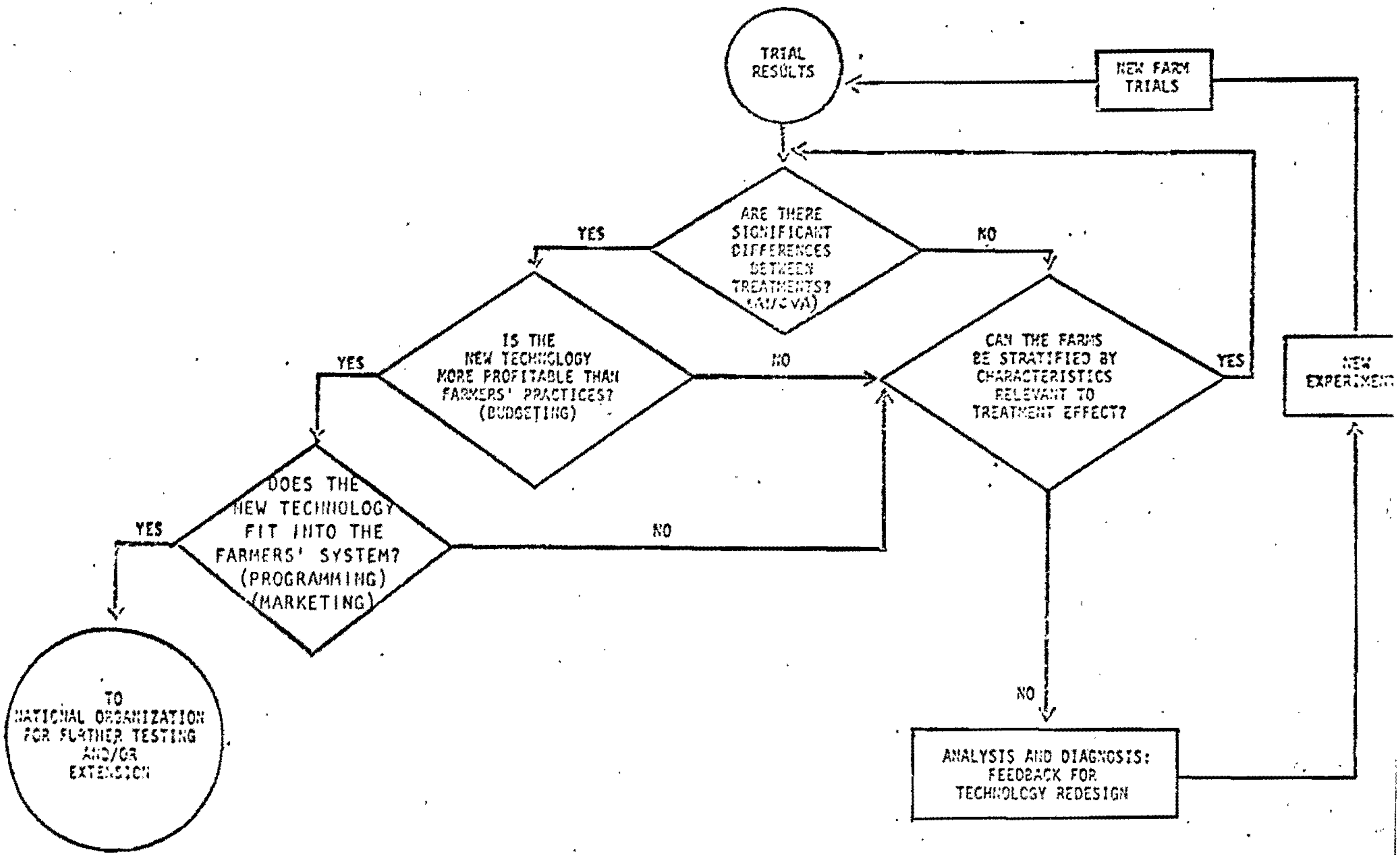
ON TO THE NATIONAL CENTERS AND EXTENSION SERVICES FOR FURTHER TESTING AND DIFFUSION ing from between farm differences. New technology may be profitable and fit on some farms and not others. It is important for future research production that the factors resulting in different treatment performances between farms be quantified. To pass the economic criteria of successful performance a new technology has to be profitable on farmers' fields, fit into the farmers' system of production (or be sufficiently profitable to change that system), and not inordinately increase risk.

A new technology has to pass through three stages of analysis in the evaluation of the farm trials (Figure 2). First, there is the traditional ANOVA analysis of the significance of the differences of treatment effects. One important qualification should be put on this analysis. There is nothing sacred about 5%, 1%, or 20% probability levels. The choice of probability levels should be determined by the costs of Type I or Type II errors and not by tradition. Statistical confidence levels on the quality of childrens' toys would be expected to be different from those on airplane parts or surgical instruments.

If the treatment effect is not significant, the farms are stratified. For example, a fertilizer response may occur on only those farms with very low initial fertility or a new variety may outyield the farmers' variety only under certain types of stress. The stratification can be done with *a priori* theoretical considerations or statistical searching devices, such as cluster analysis or multiple regression. Once the sample is stratified, the relevant sub-sample returns to the ANOVA test.

What are the sources of variation between farms within treatments, which need to be separated to analyze their impact upon technology performance? These are the location and management factors hypothesized to

FIGURE 2. FLOW CHART FOR FARM TRIAL ANALYSIS



influence the performance of a new technology:

1) Micro-climatic variation in rainfall and other weather factors;
2) Disease and insect incidence;
3) Soil differences, cropping history, and rotational patterns;
4) Management intensity (for example, quality and timeliness of weeding and spraying if this is not controlled in the farm trials).

Since there are many sources of variation from locational factors a large sample size is important. A minimum of 20 to 30 farms in each production region would be desirable for statistical analysis of the between farm differences.

Once significant treatment differences are obtained, the evaluation proceeds to profitability, riskiness, and the systems evaluation of the fit into the farmer's production system. This is traditional economic analysis applied to the ex ante decision of the viability of new technology. The trials are not demonstration trials or used for extension purposes. Nor is diffusion or actual adoption under study. The analysis uses basic economic theory to assess the ex ante issue of whether the technology will be adopted.

Although evaluation of farm trials focus on the farm system only single-crop technologies are tested in the trials. The fine tuning of cropping systems or whole farm systems is highly location specific and more the domain of national institutions. In the next two sections the results to date of testing CIAT bean and cassava technologies will be utilized to illustrate the information going back into research design and forward to the national organization.

Evaluation of Cassava Technology:

The cassava program at CIAT has followed a strategy of technology design based on minimum inputs, with improved varieties being the principal product. However, substantial yield increases over traditional practices have been obtained on the experiment station with improved agronomy. The basic agronomy package consists of the utilization of high quality planting material, an adequate plant population, and good weed control especially in the first two to three months of growth. The farm trials in a principal cassava production zone demonstrated a yield increase of 65 percent with the traditional variety utilizing improved agronomy over yields under current practices (Table 1). Improved agronomic practices do not require a large increase in input costs. However, the management input for clean stake identification is substantial. The information on the profitability of the improved agronomy was passed on to the national research organization.

Even though there were large yield advantages to the two varietal selections in regional yield trials, under farm conditions there was little difference with farmers' varieties under similar practices. There was a 40 - 60 percent price discount for these selections since they could only be sold on the industrial starch market. The quality characteristics, especially high starch content, put a large price premium for the fresh market sales.

Starch content not only varies between varieties but also is influenced by environmental factors and time in the ground. Many varieties have the characteristics of sharply declining starch levels as the optimum harvest time is passed. Farmers' varieties do not decline as rapidly in starch content over time (see Appendix A).

Why is the maintenance of starch content in the ground an important

Table 1 . Yield and Profitability of Improved Cassava Technology Tested in Farm Trials, Colombian Coast, 1977-78

Profitable New Technology

Location	Technological Practice	Income Increase (Pesos/Ha)	(%)	Increased costs of Inputs (Pesos/Ha)	Comments
ledia Luna, ،tlantic Coast	Agronomic Practices: Stake Selection Stake Treatment Plant Population Timely Weeding	11,750	65%	$ 155 a/	This package is dependent upon an intensive extension input, which substitut improved management for higher input use.

All New Technologies Tested in Media Luna

Technology	Yield (t/ha)	Profitable	Comments
'raditional Technology	7.4	Yes	Minimal purchased-input technology: low plant popu lations due to intercroppi with maize; germination pr blem due to inadequate sta storage.
mproved Agronomy with Local Variety: Seed Selection Seed Treatment Plant Population Timely Weeding	12.1	Yes	Higher plant populations greatly improved initial germination raise yields. Discarding maize may intro duce cash flow problem.
'arietal Selections:			Though giving a slight yi advantage, starch content lower resulting in a pric differential, which the yi advantage does not overcor
CMC 40	15.4	No	
M Col 22	13.7	No	
ertilizer			Not profitable and starch content was reduced by fertilization.
Local variety	13.1	No	
Varietal Selections:			Not profitable due to shar price discount from the lc starch content.
CMC 40	15.7	No	
M Col 22	17.5	No	

a/ Few or no cash inputs are utilized by these small scale farmers.

varietal characteristics of cassava? Two important characteristics of the cassava marketing system are the limited size of the fresh market and the highly perishable nature of cassava out of the ground. The farmer is usually precluded from selling his own cassava on the wholesale market, due to the requirement for volume sales, to the lack of his own transport facilities, and to the high risk that the wholesaler will not buy on a particular day, i.e. the possibility of a market glut. The farmer, therefore, relies on transport intermediaries, who act as assembly agents given the small size of most farm lots. The volume and timing of the farmer's harvest are restricted by access to the intermediary. The farmer usually markets his cassava by selling an unharvested lot to an intermediary. When the intermediary has made marketing arrangements with the wholesaler, he then schedules the harvest of various lots to fill a truck. The timing of the harvest is thus dependent upon the farmer's access to the intermediary and the intermediary's harvest.

Market supply regulation through the intermediary guarantees continuity of supply through the year and manageability of daily supplies with reduced risk of loss due to oversupply. Such supply regulation can be achieved at the farm level by staggered plantings. However, where optimal planting periods are defined by annual rainfall or temperature distribution, then storage in the ground after maturity becomes important. The rainfall distribution in the farm trial site is divided into a 7 to 8 month rainy season and a 4 to 5 month dry season. The optimum biological planting period is at the beginning of the rains. The cassava crop with the present cultivar in the farm trial site matures within eight months when planted at the start of the rains. The farmer can begin harvesting at the end of the rainy season and has four months till the start of the next planting season.

The observed marketing shows only 37 percent harvested for the fresh market at the optimal time and that the farmer is forced to sell 28 percent of his cassava on the lower priced starch market (Table 2). After the principal harvest season the farmer sells more of his cassava to the secondary market. In the linear programming solution without labor or marketing restrictions the farmer sells all his cassava to the fresh market in the optimal period. Apparently, farmers are constrained from selling on the fresh market when it is optimal. Moreover, the will take a high price discount by selling to the secondary market, in order to release their land for planting in the optimal season. In the LP model labor constraints during the optimal planting period or marketing constraints during the optimum harvest season will shift the planting into the secondary season.

What is the feedback to the breeders on the necessary variety characteristics? Yield increasing technology is necessary to increase incomes given the limited land resources of the farmers. Early maturity is useful to reduce marketing risk and take advantage of surplus labor for harvest in the slack labor season but optimal harvest period. Cultivars must be capable of being stored in the ground for long periods with little risk of yield loss or loss of quality in order to assure access to the fresh market. Resistance to root rot pathogens is important. Quality maintenance in the ground through the marketing season, particularly low fiber content and high starch content, is important.

The cassava farm trials have focused on an ex-ante analysis of factors that influence farmer adoption of new cassava technology. Given

Table 2. Observed Cassava Marketing in Media Luna, Colombia, 1978-79

Market Use	Percentage	Year	Planting Season			Optimum Harvest Season
			Optimum	Secondary		
			May - June	July - Sept	Oct - Nov	Dec-April
Fresh Market	72	First Year	-	-	-	37%
		Second Year	23%	7%	4%	1%
Starch Market	28%	First Year	-	-	-	-
		Second Year	10%	13%	3%	2%
Total Cassava Marketed	22.8 tons					

Source: Unpublished farm data from the Cassava Economics farm technology testing sample.

the principal role of improved varieties within the technology package, the trials have both attempted to measure varietal response under farm level conditions and identify varietal characteristics important within the farm production system. The trials thus aid in calibrating the varietal evaluation system and in defining breeding strategy. For fresh consumption markets minimum quality standards are essential and farm level profitability is determined by both yield and quality. The results of the farm trials on varietal starch content indicated a sharp decline of starch content under environmental stress and over time in the ground (see Appendix A). Definition of the market thus becomes an important component of the breeding strategies.

Evaluation of Bean Technology:

Southern Huila.-

Over a two year period with trials on 38 farms in southern Huila, the principal bean production zone in Colombia, bean yields were increased 31 to 50 percent with only improved agronomy practices. (CIAT, Annual Reports, 1978 and 1979). The basic agronomy practice included fertilizer on the low fertility soils; however, on 80 percent of the farms due to initially high fertility or previous rotation there was no physical response to fertilizer. With this *a priori* stratification by initial soil fertility, there was a statistically significant effect from the improved agronomy packages with and without fertilization. The new technologies were highly profitable and did not substantially increase input costs especially on the adequate fertility soils (Table 3).

Profitability and risk considerations are not sufficient if the tech-

Table 3. Return on Investment In New Technologies in Two Different Soil Fertility Conditions in Southern Huila, 1979-A

	Farmers Seed Improved Agronomy	
	No Soil Problem	Soil Problem
Increased net income ($\Delta Y.P$ - Increased Costs)[a] (pesos)	11,329	5,534
Increased Costs (pesos)	3,917	6,342[b]
Return on Additional Investment:		
$\frac{\text{Increased Net Income}}{\text{Increased Cost}}$	2.89	0.87

a. ΔY is the increased yields of the new technology compared with a sub-plot of the farmers' field.

P is the price received by farmers for the beans.

b. This improved agronomy on the low fertility soils also included fertilizer.

Source: CIAT, Annual Report, 1979, forthcoming, Cali, Colombia.

nology does not fit into the farmers' production system, there are more profitable alternatives, or the return on capital is so low that farmers' won't be interested. The introduction of new technology in Huila is compartmentalized into stages in Table 4. Moving to the right in the columns new technologies are individually introduced and the incremental income effects are shown. A 39 percent increase in income is obtained with the introduction of the high technology coffee activity. Huila is a marginal coffee area and new higher yielding coffee varieties have been introduced into Colombia. This innovation requires a substantial increase in capital and gives a low rate of return on capital (11%), the same rate of return as the new bean agronomy. If the bean agronomy is combined with new storage technology so that the post harvest price collapse is avoided, then income gains are substantially increased and a reasonably high return on capital is achieved, 33 to 69 percent. Similar results for medium size farms and for farms with soil fertility problems were obtained (Tables B-1 and B-2 in the Appendix)[1].

New bean agronomy plus storage technology and the utilization of policy instruments to increase capital availability and enable the farmer to delay his sale can result in a high rate of return on capital and substantial income increases in the Huila farming system. With this information a national program could develop a pilot project to promote new technology. Thus, the LP normative results provide an ex-ante estimate of the suggested complementary measures to introduce a new technology and the potential effect of this new technology upon income and input requirements.

1/ G. Arcia and John H. Sanders, "Ex-ante Analysis of New Bean Technology in Southern Huila", CIAT, Cali, Colombia, mimeo, February 1980.

Table B-2. Optimal Farm Plan with the Introduction of New Bean Technology in Southern Huila. Low Fertility Farms.

Item	Small Farm 1		Medium Farm	
	Restricted Credit	Unrestricted Credit	Restricted Credit	Unrestricted Credit
Gross Margin with Labor Sales (pesos)	142,284.0	142,855.0	(no farm labor sales)	
Gross Margin without Labor Sales (pesos)	132,684.0	133,105.0	221,941.0	300,922.0
Crop Area (ha)				
Low Technology Caturra Coffee				3.48
Old Coffee			2.0	
Sugarcane			4.37	
Beans, Better Agronomy and Storage				
First semester	1.94	2.0	2.64	3.83
Beans, Better Agronomy + Medium Fertilization + Storage				
First semester			1.21	0.27
Second semester	2.4	2.4	1.21	3.39
Pastures			5.36	8.2
Operating Expenses (pesos)	82,896.0	83,031.0	163,170.0	221,310.0
Borrowing (pesos)	20,000.0	20,000.0	90,000.0	90,000.0
Shadow Price of Capital	0.53	1.39	0.47	1.14

Table B-1. Incomes, Credit Requirements[a] and Returns from Various New Technologies on Medium Farms with Adequate Soil Fertility

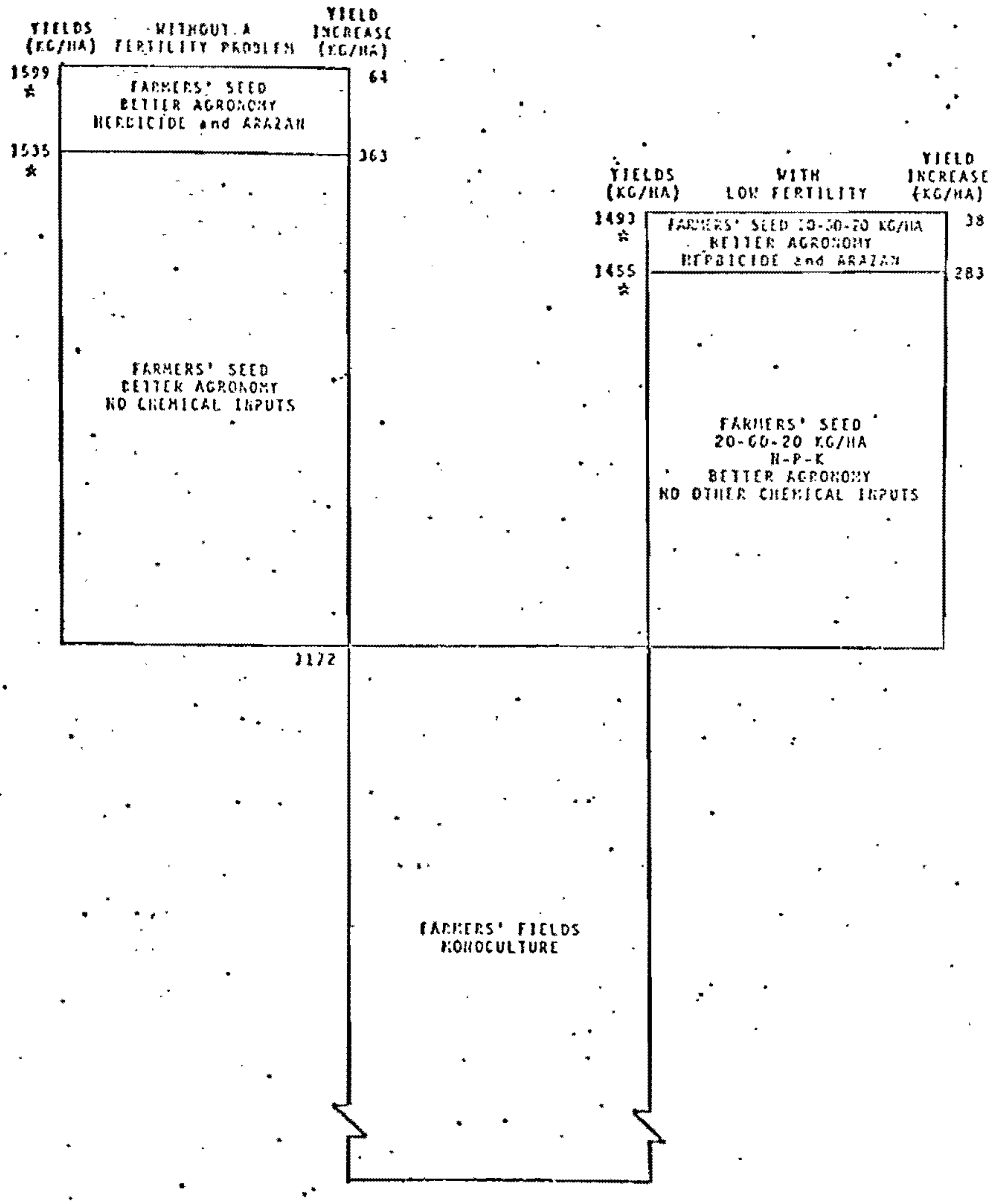
	Typical Farm (15.8 ha)	Area Expansion[b]	Introduction of High Technology Caturra plus Various Bean Technologies		
			Monoculture Beans -Improved Agronomy (MBIA)	MBIA plus 50% Storage	MBIA plus 100% Storage
Farm Income (Pesos)	182,380	248,780	264,527	288,684	332,566
Income Increase (%)	-	36	6	9	15
Capital Borrowing (Pesos)	41,323	75,000	90,000	90,000	90,000
Return on an Additional Unit of Capital	-	0.41	0.27	0.69	0.87

a/ With the present capital restrictions. Changing these restrictions to encourage specialization will give increased incomes and higher returns on capital.

b/ Includes a substantial expansion in the areas in low technology caturra coffee, sugarcane, and the corn-bean association.

Figure B-1. EFFECTS OF DIFFERENT FACTORS ON YIELDS IN THE FARM TRIALS.

HUILA, COLOMBIA, 1979-A



* Significantly different than farmers' yields at the 95 percent level.

and of the lack of response to fertilizer in 80 percent of the Huila tr
When combined with complementary policy measures such as credit and sto
in Huila, substantial income gains were possible with various types of
improved agronomy. The agronomical innovations varied substantially
between regions. The _ex-ante_ programming models indicated that profit
maximizing farmers knowing about these technologies would adopt them.

Too much emphasis is usually placed on the technical or agronomic
advantages of new agricultural technology, i.e. the yield comparison wi
farmers' practices. This paper extends the evaluation into the _ex ante_
economic analysis of profitability and the fit into the production and
marketing systems. Recommendations are principally for breeders in the
cassava program and to the national organization in the bean program.

Once ex-ante programming analysis has identified the viability of the new technology and its input requirements the next step is demonstra tion trials. Production evaluation has been finished for the Internati Center. Marketing or macro issues on the demand side may require more evaluation.

At what point do the International Centers stop their activities if the technology does not move onto farmers' fields? For the present the economic evaluation of new technology is a big job. If the technol successfully passing the technical and ex ante economic evaluation is n adopted by farmers, is it necessary to bring in other disciplines such sociology or anthropology or evaluate the efficiency of the next stages in the process, demonstration trials and extension recommendations?

Conclusions:

Since the cassava program had a principal emphasis upon improved selections in the farm trials more information was obtained for feedbac on future variety requirements. The selection between fresh and industrial starch markets will substantially influence the profitability of new variety due to the 40 to 50 percent price discount in the secondary market. Moreover, selection of high starch levels and starch maintenan under high stress levels of poor soils, irregular rainfall, and varying periods in the ground appear to be important criteria for future breedi selections.

In beans the farm trials concentrated on the evaluation of agrono practices. There was less feedback to the research designers except fo cautions on the consistent lack of response to all types of "cleaner" s systems of experiment station generated new technology. The feedback process seems to be functioning well in helping biological scientists specify future experimentation and variety specification so that the future research products will have a higher probability of farmer acceptance. There is also some technology successfully passing through the evaluation process. With the farm modeling some further specifications on instrument variables can also be made for the national organization.

Evolving Issues:

The CIAT cassava and bean programs have concentrated on producing finished varieties for release to national programs. To produce finished varieties a well defined conception of production and marketing constraints is necessary. CIAT thus relies on an information flow about target regions into the breeding program rather than a large scale selection under the stress conditions of the production zones. The *ex-ante* analysis of the farm trials evaluates the economic viability of the new technology and helps define the characteristics of the technology determining economic viability. These characteristics can be incorporated into the selection criteria of the breeding program[4]. Also, the *ex-ante* analysis identifies policy initiatives, which would improve farmer adoption. It can be extended to regional modeling to estimate input and output market equilibrium conditions.

4/ The *ex-ante* economic analysis is only part of the story. Much more information is necessary on the production and economic constraints in the target zones. The farm trials can not be done by CIAT in all the target regions so they principally provide feedback to CIAT and a methodology for other national organizations.

reduced traditional coffee area; however, area in the new variety high technology coffee was not reduced.

In both the Huila and Restrepo cases the normative modeling gave some preliminary estimates of the long run income effects and input requirements of the new technologies. Moreover, the impact of some complementary policy measures to facilitate the new technology introduction such as credit policy, were also specified. Some of the limitations of LP for short term planning are being resolved with a more complex objective function and estimated distributions of yields and prices utilizing QP programming.

Finally, the technologies, which are not successful, give an important input into research design for the national and international organizations. Research is being completed in micro-biology to find compatibility of the Rhizobium with the necessary fungicide application for root rots and to find compatibility of native and introduced Rhizobium. Consumer and producer requirements in new varieties have been better specified. Comparing the Huila and Restrepo farm trials herbicide apparently requires region specific adaptation trials before moving into farm trials. Improved seed has been overrated in bean production as over 100 farm trials in three locations over two years showed no yield effect from various types of improved seed[3].

The farm trials began as an evaluation device to verify the farm level effects, profitability, riskiness, and fit into present or potential

3/ For further detail see J. H. Sanders and John K. Lynam, "New Technology Production and Small Farmers: Some Experience with Beans and Cassava", CIAT, Cali, Colombia, mimeo, Sept. 1979, 43 pages and J. H. Sanders and J. K. Lynam, "Evaluation of Research Objectives in Commodity Programs: Beans and Cassava at CIAT", CIAT, Cali, Colombia, mimeo, July 1979, 19 pages.

Restrepo.-

With the expected decline in world coffee prices and the rapid diffusion of new high yielding coffee varieties, a concentration of Colombian coffee production in the prime coffee areas is expected. Hence, there is an increasing interest among Colombian public policy makers in diversifying marginal coffee regions. Good bean yield increases have been obtained with improved agronomy and with high fertilization levels[2] (Table 5). Neither improved seed nor herbicide demonstrated a physical response in the thirteen farm trials. The yield increases for the combined effect of reasonably high fertilizer and other improved agronomy practices were statistical significant and profitable. Input costs were substantially increased so increased capital availability would be necessary.

What is the effect upon farm income and input requirements of these potential technologies? Unlike the Huila case the technology adopted varied between farms by size. On the small farms little fertilizer was utilized. Nevertheless, the income increase and rate of return on capital were very high (Table 6). The extremely high rate of return on the small farm, 130 percent, appears to reflect the effect of a loosening of tight capital rationing as credit was expanded 51 percent to the small farmer in the model. The medium and larger farmers use more capital, expand more the bean area, obtain higher income increases, use more fertilizer-intensive technology, and have a lower rate of return on capital. In order to increase the area in the new technology bean activities all the farm sizes

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2/ With the high rainfall even in a marginal coffee region the initial soil fertility, especially phosphorus, was extremely low, hence there was an excellent physical and economic response to a fertilizer mix with a high percentage of phosphorus (10-30-10 of NPK).

Table 4. Incomes, Credit Requirements[a] and Returns from Various New Technologies on Small Farms

	Typical Farm (2.4 ha)	Introduction of High Technology Caturra Coffee	Introduction of High Technology Caturra plus Various Bean Technologies		
			Monoculture Beans -Improved Agronomy (MBIA)	MBIA plus 50% Storage	MBIA plus 100% storage
Farm Income (Pesos)	76,796	106,881	118,319	134,519	155,219
Income Increase (%)	-	39	11	14	15
Capital Borrowing (Pesos)	9,333	18,593	26,532	30,000	30,000
Return on an Additional Unit of Capital	-	0.11	0.11	0.33	0.69

a/ With the present capital restrictions. Changing these restrictions to encourage specialization will give increased incomes and higher returns on capital.

Source: G. Arcia and John H. Sanders, "Ex Ante Analysis of New Bean Technology in Southern Huila", CIAT, Cali, Colombia, mimeo, February, 1980.

Table 5. Yields, Profitability and Costs of Various

Bean[a] Technologies in Restrepo, 1978-B

	Yields	Net Income	Input Costs
	(kg/ha)	--- $/ha ---	
Farmers' fields	1,000 [a]	13,752	16,257
Farmers' seed - Improved Agronomy	1,341 [ab]	18,340	21,690
"Clean seed" - Improved Agronomy	1,254 [a]	13,280	24,340
"Clean seed"[b] - 50 kg P_2O_5 (167 kg/ha of 10-30-10)	1,547 [abc]	23,033	23,373
"Clean seed"[b] - 100 kg P_2O_5 (333 kg/ha of 10-30-10)	1,842 [bc]	30,157	25,103
"Clean seed"[b] - 100 kg P_2O_5 Herbicide	1,531 [abc]	21,757	24,173
"Clean seed"[b] - 150 kg P_2O_5 (500 kg/ha of 10-30-10)	1,942 [c]	31,420	26,840

a/ Diacol Calima was utilized in all the farm trials.

b/ All the following also utilize the improved agronomy practices of higher densities, micro-nutrients, and a more efficient chemical, Benlate. "Clean seed" refers to the seed production under irrigated conditions with rogueing.

The letters a,b,c, in the yield data, refer to the Duncan test for the significance of difference between the yields for the different treatments at the 95 percent level of probability.

Source: CIAT, Annual Report, 1979, Cali, Colombia.