A Suggested Method for Improving the Information Base for Establishing Priorities in Cassava Research

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PRIORITIES in applied agricultural research are frequently established on the basis of very limited information about existing problems and their relative economic importance in the production process. The communication between the farm sector and the research institute is often poor, and the demands at the farm level for problem-solving research frequently are not well known to the research manager.[1] Farmers in most developing countries, with the possible exception of large commercial farmers and members of efficient producer associations, have great difficulty communicating their needs to the research institutes because of institutional and social barriers. As a result, some research may be irrelevant to the actual farm problems and results may not be adopted.

Low rates of adoption of a new technology are frequently blamed on ineffective extension services. Although they may be partly at fault, certainly one of the main reasons for the low adoption rate is that new technology does not always meet the most urgent on-farm needs and farmer preferences. A continuous flow of information to the research manager on the potential gains in production, productivity, and risks in various research activities (e.g. developing resistance to diseases and insects, changing cultural practices, changing plant types, changing plant response to nutrients, etc.) will help ensure that new technology corresponds with the farmers' needs and preferences. This, in turn, will accelerate adoption and increase research payoff.[2]

Such an information flow may consist of a continuous feedback of information from the farmer through the extension service to the research institutions. Direct contact between researchers and farmers through meetings, farm visits, etc., would also be effective. To complement these we are suggesting a third method. This method combines agroeconomic analyses and agrobiological experiments.

This paper presents the methodology used to carry out the agroeconomic analysis and discusses the experience gained from the empirical testing of the methodology for cassava in Colombia with illustrations of the kind of information obtained.

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[1] The term "research manager" is used to indicate the person or group of persons making the decision on research priorities. Depending on the research organization and the level in the research process at which priorities need to be established, the research manager may be the individual scientist, a team of scientists, a research director, or any other person or group of persons in the research system.

[2] Other aspects of resource allocation in agricultural research are discussed in: Pinstrup-Andersen, Per. Allocation of Resources in Applied Agricultural Research in Latin America — Preliminary Approach. Paper prepared for the Regional Seminar on Socioeconomic Aspects of Agricultural Research, IICA, Maracay, Venezuela, April 10-13, 1973.

Pinstrup-Andersen, Per. Toward a Workable management Tool for Resource Allocation in Applied Agricultural Research in Developing Countries. Revised version of paper presented at the Ford Foundation Meeting for Program Advisors in Agriculture, Ibadan, Nigeria, April 29-May 4, 1974.

Pinstrup-Andersen, Per and David Franklin. A Systems Approach to Agricultural Research Resource Allocation in Developing Countries. Paper presented at Conference on Resource Allocation and Productivity in International Agricultural Research, Airlie House, Virginia, January 26-29, 1975.

Agroeconomic Analysis

The agroeconomic analysis attempts to transmit to the research manager the farm level demand for applied agricultural research through the establishment of a direct link between the farm and the research institute. The analysis focusses on four principal aspects: 1) describing the production process, 2) identifying factors limiting production and productivity, 3) estimating the relative importance of each of these factors, and 4) obtaining indications of the technology characteristics preferred by the farmer.

In addition to serving the needs of research managers, the information generated by the agroeconomic analyses is expected to be useful for establishing or reviewing public policy on such issues as agricultural extension, credit, and prices (Fig. 1). Finally, the information may be useful to producer associations and individual farmers. However, the primary purpose of the surveys is to supply information for establishing research priorities.

The basic framework underlying the choice of data to be collected is shown in Fig. 2. Attempts are made to describe certain key aspects of the structure, conduct and performance of the production process, the farmer objectives, and the

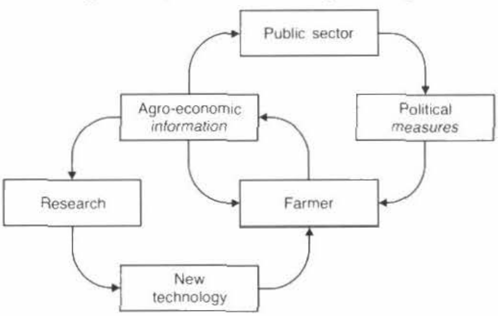

Fig. 1. The expected utility of the agroeconomic study.

interaction among these factors. Emphasis is placed on identifying the principal factors limiting production and productivity and estimating the implications of removing these factors.

Process Structure

The structure of the production process refers to the process characteristics determined by

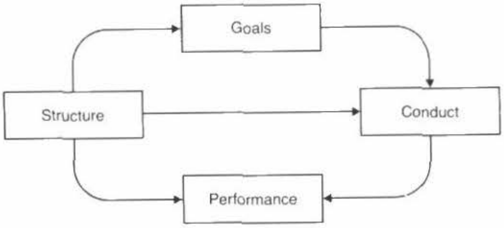

Fig. 2. Basic model underlying choice of data to be collected.

factors external to the process itself. The structure represents the constraints within which the process operates. Some of the constraints may be modified or removed by the farmer while others are beyond his control. Figure 3

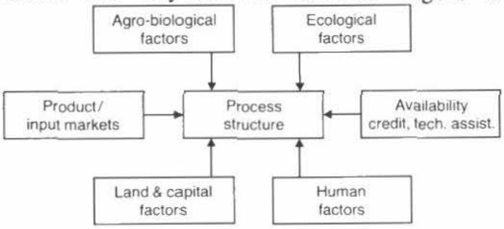

Fig. 3. Factors determining the structure of the production process.

illustrates the structural factors described by the agroeconomic surveys. Given the purpose of the survey, major emphasis is placed on agrobiological and ecological factors.

Most of the data related to the agrobiological factors are obtained from direct observation in the farmers' fields. The occurrence and severity of disease and insect damage, mineral deficiencies, and weed occurrence are noted. Furthermore, altitude, soil quality (by means of soil tests), availability of water, plant type, and general plant development are described. The farmer's perception of the agrobiological problems is compared to the field observations. In addition, data are obtained from the farmers on product and input prices and their fluctuations; availability of commercial inputs, labour, credit, and technical assistance; land tenure, farm size, capital, and certain characteristics of the farmer and his family.

Process Conduct

The conduct describes the action resulting from the farmer's decisions with respect to the production process. Data are obtained on 1) use of the land controlled by the farmer; 2) crops found in the production process studied; 3) planting, cultural, and harvesting practices; 4) use of inputs such as fertilizers and insecticides as well as credit and technical assistance; and 5) the utilization of the products produced by the process studied (Fig. 4). Emphasis is placed on

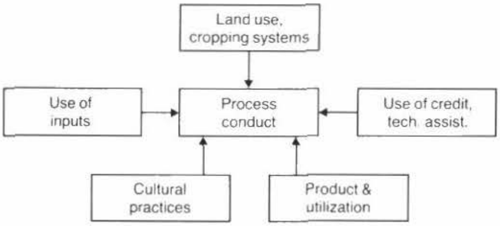

Fig. 4. Factors expressing the conduct of the production process.

analyzing the relationship between structure and objectives on the one hand and conduct on the other, to determine the major production limiting factors.

Process Performance

The performance measures the outcomes or results of the production process in terms of established goals. The analysis obtains data on yields, production, costs, labour absorption,

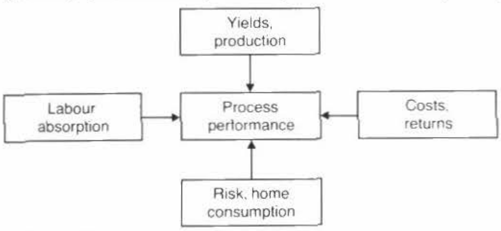

Fig. 5. Factors expressing the performance of the production process.

home consumption, yield variation (risk), and gross and net revenues (Fig. 5).

Farmers' Objectives

Attempts are made to describe the farmer's goals and the relative importance of incomes, cash flow, risk, and availability of products for home consumption in his objective function to help identify technology with expected high rate of adoption. This work includes the collection of data on reasons why various types of new technology were or were not adopted and factors underlying the choice of cropping systems.

Data-Gathering Mechanism

Primary data are obtained by a small specialized team of agronomists and economists, from a panel of farms expected to be representative of the farms for which agrobiological research is intended. The field team makes periodic visits (normally three or four) to each farm during a complete crop cycle. About half of the time on the farm is spent in the field collecting data on agrobiological issues (by direct observation), while the other half is used to interview the farmer.

Before the farm visits are initiated the field team receives extensive training in diagnosing farm-level production problems. Training of the field team is one of the most critical issues in assuring high quality data from the agroeconomic survey. Making a correct diagnosis in the field (e.g. distinguishing among the symptoms of certain diseases, insect damage, mineral deficiencies, etc.) in most cases requires considerable expertise. Hence, direct participation of a highly qualified multidisciplinary research team in the training and field execution phases is essential to the success of the survey. The field teams working on the ongoing CIAT agroeconomic surveys have received 3-4 months of such presurvey training in direct contact with the scientists from the relevant disciplines.

Agrobiological Experiments

The agroeconomic analysis provides an estimate of the area affected by each of the problems identified. Furthermore, it gives an indication of the yield-depressing effect. However, it is frequently difficult to accurately estimate the yield impact from survey data, so controlled experiments are carried out to help quantify the impact of the problems on yield.

Data Analysis

The data obtained from the agroeconomic survey and the related experiments are analyzed for the general purpose of 1) describing the structure, conduct, and performance of the production process under study, and 2) estimating the impact of changing process structure and conduct on performance. In addition to aggregating the data to present a description of the process, attempts are made to estimate the economic loss caused by each of the agrobiological and ecological factors. These include diseases, insects, weeds, soil deficiencies, and adverse rainfall conditions and the implications of changing these factors. Furthermore, estimation is made of 1) production costs and labour absorption by production activity, 2) net returns to the process for each of the principal cropping systems, 3) the contribution of each of the principal resources to net returns, and 4) the factors influencing the farmer decision-making on adoption of new technology and choice of cropping system.

On the basis of the data from the agroeconomic analysis attempts are made to estimate relative benefit/cost relationships for alternative lines of research. The estimates are difficult to make with any degree of confidence.

Illustration of Empirical Results

Projects are currently under way in Colombia to field test the above methodology for maize, cassava, and beans. While the information obtained from these empirical studies is expected to be useful to Colombian national institutions and CIAT, the primary purpose of the work is to develop and test a simple methodology for use by national research agencies in Latin America and elsewhere. The purpose of this section is to present preliminary results from the agroeconomic analysis of cassava production in Colombia to illustrate the kind of information obtained. The data collection is not yet completed, hence, only limited analysis has been done.

The agroeconomic analysis of the cassava production process in Colombia is based on the collection of primary data from personal visits to approximately 300 cassava producers located in five regions of Colombia (Fig. 6). Each farm is visited three times during the growing season by a team of two agronomists and an agricultural economist previously trained in identifying agrobiological problems in cassava and carrying out farm interviews. The growing season for cassava in Colombia is around 12 months except in one zone (North Coast Region) where it is 8-10 months. The first visit is made less than 4 months after planting and the last right after harvest.

The selection of zones was based on their contribution to the total national cassava production and their ability to represent the characteristics of the various cassava-producing regions of the country.

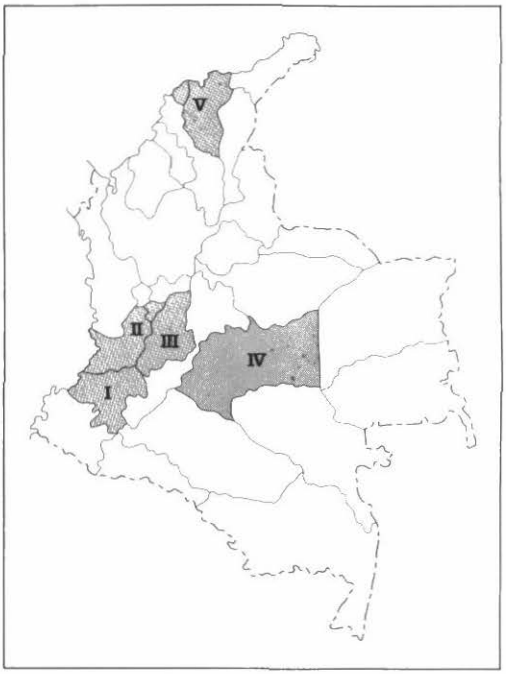

Fig. 6. Locations of the five zones included in the agroeconomic analysis of cassava production in Colombia.

Table 1 shows the altitude, farm size, and land use characteristics of the sample farms. The altitude of the farms varies from over 1000 m in zones I and II to almost sea level in zone V. A large portion of the land is idle or in pasture, hence the cultivated area per farm is small. Although a few of the farms had large cassava plantations, the average was about 5 ha. The farms visited had, on the average, two fields with cassava. The importance of other crops on the sample farms varied with location. Coffee and plantain, in most cases intercropped, were the most important crops in zones I, II, and III, and sugar cane, maize, and banana were important in certain zones.

Table 2 shows the most common cropping systems used on the sample farms, and field size and plant population for each system. More than 14 different crop combinations were identified on the first visit. Over 50% of the farmers grew cassava alone while about 25% grew cassava intercropped with maize. About 60% of the area was planted with cassava alone. Although field size varied greatly with cropping

TABLE 1. Altitude, farm size and land use on sample farms.

	Zone					Simple average
	I	II	III	IV	V	
Altitude of farm (*m*)	1254	1187	886	396	33	761
Total farm size (*ha*)	7.2	37.5	16.5	61.3	18.0	25.9
Area in crops (*ha*)	3.5	18.3	4.7	10.9	8.4	9.9
Area in cassava (*ha*)	2.9	6.4	2.0	9.4	5.3	5.2
Area in pasture and unused land (*ha*)	3.7	19.2	11.8	50.4	9.6	16.0
Number of cassava lots/farm	2.16	1.91	2.16	1.98	1.59	1.96
Size of cassava lot observed (*ha*)	1.30	3.35	0.90	3.37	2.16	2.22
Crops other than cassava (*% of farms*)						
Coffee	32.4	61.4	31.6	10.0	0.0	28.7
Plantain	18.9	54.5	5.3	10.0	4.5	22.0
Maize	2.7	11.4	15.8	15.0	4.5	8.5
Sugar cane	5.4	0.0	26.3	0.0	0.0	4.3
Banana	2.7	0.0	0.0	0.0	6.8	2.4
Other crops	0.0	9.1	5.3	10.0	18.2	9.1

system, additional data analysis is needed to determine the possible relationship between these two variables.

The plant population of cassava was similar whether grown alone or intercropped. However, when grown with two or more crops, the cassava plant population diminishes. A comparative economic analysis of various cropping systems for cassava, including the factors determining the farmer's choice of system, has been initiated.

The occurrence of insects, insect damage, and diseases in cassava was estimated on the basis of direct field observations. The final results from the first visit and preliminary results from the second and third visits are shown in Tables 3-6.

Thrips was the insect most frequently found, followed by gall midge and white fly (*Bemisia* sp, Table 3). It appears that the occurrence of these insects and the visible damage they cause is less frequent in crops more than 8 months old. This is not the case, however, for other insects including white fly and mites. One explanation is that the crop in many cases outgrows the visual damage caused by the initial attacks. However, data are not yet available to determine whether the attacks had any significant impact on yields.

The occurrence of each of the major insects varies considerably between zones (Table 4). For example, fruit fly (in stems) was found on 76% of the farms in zone II while it was of little importance in the other zones. Leaf hopper was important only in zone V and white fly (*Bemisia*) was found on 70% of the farms in Cauca, Magdalena, and Atlantico (zones I and V) and much less important in the other three zones.

The visible damage caused by diseases in cassava was most pronounced between 4 and 8 months. The diseases most frequently found were white leaf spot, *Phoma* leaf spot, brown leaf spot, powdery mildew, and *Cercospora* leaf blight (Table 5). As in the case of insects, it appears that the cassava plant in some cases is capable of outgrowing the disease symptoms. However, for most diseases the proportion of the field affected increases with the age of the

TABLE 2. Cropping systems, lot sizes, and plant population.

Cropping system	Percent of farms	Lot size (*ha*)	Percent of area	Plant population (No. of plants/ha) Cassava	2nd crop	3rd crop
Cassava alone	60.0	2.5	69.3	9811	–	–
Cassava – Maize	24.5	1.4	15.8	9421	5578	
Cassava – Plantain	4.1	3.6	6.8	12172	574	–
Cassava – Beans	3.4	2.7	4.2	9455	2127	–
Cassava – Maize – Beans	2.2	0.6	0.6	8988	5113	7813
Cassava – Maize – Plantain	1.3	2.0	1.2	7617	3583	833
Cassava – Maize – Sesame	1.0	0.6	0.3	7333	4133	4283
Cassava with other crops	2.3	1.7	1.8	7386	–	–

TABLE 3. Preliminary data on insect occurrence in cassava.

Insect	First visit (305 farms)			Second visit (248 farms)			Third visit (162 farms)		
	% of farms	% of lot	Intensity[a]	% of farms	% of lot	Intensity	% of farms	% of lot	Intensity
Thrips	80	81	2	84	42	2	46	42	2
Gall midge	51	22	2	54	16	1	21	18	1
White fly (*Bemisia*)	44	27	2	41	37	2	21	15	2
Shoot fly	17	25	3	16	16	2	1	10	1
Leaf cutter ants	14	35	4	12	14	2	10	25	1
Leaf hoppers	13	16	2	4	16	2	0	–	
Fruit fly (in stems)	12	26	2	24	37	2	9	37	1
Horn worm	7	18	2	2	21	2	2	12	1
White fly	6	12	2	16	23	1	19	45	2
Chrysome lids	4	12	1	4	15	2	0	–	–
Tingids	4	23	2	8	19	2	4	16	1
Mites	2	4	2	25	41	2	27	60	3
Termites	1	37	2	0	–	–	2	28	1
Ants	1	10	2	2	14	1	0		–
Cutworms	1	45	1	0	–	–	0	–	–
Stemborers (lepidopterous)	1	15	1	0	30	2	0	–	–
Scale insects	–	–	–	0	–	–	1	35	2
Stemborers (coleopterous)	–	–	–	0	–	–	1	5	1

a Intensity of attack using scale of 1–4 with 1 being low and 4 high.

crop. One possible conclusion might be that while lighter attacks tend to be overcome by plant growth, the somewhat more serious attacks continue to spread in the field. The relationship between rainfall conditions and disease spread will be analyzed as more data are collected.

The occurrence of cassava disease also varies greatly between zones. *Phoma* leaf spot, the disease most frequently found during the second visit (in plantations 4-8 months old), was found on about 70% of the farms in Cauca, Valle, and Quindio (zones I and II) and only 30-40% of the farms in the other three zones (Table 6). Superelongation, while important in four zones, was found on two-thirds of the farms in Tolima (zone III). Likewise, the occurrence of cassava bacterial blight and white leaf spot differed greatly between zones.

TABLE 4. Distribution of major insect occurrence among zones, second visit (preliminary data from 248 farms, in % of farms).

Insect	Zone				
	I	II	III	IV	V
Thrips	61	89	100	100	83
Gall midge	25	46	68	68	85
White fly (*Bemisia* sp.)	70	10	24	26	71
Shoot fly	8	32	5	38	0
Leaf cutter ants	20	6	32	21	2
Leaf hoppers	2	2	0	0	15
Fruit fly (in stems)	7	76	3	6	8
Horn worm	0	2	0	0	10
White fly	46	5	16	0	4
Chrysome lids	5	6	0	0	6
Tingids	15	3	13	12	0
Mites	7	8	38	15	44

During the first visits, 92 weeds were identified. Table 7 shows the ten most common weeds. *Pteridium candatum* was found on 25% of the sample farms but the plant density was relatively low. It was most frequently found in zone III (79% of all farms), but not in zone V.

Other agrobiological problems in cassava production assessed by the field team include water supply. Excess water was a severe problem in Valle and Quindio (zone II) while water scarcity reduced yields in Magdalena and Atlantico (zone V).

Once the data collection is completed, attempts will be made to estimate the relative economic loss caused by each of the major insects, diseases, weeds, and other agrobiological problems, in collaboration with the respective biological scientists within the cassava pro-

TABLE 5. Preliminary data on disease occurrence in cassava.

	First visit (305 farms)			Second visit (248 farms)			Third visit (162 farms)		
Disease	% of farms	% of lot	Intensity[a]	% of farms	% of lot	Intensity	% of farms	% of lot	Intensity
Brown leaf spot	34	22	2	54	33	2	35	36	2
White leaf spot	28	33	2	59	41	2	36	54	2
Cassava ash disease	19	40	2	43	42	2	20	57	2
Cercospora leaf blight	15	17	2	23	26	1	7	40	1
Phoma leaf spot	15	20	2	54	33	2	43	36	2
Superelongation	6	23	3	12	45	4	1	48	2
Cassava bacterial blight	5	27	2	13	38	3	9	45	3
Root rotting	1	43	3	1	15	3	–	–	–
Leaf sooty mold	1	10	1	2	42	3	2	27	1
Frog skin – root disease	–	–	–	–	–	–	4	–	–

a Intensity of attack using a scale of 1–4 with 1 low and 4 high.

gram.[3] Such estimates are expected to be useful to the cassava program in establishing and reviewing priorities among and within disciplines.

The distribution of production costs and labour requirements among production activities is another factor likely to provide guidelines for research resource allocation. Table 8 shows the estimated labour requirements by production activity and the percentage distribution of labour requirements and available costs.[4] Weeding was the most labour-consuming activity (and accounted for the highest percentage of variable costs), followed by harvesting/packing, land preparation, and planting.

The data reported in Table 8 suggest that high priority might be placed on improving the efficiency of weeding, harvesting/planting, and land preparation, e.g. estimating the impact of alternative degrees of land preparation and weeding on yields and economic net return, and the impact of alternative methods applied in these activities and harvesting/packing.

The potential impact of the development and adoption of mechanical, chemical, and biological technology on labour use in cassava production was estimated for various adoption rates. Extensive mechanization and/or herbicide use was assumed to have a significant negative impact on labour demand, while biological technology is expected to increase labour demand slightly.[5] The impact of the various types of technology on costs would depend on existing relative prices, hence may differ between localities.

Before such data are used to help establish research priorities, the objectives of the society

TABLE 6. Distribution of major disease occurrence on second visit to 248 farms (in % of farms).

	Zone				
Disease	I	II	III	IV	V
Brown leaf spot	28	32	79	68	83
White leaf spot	71	95	28	9	54
Cassava ash disease	43	57	84	15	10
Cercospora leaf blight	39	8	40	18	14
Phoma leaf spot	72	71	34	32	42
Superelongation	2	0	66	9	0
Cassava bacterial blight	2	0	11	24	37
Root rotting	2	3	0	0	0

[3]The data collection extends over a 2-year period to cover two complete growing seasons and most of the data analysis cannot be performed until a complete data set is obtained in mid 1975.

[4]Since the data collection within the agroeconomic survey is not sufficiently advanced to provide estimates of labour and cost distribution, the data presented in Table 8 are taken from prior work (Rafael O. Díaz, Per Pinstrup-Andersen, and Rubén Dario Estrada. *Costs and Use of Inputs in Cassava Production in Colombia: A Brief Description*. CIAT, EE-No.5, September 1974).

[5]The quantitative results of the analysis are reported in Per Pinstrup-Andersen and Rafael O. Díaz. *Present and Potential Labor Use in Cassava Production in Colombia*. Paper presented at the third International Symposium on Tropical Root Crops, Ibadan, Nigeria, 2-9 December, 1973.

TABLE 7. The ten most important weeds in cassava in terms of proportion of sample farms where they occurred (first visit).

Weed	% of farms	Weed density (plants/ha)
Pteridium caudatum	24	78,000
Sida acuta	18	90,000
Commelina difusa	17	136,000
Bidenes pilosa	16	102,000
Melinis minutiflora	14	134,000
Portulaca oleracea	12	168,000
Cyperus ferax	10	148,000
Rychardia scabra	10	84,000
Cyperus rotundus	10	188,000
Drymaria cordata	9	234,000

for which the research is intended must be clearly defined. Social and private objectives may conflict (e.g. the social objective of creating productive employment may conflict with private objectives of maximizing profits). Chemical weed control, for example, may increase net returns to the producer but reduce employment. The impact of new technology on net returns depends, at least in part, on relative factor prices, which in turn may be influenced by public policy. It is important that possible conflicts between social and private objectives, as well as government's ability and desire to introduce corrective and facilitating policy measures, be fully understood before research priorities are established. This will help ensure that the research significantly contributes to social and economic development goals.

The agroeconomic survey also seeks information on a number of other issues expected to be useful for the cassava program in allocating its research resources.

Training Benefits

This work also provides a valuable training opportunity for young agronomists and economists interested in production. The extensive initial training along with the experience gained while carrying out the surveys produce professionals knowledgeable of farm-level production limitations and the possible ways to remove these limitations. These professionals in their future activities will hopefully provide a close link between research and farm-level problems.

Conclusions

A very large number of farm surveys have been carried out in the past, so our survey is not entirely unique. However, certain aspects of the work tend to distinguish it from traditional farm surveys and will hopefully make it more useful for establishing priorities in applied agricultural research. These aspects are: 1) a considerable proportion of the data are obtained from direct field observations made by agronomists previously trained for this job; 2) each farm is visited periodically during a complete growing season; 3) the work is multidisciplinary in nature and involves direct participation by professionals from all the relevant disciplines; and 4) The work is specifically focussed on providing information needed to establish research priorities. Although the information may be useful for other purposes, such utility is considered secondary.

TABLE 8. Distribution of labour requirements and variable costs among cassava production activities in Colombia.

	Labour requirements				
	Mechanical land preparation Man-days/ha	%	Manual land preparation Man-days/ha	%	Variable costs (%)
Land preparation	–	–	25.0	23.6	23
Planting	9.1	10.4	10.8	10.2	8
Replanting	0.3	0.3	0.6	0.6	1
Weeding	46.8	53.4	43.7	41.2	36
Fertilizers and application	0.5	0.6	0.3	0.3	1
Insecticides and application	0.3	0.3	0.6	0.6	1
Harvesting and packing	30.7	35.0	24.9	23.5	24
Seed	–	–	–	–	6

[a] Source: Rafael O. Diaz, Per Pinstrup-Andersen and Rubén Dario Estrada. *Costs and use of inputs in cassava production in Colombia: a brief description.* CIAT, Series EE No. 5 September 1974.

It is too early to evaluate the contribution of the above work to research resource allocation. However, the direct participation of the CIAT agricultural production scientists in project planning and training of field agronomists, and the preliminary project findings, have been of some value to the scientists in planning their future research.

The methodology and experience gained from the work will be made available to interested national research agencies upon request. Furthermore, CIAT will consider requests for technical assistance for projects of this type. Currently, a collaborative project with INIAP, Ecuador, for cassava is being planned. The possibility of carrying out projects for cassava in Brazil and Thailand are being discussed, and funds have been assured to provide technical assistance for two similar projects for beans in Latin America.

Cultivars which perform well in the regional trials are then distributed to selected farmers for commercial scale evaluation.