CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
Program of Bovines and Small Species

PROJECT

MILK AND BEEF PRODUCTION SYSTEMS FOR THE SMALL FARMERS USING CROP DERIVATIVES

1977 PROGRESS REPORT

Due acknowledgment is granted to the INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

Revised version
July, 1978
Turrialba, Costa Rica

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TABLES AND FIGURES

I. INTRODUCTION

On December 17, 1976, a grant by the International Development Research Centre (IDRC) was given to CATIE, in order to develop integrated crop-livestock production systems appropriate to small and medium-sized farms in Central America. As required by the Agreement between IDRC and CATIE, periodic financial and progress reports have to be submitted to the proper authorities of both institutions, as a condition for receiving each grant installment.

The present document is the first progress report submitted to IDRC, and is characterized by an in-depth description of methodology, preliminary achievements and projection. The decision to proceed in this manner was prompted by the necessity of having a reference document for all concerned with the development of the Project, and a growing interest among research and planning professionals elsewhere, to know the philosophical bases and procedures developed for the present Project. With this in view, various staff members of IDRC were consulted on the possibility of distributing copies of this report to related projects in Panama, Costa Rica, and the Dominican Republic. This appears to be feasible as long as due acknowledgment is given to IDRC.

Future reports will not be as elaborate as the present one, restricting themselves to an account of the progress in biological and actual farm-situation research, in addition to the financial statement.

It remains to state that the first year of work of this Project has been characterized by a consolidation of methodology, team-work organization, acquisition of groundwork knowledge and the creation of a high expentancy and an enthusiastic spirit among all involved with the Project. These features will probably be apparent throughout the contents of this Report.

II. CONCEPTUAL FRAMEWORK

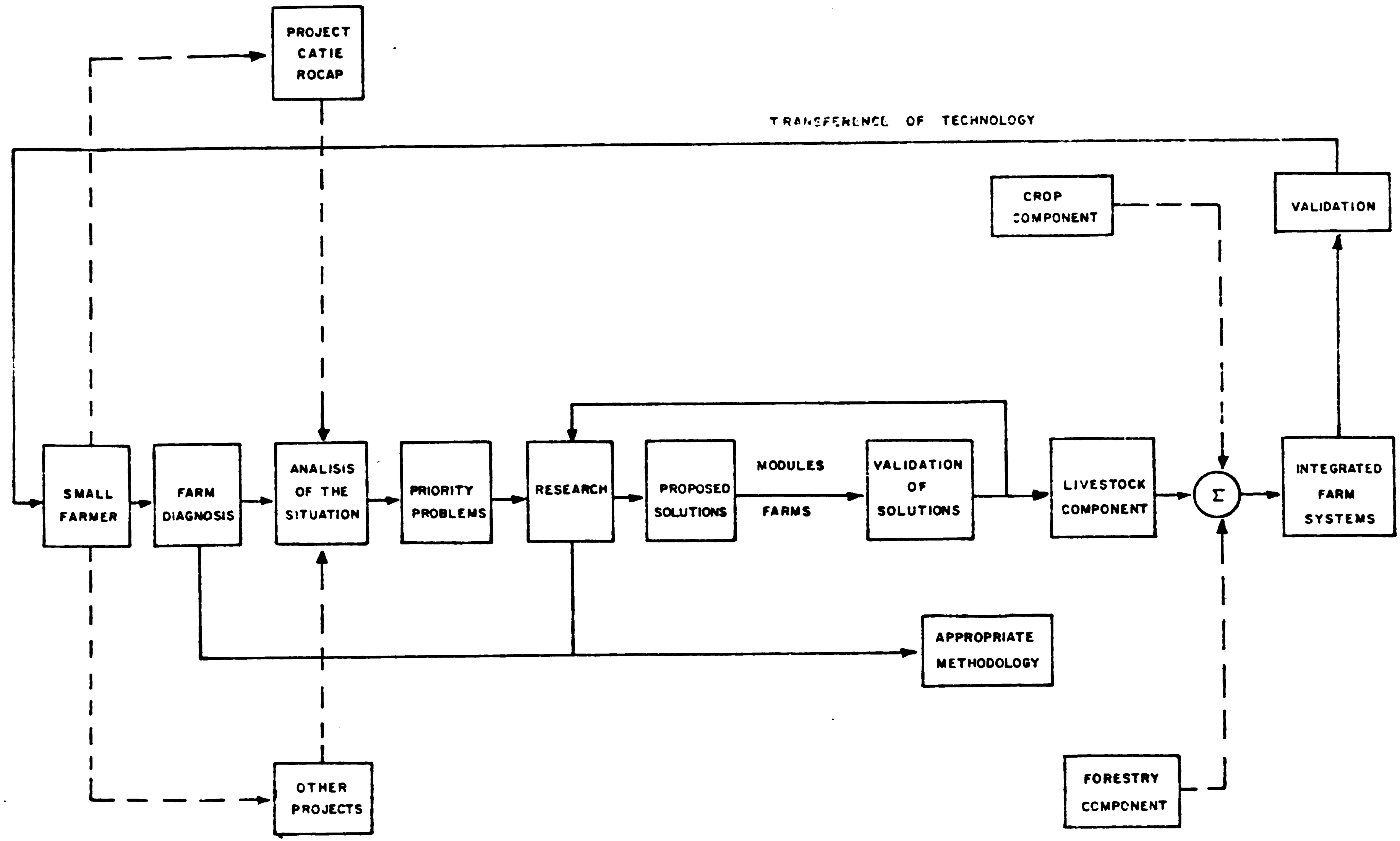
In order to properly plan the Project activities and to provide a general reference framework for the staff of the present Project and related projects, a scheme was developed (Fig. 1) to show the principal components which will be the focus of this study. The scheme represents the project in all its various aspects, showing a step-wise procedure and expected feed-back links. The basis and final goal of the Project is the small farms where there is a livestock component, as well as a crop component, as is usually the case in reality. Despite the fact that there exists much worldwide interest in helping out the small farmer, not much is known about the reasons or circumstances that force him to act in a variety of ways to exploit his land. The Project will produce a significant amount of information on the production systems prevalent in small farms with a livestock component. The information will be of a descriptive (both qualitative and quantitative) and dynamic nature (i.e., the changes that occur throughout the year and their causes).

The diagnosis will not only serve to identify the basis and final target of this Project, but it will also be of capital importance in determining the nature, scope and, therefore, the specific aspects of the research program. This latter derivation will result from a proper analysis of the farm situation and the identification of primary problems. The solutions to these problems will have to be provided by the research activities.

Research will result in a number of possible solutions to farm management problems. Some of these solutions will be screened out by testing them at the module, or modules, created by the Project Personnel, or at collaborating farms. Those solutions that prove to be viable due to their simplicity and low cost, which increases the probability of their acceptance, will then be considered validated. A set of interrelated solutions could then be integrated in sub-systems within the livestock system. If other non-nutritional information is derived from other sources (especially from the basic research program carried out by CATIE's Program on Bovines and Small Species) it is feasible to develop complete milk and/or beef production systems.

As established throughout the Project, the animal production systems to be developed will have the particular characteristic of being based on the utilization

Fig. I THE PROJECT'S CONCEPTUAL FRAMEWORK



of crops and/or crop residues commonly found on small farms. This implies close interactions with the agronomic activities at the farm. Since the farmer does not act solely as a rancher or solely as an agronomist, but as a multifaceted administrator, there will be a need to integrate the animal production systems with the crop production systems and, in some cases, with forestry production systems. The combination of these three basic agricultural activities (ranging from 0 to 100) makes up the farming system. This is the target and also the basis since the full cycle just described will have to be repeated, every time with more efficiency and finesse, since the farm itself is an evolutionary entity.

Finally, in order to increase efficiency in the operation of the Project, links with institutions and other projects will be established. The objectives of these relations are to provide support of research activities, complementary information, training of research and extension workers, and the creation of adequate channels for the transference of technology to the farmer. Some progress in establishing inter-institutional and inter-project links has already been achieved (see section III. F), and more links will be established in 1978 (see section V.D.). As a result of this, there is a growing interest among research colleagues with regard to the information that this Project is beginning to produce.

III. DESCRIPTION OF PROGRESS

A. PROJECT STAFF

CATIE named Dr. Manuel E. Ruiz, Nutritionist of the Bovine and Small Species Program, Leader of this Project, not only because of his particular field of interest and experience, but also in recognition of his initiative and the fundamental role in conceptualizing and preparing the Project Proposal.

The group directly involved in the Project, as considered in the portion of the budget contributed by IDRC was completed in November, 1977. The two research assistants were the first to be hired. One in February and the other in April. These persons were assigned preparatory duties such as the planning and development of a Module (see Section III. D.) and exploratory experiments on the utilization of bean crop residues, corn stalks and sweet potato tops as feedstuffs (see Section III. C.). A major problem was the finding of a suitable economist. Various applicants for this position were considered although not all of them had sufficient qualifications required by the nature of the Project. As soon as the economist was hired, the four fieldwork assistants were also hired and started the farm diagnosis at once, undergoing on-the-spot training.

The Project is now comprised of the following staff:

Manuel E. Ruiz, Ph.D.	(Peru)	Leader (CATIE)
Marcelino Avila, Ph.D. - candidate	(Belize)	Economist
Danilo Pezo, M.S.	(Peru)	Research Assistant
Arnoldo Ruiz, M.S.	(Costa Rica)	Research Assistant
Martîn Marîn	(Costa Rica)	Fieldwork Assistant
Johnny Montenegro	(Costa Rica)	Fieldwork Assistant
Oscar Garcîa	(Costa Rica)	Fieldwork Assistant
Alfredo Sojo	(Costa Rica)	Fieldwork Assistant

B. DIAGNOSIS OF SMALL FARMS

1. Introduction

Considering that most traditional research projects are based on discipline-oriented knowledge and methodologies, the present effort sets a new precedent. In particular, the Project is very much concerned with the dynamic interactions existing at the farm level. Since the farmer is the decision-maker in a system which involves various components --annual crops, perennial crops, livestock activities, forestry, off-farm activities, and furthermore, the complementary, supplementary and competitive relationships among a few, or perhaps all, of these various components-- it is extremely fruitful to study the operational and managerial features of the actual farms, as they pertain to the spacial and chronological allocation of productive resources. Therefore, instead of isolating and analyzing a specific component, as would be the case with a purely agronomic or livestock approach to farm betterment, an effort will be made to understand the complexity of the total environment, ecological as well as cultural, in which various farmers function, and to specify the different ways in which they have responded to their particular situations. Through the use of this approach, it is expected that the probability of designing and recommending appropriate farm improvement strategies for the target population would be greatly increased. How such an understanding of the farmer can be realized is the objective of this section.

Accordingly, in order to delineate the progress made so far, the presentation will be divided into three parts: a review of the state of the arts, a description of the methodology being developed and the selection of the geographical focus of the Project.

2. The state of the arts

A modest review of the literature on cattle production systems indicates that research efforts have primarily focussed on the managerial and technical aspects of the cattle component of farms (1, 2, 5, 11, 12, 15, 16, 23, 24); consequently, appropriate methodologies for such studies are well developed. The following is a conventional list of the principal features which has been used for the purpose of characterizing cattle farms: general data such as tenure, size of farms, livestock population: socio-economic characteristics of the farmer; the physical ecology such as climatic conditions, soil types, topography and vegetation; the types of management represented by the nutritional, health, reproductive and other production practices; and the use of indicators of technical efficiency. To complement such information, it is a common practice to do an economic analysis using standard techniques (for example, revenue and cost analyses, profitability and returns to the factors of production) and optimization algorithms (25). It suffices to say that a variety of production systems has been documented and analyzed following the methodology previously described. These experiences and results definitely aid in understanding and conceptualizing the work requirements of the Project. However, the studies reviewed focus on farms whose principal activity is cattle and do not make any pretense of integrating the various components, even if two or more exist, at the farm level.

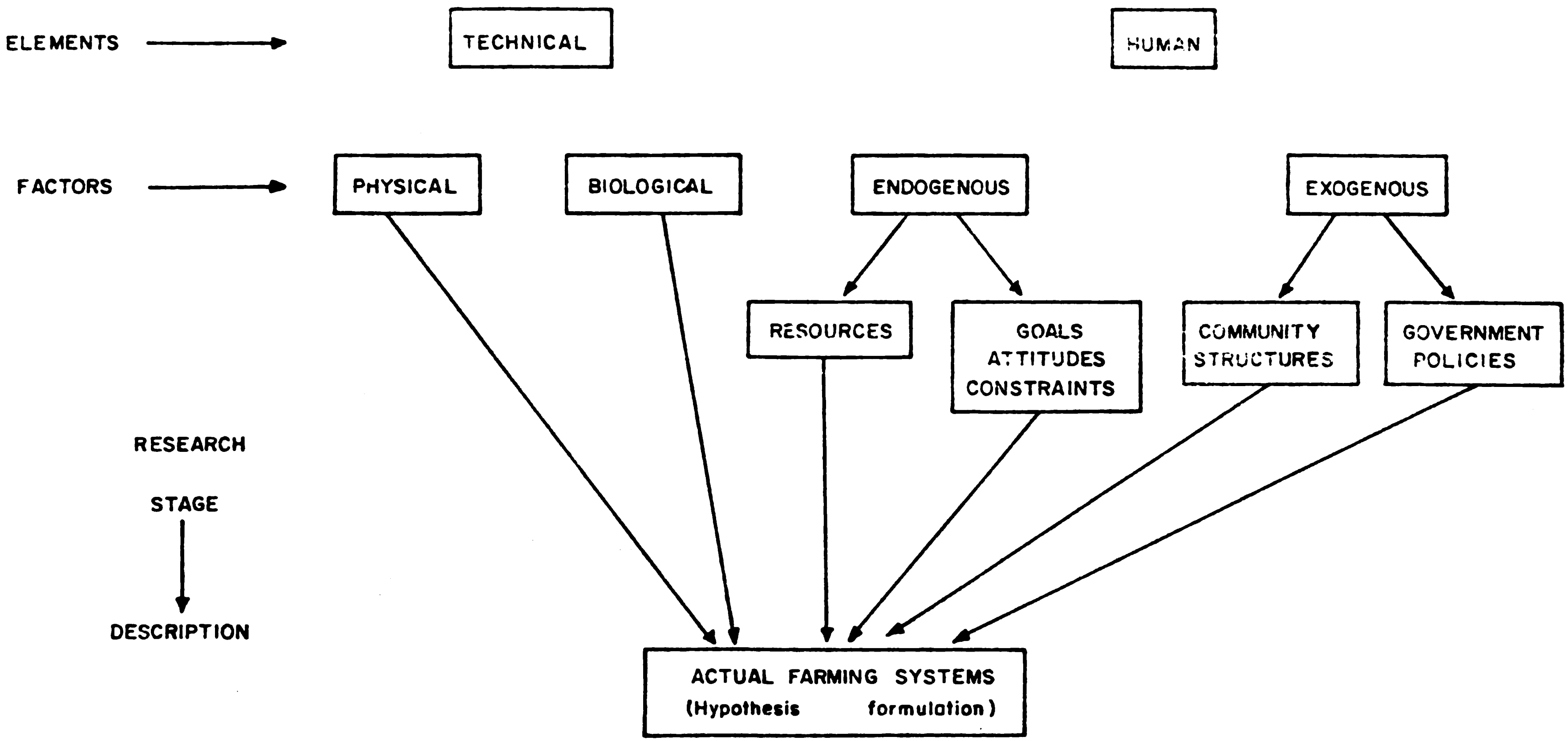
A second source of existing information is the Small Farm Cropping Systems Project in the Annual Crop Program of CATIE. In June, 1975, research on the production systems of small farmers, with AID/ROCAP funding, began (9). Ever since, the professional staff of this Project has experimented with a series of progressive methodologies aimed at perfecting information-retrieval and feedback mechanisms (3, 10, 17, 20). Some of these include: field surveys, experimental station trials, corroboration of potentially superior systems using farmers' plots, case studies of farmers, and finally a farm survey based on the farming system concept. From the analysis of this information, one overriding conclusion is clear; the management and distribution of activities of the small farmer are the impact of the ever changing interaction between the farm as an entity and all the environmental factors (18, 19). Contrary to the common assumption that small farm agriculture is static, the Small Farm Cropping Systems Project possesses ample evidence to assert that the decision-making process of the small farmer is dynamic and logical; his decisions reflect utmost consideration for biological factors, price incentives, diversification of crops, available labor, governmental policies, just to mention a few, and since these conditions are always in a state of flux, the farmer's life is one of continuous adjustments.

In summary, the following observations about the achievements of the Cropping Systems Project can be made (3, 9, 10, 20). First, there exists a broad knowledge base of crop production practices of the small farmers in three countries of Central America. The information relates to the types of activities carried out, their chronological and spacial distribution, and crop production technologies. Second, there is information on experimental cropping systems which represent potentially more efficient alternatives or modifications of existing practices. Third, there is a team of dedicated professionals trained in research and improvement methodologies directly relating to production systems. Fourth, in consequence to the painful but rewarding exercise of continual "tuning" to the small farm sector, there is real interest in the research perspective of the integrated or farming systems concept.

What is the concept of farming system? Needless to say, it is systems analysis applied to the farm sector. The concept has been adopted in order to channel researchers' thought processes into understanding the totally and complexity of reality as the farmers perceive it. Essentially, this perspective involves all the elements and factors that should be considered in developing a research methodology encompassing the entire spectrum from "basic" to "applied" research. Norman (Figure 2) has developed a schematic framework, whose components are self-explanatory, to conceptualize the varied factors which directly or indirectly, determine the actual farming system. He contends that agricultural research in the developed regions of the world has placed tremendous emphasis on the technical element, rightly so since the physical and biological factors are amenable to short run policy measures, to the exclusion, or at best insufficient emphasis, of the human element (21, 22). Apparently, the farmer in the developing countries functions in a manner that, given his personal limitations and attitudes, he allocates available resources to one or usually a combination of many possible processes simultaneously --crops, livestock, forestry, and oof-farm activities-- to realize his subcjective goals. One way to express such view is that the technical factors determine the feasibility of the various options and, therefore, can be considered the necessary condition, whereas the human factors limit further the possible set of alternatives, thereby providing the sufficient condition for the existence of a particular farm system (14).

Undoubtedly, previous research on cattle production systems, the expertise of the Annual Crop Program, and the conceptual framework developed by Norman will be of tremendous value to the realization of the diagnostic part of the present Project.

Fig. 2 SCHEMATIC FRAMEWORK FOR FARMING SYSTEMS RESEARCH



Source : David W. Norman, "Farming Systems Research in the Context of Mali" Paper arising out of Workshop sponsored by the Institut d'Economic Rurale and the Ford Foundation, Bamako, Mali, 1976

3. The methodology

In brief, the specific objective of the diagnosis of small and interme diate farms is to identify their present systems of beef and milk production (8). In order to accomplish this objective more effectively, the diagnosis has been divided into two sequencial stages: a static part involving a a survey of 240 farms in 4 regions of Costa Rica, to be carried out during a month of interviewing, and a dynamic part involving the observation of 40 farmers for a period of approximately one year, in order to acquire a solid understanding of the farmers' decision-making process and an in-depth analysis of the criteria he uses to discriminate among managerial decisions. Therefore, in an effort to be more precise as to the coverage of each phase, the research team of the Project has defined the goals that each phase is expected to accomplish.

With respect to the static diagnosis, three goals were set:

a) To generally characterize the predominant cattle production systems.

b) To lay the groundwork for the subsequent dynamic diagnosis by developing:

   i) An appropriate methodology.

   ii) Selecting the specific geographic focus.

c) To provide a basic information source to complement the experimental efforts of the research team.

It is expected that this phase should answer the questions of what the farmers has and how he manages his farm.

With respect to the dynamic diagnosis, the following goals have been set:

a) To characterize more precisely the predominant production systems.

b) To identify the critical factors which determine the productivity levels of these production systems.

c) To create a sound knowledge base to guide bio-economic experimentation and to pave the way for a subsequent technology transfer phase.

Again, it is expected that the dynamic diagnosis should lead to a better understanding of why the farmer does what he does, thereby assisting in the validation of a subset of potentially primising systems.

Since most of the research team's effort, up to this moment, has been concentrated on the static diagnosis, a description of the methodology developed for this phase will follow. There were serveral considerations that weighed heavily in the development of an appropriate instrument. For one, the instrument had to lend itself to extrapolation and generalization. While it is true that broad generalizations tend to go contrary to location specificity, some level of abstraction is always deemed necessary for cross-sectional or regional comparisons. Another consideration pertains to the errors of measurement resulting from the recall capacity of the farmer or lack of it thereof. Evidently, accurate information on certain feature of the farm system can be derived from a single interview while the information on other factors, such as family labor, cannot be derived, simply because the nature of the factor precludes easy recollection by the farmer.

Therefore, having looked at a sample of survey questionnaires (26), the team constructed its own version to conform to the specific objectives of the Project. The result is a structured questionnaire to be administered by the Project's four fieldwork assistants. A brisk review of the format includes these components: socio-economic characteristics of the farmer, the types of activities and their spacial distribution and production during the last year of operations, topography, tenure, investments (an inventory of constructions, animals, mechanical and manual equipment), types of management (genetics and reproduction, nutrition, health, pasture management and other particular practices), marketing, the use and availability of family and hired labor, and the use of credit and technical assistance. At the moment of this progress report, the survey team has pre-tested the questionnaire, edited and coded the preliminary responses, and reconstructed a final format. Certainly the scope of the questionnaire does not pretend to be exhaustive, but it is intended to detect the most salient features of the systems and to render maximum assistance to the experiment station trials and to the latter phase of the diagnosis.

Another concern for the research team comes from the desire to make the original sample representaive. Since survey populations for Costa Rican farmers in the regions to be focussed in this Project do not exist, it was necessary to explore alternative sampling methods. The area frame sampling procedure appeared to be the most pertinent and, consequently, was selected (13). Briefly, the procedure to be followed is to select districts (see last part of this exposition) in each region using efficiency criteria or indexes of resource use. Subsequently, using topography and road maps, each district is divided into clearly identifiable boundaries, and a random sample of blocks is made. The number of blocks and the number of farmers to be interviewed per block is determined in proportion to the corresponding farm populations of the districts as defined by the Costa Rican Census of 1973 (6).

4. Selection of regions

The Republic of Costa Rica with a surface area of 50,900 square kilometers has a strong agricultural sector (4, 7). Out of a total population of 1,993,784, approximately 34% and 66% area urban and rural, respectively, and 55% of the active labor force is employed in agriculture. Among the important agricultural products are: coffee, cacao, bananas, sugarcane, rice, beans, maize, tobacco and livestock products, particularly milk and beef. The agricultural sector provides approximately 25% of the Gross National Product of Costa Rica and earns 70% of the total export revenue.

The climate of the country varies with the relative altitude (4). The coastal regions of less than 900 meters above sea level, are typically tropical, hot and humid, and the temperature fluctuates between 22 and 28ºC. The regions with altitudes between 900 and 1,500 meters are temperate, their temperature ranging between 14 and 20ºC. High altitude areas are usually cold. Table 1 provides meteorological statistics for one site in each selected region. As mentioned before, with the help of the static diagnosis the team will acquire better knowledge of these climatic factors specific to each site, where the dynamic diagnosis will take place.

To select the regions to be surveyed in the static phase the following procedure was used. First, as presented in Table 2, statistics on the distribution of cattle population and the number of farms, with a cattle component, per strata of farm size, were acquired. This information points out that about 74% of farms, having between 3.08 and 22.9 heads of cattle per farm on an average, have less than 50 hectares of land. Therefore, a research strategy of working with farms with less than 50 hectares or less than 25 head of cattle is expected to have a siazeable multiplier impact on Costa Rican agriculture.

Table 1

Average rainfall, humidity and temperature
of four sites in Costa Rica
by month
1972-1976

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
TURRIALBA													
Rainfall mm	211.3	102.1	24.5	107.8	231.2	276.8	234.2	304.5	304.0	229.2	311.5	385.8	2722.9
Humidity %	87	84	83	82	85	86	88	88	87	88	88	87	86
Temp. °C	20.1	20.0	21.0	21.2	22.1	21.6	21.4	21.2	21.8	21.4	21.3	20.1	21.1
CIUDAD QUESADA, SAN CARLOS													
Rainfall mm	234.6	223.9	42.2	110.2	354.3	494.6	588.0	497.0	519.2	522.6	496.2	425.1	4507.9
Humidity %	86	84	83	82	86	88	91	91	89	90	89	97	87
Temp. °C	22.7	22.5	23.2	23.4	23.7	23.3	22.9	23.1	23.3	23.2	23.3	22.3	23.1
SAN ISIDRO DEL GENERAL, PEREZ ZELEDON													
Rainfall mm	50.4	0.0	18,8	111.1	296,3	270.5	280.0	500.7	448.3	517.0	269.1	74.1	2936.3
Humidity %	87	84	84	85	91	92	92	92	92	93	92	89	89
Temp. °C	24.4	25.2	25.2	25.5	25.3	25.0	24.8	24.3	24.5	24.5	24.4	23.5	24.7
LOS DIAMANTES, GUAPILES													
Rainfall mm	358.1	161.4	143.2	267.7	396.7	457.6	503.5	393.7	371.0	455.0	478.4	673.4	4659.7
Humidity %	89	88	86	88	90	91	92	91	91	90	91	91	90
Temp. °C	22.8	22.8	23.9	24.2	24.9	24.6	24.2	24.5	24.7	24.3	24.3	23.4	24.0

Source: Ministerio de Agricultura y Ganadería
Instituto Meteorológico Nacional, San José, Costa Rica.

Table 2

Costa Rican distribution of cattle population
in relation to size of cattle farms
1973

Farm size in hectares	Nº Farms	%	Nº Cattle	%
Less than 1	2,589	5.92	7,990	0.47
1 to less than 5	7,968	18.23	35,554	2.10
5 to less than 10	5,680	13.00	43.696	2.60
10 to less than 20	6,363	14.64	76,465	4.51
20 to less than 50	9,699	22.19	221,946	13.10
50 to less than 100	4,930	11.28	238,280	14.07
100 to less than 200	2,549	5.83	231,262	13.65
200 to less than 1000	2,118	4.85	519,830	30.69
more than 1000	262	0.60	313,634	18.51
Landless	1,541	3.53	5,255	0.31
T o t a l	43,699	100.00	1,693,912	100.00

Source: Ministerio de Economía, Industria y Comercio
Dirección General de Estadística y Censos
Censo Agropecuario Nacional 1973.

Second, in order to get an idea of what regions the Project should concentrate its attention, information on cattle population, number of livestock farms and number of milk-producing farms per agricultural region as defined in the Census of 1973 was acquired (see Table 3). Since the Project intends to lay emphasis on milk production, the team selected the East Central Valley, Northern Region and the Southern Pacific Region because of their high percentages of milk production. The Atlantic Region was selected because of its potential as a cattle-raising region.

Finally, since the geographical area of each region is too extensive, a closer inspection of each canton and its districts* was made by computing the average size of farms, average cattle population per farm, ratio of crop against pasture land, and stocking rate. The results are on Table 4. It is evident, that the indexes of the selected areas demonstrate a wide variety of current practices.

For the sixteen districts, Table 5 provides data on the relative importance of cattle farming in each district; it ranges from 35% for the district of Turrialba to 88% for the district of Buena Vista (see Table 5). Overall, out of a total of 4,868 farms in the four cantons, 2,974 (i.e. 57%) farms have cattle. On the basis of this information, the total sample of interviews was distributed proportionately to the number of cattle farms per district. Figure 3 gives an idea of the location of the selected districts and their respective provinces.

5. Final comments

While it is true that a more detailed description of each Section of this Report could be given, the objective is to render an accurate account of the progress made so far, and this includes: a review of the empirical work on production systems and the theoretical framework relevant to the integrated farm concept, a description of the sample and questionnaire designs, and a description of the process of selecting the specific geographical focus of the Project. At this point in time, the survey part of the static diagnosis has been completed, and the results are being analyzed. Undoubtedly, the process is well under way, and it is expected that future activities will porceed rapidly.

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* For administrative purposes, Costa Rica is divided, in descending order, into provinces, cantons and districts.

Table 3

Comparison of total cattle population
and total cattle farms
with the number of milk-producing farms
in Costa Rica
1973

AGRICULTURAL REGIONS	CATTLE POPULATION	CATTLE FARMS	MILK-PRODUCING FARMS	%
East Central Valley	106,600	5,622	3,255	57.90
West Central Valley	137,415	5,970	3,455	57.87
North Zone	293,445	5,854	3,716	63.48
Dry Pacific	805,250	10,415	5,170	49.64
Central Pacific	144,464	5,601	3,196	57.06
South Pacific	164,630	7,693	5,028	65.36
Atlantic	72,108	2,544	1,247	49.02
T o t a l	1,693,912	43,699	25,067	57.36

Source: Ministerio de Economía, Industria y Comercio
Dirección General de Estadística y Censos
Censo Agropecuario Nacional 1973

Table 4

Districts of Costa Rica Selected
for the static diagnosis

Districts by Canton	Average size of farms in hectares	Average number of cattle/farm	Proportion of crop land to pasture	Stocking rate cattle/ha. of pasture
PEREZ ZELEDON				
General	26.30	16.61	.37	.87
Daniel Flores	11.82	11.81	.49	.86
Platanares	13.27	9.07	.67	.89
Cajón	20.91	21.56	.36	.89
SAN CARLOS				
Ciudad Quesada	32.06	32.89	.26	1.13
Buena Vista	44.63	47.00	.01	1.21
Venecia	33.34	39.95	.10	1.13
La Tigra	19.08	9.15	.92	1.06
TURRIALBA				
Turrialba	22.46	29.24	1.12	1.30
Santa Cruz	29.74	32.52	.04	.99
Tuis	14.53	10.43	.64	1.09
Santa Rosa	13.37	7.72	5.38	1.56
POCOCI				
Guápiles	56.56	36.11	.41	1.00
Cariari	33.16	16.15	1.38	1.31
GUACIMO				
Guácimo	22.51	24.98	.46	1.67
Pocora	100.27	98.23	.02	.47

Table 5

Total number of farms,
number and percentage of farms with cattle,
number of interviews to be attempted per district of selected cantons

Districts by Canton	Number of farms	N° of farms with cattle	%	Projected N° of interviews
PEREZ ZELEDON				
General	334	204	61	16
Daniel Flores	404	172	43	14
Platanares	599	356	59	24
Cajón	443	199	45	16
Sub-total	1780	931		70
SAN CARLOS				
Ciudad Quesada	589	332	56	24
Buena Vista	33	29	88	8
Venecia	301	168	62	16
La Tigra	186	117	63	12
Sub-total	1109	666		60
TURRIALBA				
Turrialba	360	126	35	12
Santa Cruz	270	227	84	20
Tuis	175	110	63	10
Santa Rosa	193	72	37	8
Sub-total	988	525		50
POCOCI and GUACIMO				
Guápiles	230	176	77	16
Cariari	429	247	58	20
Guácimo	291	226	78	20
Pocora	31	13	42	4
Sub-total	981	662		60
TOTAL	4868	2794	57	240

Fig. 3 MAP OF COSTA RICA

LEGEND

- Province boundaries
- Cantons selected for Static Diagnosis

1 Pérez Zeledón
2 San Carlos
3 Turrialba
4 Pococí and Guácimo

C. RESEARCH

1. Specific objectives of research

During the first year of activities of the Project, part of the work effort has been oriented towards defining the specific objectives of research. Such objectives have been defined as follows:

a) To generate information concerning the nutritional value of crop by-products.

b) To develop conservation methods for crop by-products potentially useful in animal feeding.

c) To develop sub-systems for feeding dairy and beef cattle, based on the use of resources derived from the farm, as a complement or a substitute for grasses.

d) To provide information for the development of milk and beef production systems for the small farmer.

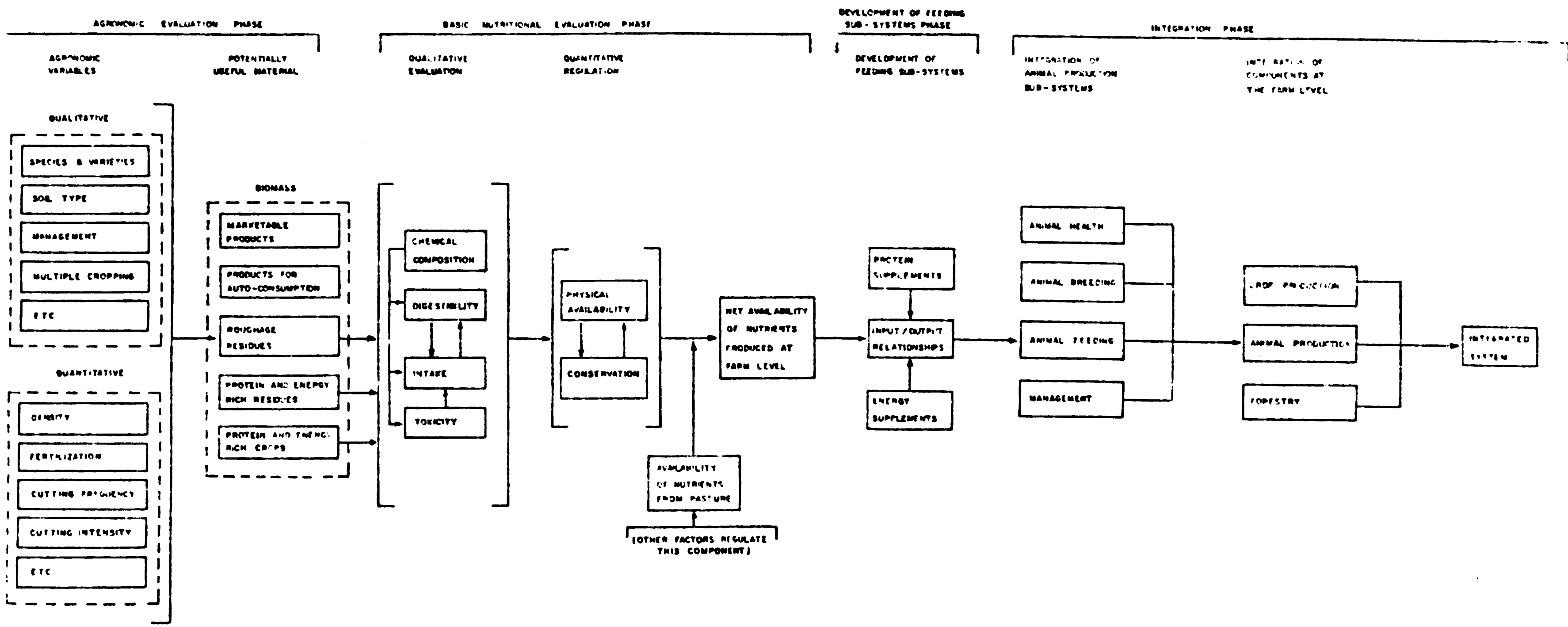
2. Research Program

In order to formulate a definitive research program for the Project, it is considered essential to rely at least on the information to be derived from the initial static diagnosis. For this reason, great importance to this moment, has been given to the development of the conceptual framework, which will define the scope of the research program.

In Figure 4, the scope of the proposed research program is graphically presented. The different phases of the proposed research, the aspects to be considered in each phase and the multiple relationships among them are shown in this Figure and discussed in the following paragraphs.

a) Agronomic evaluation phase. The study of different qualitative as well as quantitative agronomic variables, is considered in this phase. The qualitative variables include: Plant species and varieties, types of soils, management techniques, the use of single or multiple corpping systems,

Fig. 4 SCHEMATIC FRAMEWORK FOR THE "MILK AND BEEF PRODUCTION SYSTEMS FOR THE SMALL FARMER USING CROP DERIVATIVES"



etcetera. Some of the quantitative variables are: sowing density, levels of fertilizer application, frequency and intensity of harvesting, etcetera. These variables will be evaluated in terms of their effect on the total biomass yield or in terms of the biomass components: marketable products, home consumption products, coarse by-products and energy or protein-rich derivatives of cropping, not directly used by man. Also, the case of total biomass use will be considered, with regard to those crops planted for the sole purpose of producing energy and protein for feeding cattle. For the assessment of the production potential of crop residues on farms managed for agricultural purposes, the information will be derived from the work of the Small Farm Cropping Systems Project at the Annual Crop Program of CATIE.

b) Basic nutrition evaluation phase. This phase comprises the study of different crop residues and by-products in terms of their chemical composition, dry matter digestibility, intake, possible content of toxic substances. Interrelationships among these parameters will be studied in those agricultural products or crop residues potentially useful in feeding sub-systems that would be derived from this Project. An important aspect to be considered in this Project is the study of different conservation methods for crop by-products. Frequently, these by-products cannot be totally used at the time of harvest, mainly because harvesting is done in a relatively short period. Furthermore, the availability of substantial quantities of crop residues will usually coincide with periods of high pasture availability. Consequently, adequate conservation methods will have to be developed, in order to prevent the loss of these products.

c) Feeding sub-system development phase. Once the limitation and advantages of a given by-product are known, then the following step is to evaluate the animal performance, be it for milk and/or beef production, as a response to the use of such residues. These could be used either as basal diet components or as supplements to grazing animals or in combination with other supplements rich in energy and/or protein. This type of study will establish the input/output relationships, which in turn will serve as a basis for the economic evaluation of the use of these crop residues in feeding sub-systems.

Also, within this phase, basic studies will be carried out in order to explain the causes of the results obtained or provide insights for improving the biological and economic efficiency of the use of crop derivatives in the feeding sub-systems.

d) Integration phase. The integration of the information obtained in the previous phases will be considered, both horizontally (at the animal production sub-system level), as well as vertically (at the farming system level).

When speaking of the horizontal level, reference is made to the integration of information obtained at CATIE, by the Bovine and Small Species Program, and other research groups working on health, genetic and management sub-systems. The combination of these components with the feeding sub-systems developed by the Project, will result in animal production systems.

When considering vertical integration, reference is made to the incorporation of information provided by research developed at CATIE and/or by other research groups related to crop production and forestry systems, which, combined with animal production systems, will result in integrated systems or farming systems.

3. Preliminary studies

Three exploratory studies have been conducted up to this time, which fit into the Basic Nutrition Evaluation Phase. The field work for the three studies has been completed, except for some complementary laboratory information.

The preliminary studies were:

a) Intake, chemical composition and *in vitro* digestibility of bean straw (*Phaseolus vulgaris* L.).

b) Evaluation of the nutritional quality of chopped corn stalks (*Zea mays* L.).

c) Effect of the addition of different levels of urea and non-commercial sweet potato tubers on the quality of silage of sweet potato vines (*Ipomoea batatas* L.).

The crop residues used in the three preliminary studies have been procured from CATIE's Project on Small Farm Cropping Systems.

A summary of each of these experiments is presented as follows:

a) Intake, chemical composition and *in vitro* digestibility of bean straw (*Phaseolus vulgaris* L.). It has been estimated that the bean residue yield varies between 600 and 1,225 kg dry matter/ha when beans are produced as a single crop. When produced in a multiple cropping scheme, the bean residue yields are between 526 and 888 kg DM/ha.

With the purpose of minimizing residue processing and, in this way, facilitating the farmers' job, the material was used without chopping, and different levels of molasses were added to promote consumption. Also, urea was added to all treatments at a constant level, in order to increase the protein content of the ration to 8 per cent, preventing consumption problems due to low protein levels.

The animals accepted the bean straw well. Consumption varied between 2.6 and 3.0 kg DM/100 kg live weight/day, for levels of molasses of 0.65 and 17.9 per cent of the total diet (Table 6). However, the consumption of residues tended to diminish in proportion to the increased level of added molasses.

The animals showed preference for the pods in relations to the stalks; in the material offered, the proportion stalks/pods was 55-45, while in the material rejected, the proportion was 86-92% stalks against 8-14% pods. There was less selectivity of pods when the highest level of molasses (17.9%) was added.

Based on the consumption data and the weight gain observed (120-510 g/head/day) the bean crop residues could be considered as a promising component of feeding sub-systems, in mixed enterprise farms. Bean vines could be used as an ingredient in rations for growing or milking cattle in times of forage scarcity. These assumptions should be supported with production trials.

b) Evaluation of the nutritional quality of chopped corn stalks (*Zea mays* L.). The variable under study in this experiment was the particle size of chopped corn stalks since corn stalk is tough and difficult to consume. Three lengths were studied: 2, 6, and 10 cm. The largest size could be obtained by the farmer by chopping the stalk with a machete, while the other two could be obtained in a practical manner, only through the use of chopping machines.

Table 6

Voluntary intake of bean straw
with different levels of molasses added

RATIONS*	INGREDIENTS			CONSUMPTION (kg.DM/100 kg.L.W.)	
	Bean	molasses	Urea	Ration	Bean Straw
I	98.1	0.65	1.25	2.57	2.52
II	89.9	8.80	1.30	2.69	2.41
III	80.8	17.90	1.30	2.96	2.39

* The data are expressed as percentages of dry matter (DM).
All the rations contained 8% crude protein, with 46% of the total protein in the form of NNP.

The consumption observed in the case of corn crop residues was much less than in the case of the bean straw fluctuating between 1.7 and 2.0 kg DM/100 kg live weight/day. There was 3 and 15 per cent increase in the consumption of this residue when it was chopped at 6 or 2 cm, respectively, as compared to the 10 cm chopping length (Table 7).

In addition to the low acceptability of the corn stalks this roughage has protein and energy limitations which make it inadequate even for weight maintenance. If it has to be used, it should be adequately supplemented with high-protein and high-energy feeds. This assumption should be supported with production tests.

c) Effect of the addition of different levels of urea and non-commercial sweet potato tubers on the quality of silage of sweet potato vines (*Ipomoea batatas* L.). The aerial part of the sweet potato is a roughage of good quality which must be adequately stored, since this harvest is concentrated in a very short period. Besides it has a high moisture content (69%) and is easily fermentable; consequently, there is a risk of partial or total loss by rotting. Taking this into consideration, an experiment was planned with the objective of testing different levels of additives to silages of aerial parts of the sweet potato. Five levels of urea (0, 0.4, 0.8, 1.2, and 1.5% of the weight of the ensilable aerial part) and five levels of non-commercial sweet potato tubers (0, 3, 6, 9 and 12% of the weight of the ensilable aerial part) were studied.

Table 8 shows that the addition of increasing levels of urea tended to increase the crude protein of the ensiled product, while the addition of sweet potato tubers decreases the concentration of crude protein. The ammonium nitrogen content (Table 9) tended to increase with the addition of urea and tubers.

The pH of the silages (Table 10) tended to increase with the addition of urea and to decrease in proportion to the increase in the levels of tubers in the silage. Adequate pH levels (between 3.5 and 4.2) were obtained only in those silages in which urea was not added. Analyses of the different organic acids used as indicator of the quality of silage are being obtained at the laboratories of CEAGANA (National Sugarcane Center, Santo Domingo, Dominican Republic).

Table 7

Consumption of corn stalks
chopped at different lengths*

Length (cm)	DM Consumption (kg/100 kg L.W.)	Relative Consumption %
10	1,697	100
6	1,740	103
2	1,950	115

* The ration consisted of 88.5% of corn stalks, 10% molasses, and 1.5% urea for all treatments. The content of crude protein was 7.9%.

Table 8

The effect of the addition of urea and sweet potato tubers on the crude protein content in silages of sweet potato vines, % crude protein on dry matter basis.

Urea (%) \ Tubers (%)	0	3	6	9	12	$\bar{X}$
0	13.4	13.4	12.2	12.5	11.7	12.6
0.4	15.9	16.8	14.2	41.1	13.9	14.9
0.8	16.5	17.3	15.8	15.6	15.9	16.2
1.2	17.4	18.9	15.8	15.8	18.2	17.3
1.6	17.4	18.5	18.6	17.8	17.2	17.9
$\bar{X}$	16.2	17.0	15.3	15.2	15.3	15.8

Table 9

The effect of the addition of urea and sweet potato tubers on the ammonium nitrogen content (p.pm.) of sweet potato vines silage (on dry matter basis).

Urea (%) \ Tubers (%)	0	3	6	9	12	$\bar{X}$
0	131	186	142	210	216	177
0.4	187	224	230	221	268	226
0.8	214	225	188	278	292	239
1.2	188	275	181	304	326	255
1.6	245	273	241	226	317	260
$\bar{X}$	193	237	196	248	284	231

Table 10

The effect of the addition of urea
and sweet potato tubers
on the pH of the sweet potato vines silage.

Urea (%) \ Tubers (%)	0	3	6	9	12	$\overline{X}$
0	3.9	3.9	3.7	3.8	3.7	3.8
0.4	4.8	4.5	4.3	4.3	4.4	4.5
0.8	5.0	5.0	5.2	5.3	4.9	5.4
1.2	5.9	6.4	6.3	5.9	6.4	6.2
1.6	7.6	7.8	7.6	6.7	5.5	7.0
$\overline{X}$	5.4	5.5	5.4	5.2	5.0	5.4

The addition of urea and tubers improved the in vitro dry matter digestibility (Table 11), reaching an average of 59.4 and 61.3% for 0 and 1.6% urea, and 59.1% and 62.3% for 0 and 12% tubers, respectively.

As a result of the information analysed so far, it can be concluded that it is preferable to make silage of the aerial parts of the sweet potato, without additives of any kind. The resulting product is one of adequate nutritional quality. Also, it is considered that sweet potato vines are a promising crop residue. Emphasis on research regarding its production and utilization will be given in 1978.

Table 11

The effect of the addition of urea and sweet potato tubers on the *in vitro* digestibility (%) of sweet potato vines silage (on dry-matter basis)

Urea (%) \ Tubers (%)	0	3	6	9	12	$\bar{X}$
0	56.3	58.7	60.0	61.7	60.0	59.4
0.4	58.5	57.5	58.5	62.2	67.2	60.8
0.8	59.4	56.6	60.9	61.5	60.0	59.7
1.2	61.1	57.0	59.7	64.2	60.4	60.4
1.6	60.3	56.5	59.8	65.6	61.3	61.3
$\bar{X}$	59.1	57.3	59.8	63.0	62.4	60.3

D. INTEGRATION OF RESEARCH RESULTS

1. Establishment of production demonstration units

Although the Project, in its present form, does not consider the transfer of improved technology to the producer until a later stage, it has been considered necessary to establish production demonstration units. These units, tentatively three, will work as commercial operations within the Experiment Station at CATIE, but will be independent from the regular management and budget of the Station.

The initial investment for these units will come from the rotatory fund of the Project and will be reimbursed with the income produced by such units. Should the income obtained be greater than the initial investment, this money will be used to establish new units, or to support other Project activities.

Based on the experience gained at CATIE, the establishment of production demonstration units will serve the following objetives:

a) To simulate the small farmer's operations thus permiting the detection and better understanding of his production problems.

b) To evaluate CATIE's previous research within the context of the small farmer. After many years of research, several improved methods of cattle production have been generated that appear to have great potential on small farms, and thus need to be validated at this level. Similarly, agronomic production sub-systems have been developed and are in the process of being validated and transferred to the small farmer. As such, this process does not include a livestock component, which should be considered in integrated production systems. Consequently, the production demonstration units will serve as a tool for the integration and validation of animal and agronomic sub-systems within a more realistic system of production common to the small farmer.

c) To assist in the transfer of new technology by demonstrating the bio-economic feasibility of integrated systems of production.

d) To serve as a mechanism to attract the interest and cooperation of other institutions and projects for the support and diffusion of the technology developed.

e) To train extension agents and farmers, which could be carried out through short term visits which will allow them to learn the improved technology "by doing it".

Due to the size and purpose of these units, no large scale investigation will be undertaken. However, this does not exclude exploratory trials that will help in the orientation of research and in the detection of problems that could otherwise escape diagnosis and/or the researcher's criteria.

2. Establishment of a dual purpose production unit

A dual purpose production unit is in the process of being established, in line with the objectives previously presented. This unit will include the production of both milk and beef, as well as the production of grain. An area of approximately 0.6 hectares has been delimited, in which 2 hectares will be dedicated to agriculture, and the rest will be used for animal production.

A hilly area, typical of the topography of Central American small farms, was chosen. It was also decided that 6.0 hectares is within the range of land size that one man can manage using family labor.

It is very common for the small farmer to use part of his land and capital for the production of milk and beef. Most of the products obtained are consumed by his family, although the possibility of selling his produce at the local market cannot be disregarded. For this reason, it was concluded that a dual purpose operation, managed at a more commercial level, should be one of the first aspects of animal production to be considered in the Project.

CATIE's Program on Annual Crops was consulted before deciding the type of agricultural activities to be undertaken in this unit. It was decided, based on their experience, that the production of basic grains, such as corn, black beans, and other crops common to small farm operations, could be one of the possibilities. It was also considered that the production of basic grain is one of the agricultural activities that produces large amounts of non-commercial by-products which can be used in animal feeding.

The forestry component was also included within this unit, not as another commercial activity that will compete for the basic resources of the producer, but as a supplement to the other main activities. Consequently, two different species of legume trees, very commonly used as live-post fences, have been planted. Such species are characterized by: 1) high nitrogen fixation, 2) production of good quality poles that can be used as dead or live-post fences, and 3) high production of foliage, rich in crude protein content, which could be used in animal feeding. The species so far considered include: Erythrina poeppigiana (Walp) Cook and Gliricidia sepium (Jacq) Steud. A third specie, Leucaena leucocephala L., will be considered.

As it was previously explined, this unit will work independently from the regular management and budget of the Animal Production Experiment Station. It will be operated by one man with occasional assistance of hired labor. The income obtained from the sale of the goods produced in this unit will be deposited in the rotatory fund of the Project, first as payment for the initial investment, and then as a funding source for new units or for any other activity within the Project.

As of now, the perimeter of the unit is completely fenced, and the different sections dedicated to crop and animal production have been separated. The production of white corn (Zea mays L.) is the main agricultural activity taking place which will be followed by the production of black beans (Phaseolus vulgaris L.). Also, 15 dual purpose cows have been purchased. In order to acquire these animals, different cattle ranchers were visited in Nicaragua. Nevertheless, it was not possible to purchase the cows, due to sanitary restrictions recently imposed by the Costa Rican Government. Due to these circumstances, visits to the Northern and Atlantic zones of Costa Rica were made, where the cattle was finally acquired. These cows are crosses of Criollo and Zebu type of cattle with any of the specialized dairy breeds, where none of the breeds involved exceeds 7/8. Based on CATIE's previous experience, this cattle is typical of the cattle that the small farmer of Central America utilizes.

The construction of the milking barn has been finished, and it includes a storage area, milking facilities, a waiting area, and a calves' corral. The cows graze Guinea grass (Panicum maximun) in a rotational grazing system, where the cow is hand-milked once a day and spends a 6 hour-day with her calf right after milking.

3. Exploratory trials

As previously mentioned, the purpose of these units is not to undertake large-scale experiments. However, a series of small exploratory trials have been planned, which will be detailed in the following paragraphs.

a) The effect of bending vs. cutting corn tops upon the production of grain. It is common practice in rainy areas to bend the top part of the plant, once the grain is fully formed, in order to protect the ear from rot and molds. This practice has been modified in Guatemala, where the plant top is cut off, prior to bending the plant. This could be a valuable practice if corn tops are to be used in animal feeding, since a more valuable material, from the stand point of animal nutrition, could be obtained, as compared with the material left in the field once harvest has taken place. Nevertheless, no information is available about the effect of these two practices upon the production of grain.

Consequently, a preliminary trial is in progress, where 6 plots of 400 m^2 each have been delimited within the corn field of the production demonstration unit. Three of these plots will receive the traditional practice of bending the top of the plant, while in the other three plots, the tops will be cut off, prior to bending. This will permit a comparison of: 1) total grain production, and 2) quantity and quality of the by-product obtained (fresch cut top vs. sun dried plant) with both practices.

b) Ensiling corn tops with different levels of poultry litter. Very frequent, the utilization of a given crop derivative as animal feed cannot take place at the same time it is available. For this reason, it is necessary to develop methods of conservation that not only will allow for the use of these residues during critical periods, but also will enhance their nutritional value. One of the available possibilities is the conservation of crop residues in the form of silage.

Although the corn tops are green at the time they are cut, the plant has completely matured, and consequently, the crude protein content of this material may be low, which could be limiting animal response. Poultry litter and poultry manure are two agro-industrial by-products that could be used as silage additives due to their relatively high nitrogen content.

In view of this, fourteen micro-silos were prepared, coresponding to a completely randomized design where poultry litter (broiler) was added to corn tops at levels of 0, 5, 10, 15, 20 25 and 30% of the fresh weight of the corn tops to be ensiled. Two replications were prepared for each treatment. Also, 2 per cent sugarcane molasses was added to all treatments, considering that both corn tops and poultry litter are low in easily fermentable carbohydrates that would ensure a good quality silage.

c) Comparison of two tree species used in live-post fences. It is a common practice among cattlemen in the tropics to use live-post fences with the purpose of prolonging the useful life time of the fences, and of providing shade for the cattle. Two different species of legume trees, *Erythrina poeppigiana* (Walp) Cook and *Gliricidia sepium* (Jacq) Steud, have been considered; both produce a good amount of foliage rich in protein which can be used in animal feeding.

This trial will be conducted with the following purposes: a) to compare total protein production and b) to produce enough material for a consumption trial which will be realized subsequently. Should this material not be produced in sufficiently large quantity to permit such an experiment, it will be combined with any other crop residue of the low protein type used in a study of storing practices or in feeding trials.

E. TRAINING

During the year 1977 no student was awarded a scholarship by the Project, but a great deal of effort has been devoted to laying the groundwork for the operation of this important aspect. However, three graduate student (Table 12) of the Agricultural Sciences and Natural Resource Program under the University of Costa Rica-CATIE Agreement have done part of their research and will do their M.S. thesis work in topics of immediate interest to the Project.

Table 12

Students participating in the research program of the Project

Name	Native Country	Source of Scholarship
LAZARTE, Miguel A.	Peru	Government of the Netherlands
LOZANO, Enrique	Peru	IICA*
OLIVO, Rómulo	Venezuela	Government of Venezuela

* Interamerican Institute of Agricultural Science of the Organization of American States.

F. RELATIONS WITH OTHER INSTITUTIONS AND PROJECTS

1. Small Farm Cropping Systems Project (CATIE)

As proposed, the Project is closely related to the Small Farm Cropping Systems Project that is being carried out by CATIE with the financial assistance of the United States Agency for International Development. Much has been learned from this Project, especially with respect to the farm diagnostic experiences accumulated in 1976 and 1977.

During the period under report, the following benefits obtained from the Small Farm Cropping Systems Project were of particular relevance:

a) Assistance in the design and establishment of the proper diagnostic methodology for this Project.

b) Information on their own diagnosis and research at the farm level.

c) Assistance in agronomic aspects involved in the development of the IDRC-module and preliminary experiments.

2. National Sugarcane Center - Animal Production Division (CEAGANA - Dominican Republic)

A good relationship has been established with the research group at CEAGANA. There are some points of common interest, for example, the research on cassava, sugarcane and *Leucaena leucocephala* utilization as cattle feedstuffs.

Help has been obtained from CEAGANA in the gas cromatographic determination of organic acids in sweet potato vine silages. Also there will be frequent communications regarding the visits to CEAGANA by highly qualified scientists, who might be of value to this Project, and could be invited as consultants for short periods, depending on research needs.

3. Panamanian Agricultural Research Institute (IDIAP)

Since the livestock division of IDIAP receives technical assistance from CATIE and it has recently received a grant from IDRC to develop a project similar to IDRC/CATIE, a very close working relationship is expected between both projects.

The experiences and methodologies developed at CATIE, plus technical assistance, will be provided to the Panamanian group. Also, the ensuing exchange and comparisons of information will be of mutual benefit to both Projects. At present, an agreement has been reached to provide training to the Economist of the IDIAP/IDRC Project. In addition, in September 1977, Dr. Manuel E. Ruiz participated in the programming of IDIAP/IDRC research and diagnostic activities scheduled for 1978.

4. Other institutions

The present Project has aroused much interest among institutions in Costa Rica and elsewhere. Preliminary conversations have led to informal agreements for collaboration. Later in this Report, specific areas of collaboration will be identified (see Section IV. D.).

IV. PROJECTIONS

A. DIAGNOSIS OF SMALL FARMS

A priori, the design of a farm survey has two principal concerns: representativeness and reliability. The former refers to sufficient and random cross-sectional coverage, whereas the latter to the dependability and quality of the respondent's answers. Due to a diverse combination of valid reasons, very few survey projects are able to satisfy both requirements, at least not as well as can be anticipated in the present Project. Since the static diagnosis is based on a single interview, its sampling design is an attempt to get a very representative coverage of the farm population under study. Considering the very short attention span of any respondent, the questionnaire was designed to solicit only information pertinent to the specific objectives of this static phase. On the other hand, the dynamic diagnosis, besides having an adequate sample size, will involve an in-depth analysis of the farming systems. Considering the continual monitoring of the farmer's decisions and activities and the personal intimacy expected to develop between the farmer and the Project's fieldwork assistant, the accuracy of the information should be of high standard.

Although the specific objectives of the dynamic phase of the diagnosis were stated earlier, perhaps it is in order to deliberate on their justification by explining what can be accomplished through this medium. Since every system, real or simulated, has laws governing its functions, the question is what laws govern the farm systems to be identified. Past empirical studies and theoretical implications point to a multiplicity of laws; they could stem from the subjective goals and attitudes of the farmer or his family, communal or peer influence, political pressures, or purely economic and, of course, other considerations. The perennial problem is that it is impossible to concentrate on everything simultaneously. Therefore, the team has planned the following steps:

1. Identify the different systems precisely.

2. Specify ecological, social, economic and technical aspects of each identified system.

3. Identify problems and/or critical factors associated with each system.

4. Integrate steps 1, 2, 3 by constructing a computer programming model that permits variation of input information to correspond to each system and the testing of "superior" alternatives.

5. Complement step 4 with continual feedback from the farmer, thereby validating the experimental results of the Project.

This is not to suggest that steps 1 through 5 must be realized in strictly chronological order. On the contrary, the general philosophy is that together these steps, as the need arises, should serve as a basis for the modification of existing systems, as a test of possible improvements, and as a first step of technology diffusion in their respective regions.

With respect to the future schedule of events, the following has been planned:

Dec. 27 - Jan. 20	Data editing, coding, and card punching.
Jan. 23 - Feb. 6	Preliminary analysis of the data.
Feb. 7	Beginning of the dynamic phase.

One principal element impinging on the successful execution of the static and dynamic phases of the diagnosis is the performance of the Project's four fieldwork assistants who will have first hand contact with the farmers. Consequently, great care was exercised in their selection to insure an adequate level of education, technical skills in agriculture, particularly cattle, and a farm background and thus some capability to relate well to farmers. All four assistants participated in the pre-testing, coding, analysis of the preliminary interviews and the "debugging" stages of the questionnaire. Subsequently, they executed the survey for the static diagnosis. All four have made good progress in their understanding of the methodology, and there is every indication they will fulfill their job responsibilities exceptionally well.

B. RESEARCH

It has been stated previously that the definite formulation of the research program of the present Project will be based on the information obtained from the static survey; however, some research assignments have been scheduled a priori, taking into consideration the available information with reference to the predominant crops at the small farm level in Costa Rica.

1. Agronomic evaluation phase

The study of the potential of cassava for the production of forage of high protein content has been programmed in this phase. For this, the effect of sowing density, defoliation frequency and intensity in two morphologically different varieties of cassava, on the total biomass production (aerial parts and roots) will be studied. Similar criteria will be considered in the study of other species that could be planted with the purpose of integrating them into feeding sub-systems, as is the case of sweet potato (Ipomoea batatas L.), malanga (Colocasia esculenta L.) (Schott), Leucaena (Leucaena leucocephala L.) and others.

In the same manner, the evaluation of the production potential of crop derivatives under alternative technologies commonly used by the small farmers in Costa Rica will continue in the Central Experiment of the Small Farm Cropping Systems Project as well as in the module of the Project.

2. Basic nutrition evaluation phase

In this stage, the study of the parameters indicating nutritive quality (consumption, digestibility and chemical composition) as well as the study of the presence of toxic substances in the residues of predominant crops, will continue. The development of alternative technologies for reducing or eliminating the presence of toxic substances in the crop by-products will be studied with the purpose of introducing them without risk in feeding sub-systems.

Recognizing the need to store crop residues, the study on silage and ensiling techniques for the storage of cassava forage, leucaena, and other residues that do not necessarily present risks of the toxic substances will continue.

3. Feeding sub-systems development phase

In this phase work will be done on those residues which up to this moment have appeared promising in the preliminary evaluations.

A plan of study has been designed, focusing on the use of the bean crop residues for feeding growing young bulls. In this study, aspects core-sponding to animal response will be considered, as well as aspects of basic metabolism (nitrogen retention, digestibility, the nature of fermentation products, etc.).

Another consideration is the study of milk production using cows supplemented with different levels of a starch source characteristic of the tropics. This work will be complemented with another basic study of the effect of starch sources on the synthesis of bacterial protein, as a way of explaining the result that would be obtained in the study of milk production.

Subsequent studies could be programmed according to the progress made in generating information in phases 1 and 2 of the research program and on the basis of the information provided by the farm diagnosis.

4. Integration phase

It is early to speak of integration for the second year of the present Project; however, in order to proceed to this phase, it is necessary to accumulate as much information as possible related to the other stages of the research in the development of feeding sub-systems, as well as in the other components of the integrated system.

C. TRAINING

As part of the activities for the coming year, the three students mentioned in Table 12, as well as two students who entered the Graduate Program in Agricultural Sciences and Natural Resources under the University of Costa Rica/CATIE Agreement in July 1977, will participate in activities relating to the Project. This does not represent any demand on the scholarship budget since all the students have their program of studies financed. Probably it may be necessary to use part of the scholarship budget of the present Project to allow the first three students, already involved, to complete their training. This should represent the equivalent of one 9-month scholarship or less.

It has been considered that by the beginning of March, 1978, the Project could finance three students to attend the Graduate Program of the University of Costa Rica/CATIE Agreement as long as their credentials and interests in the research program of the Project justify such assistance.

D. RELATIONS WITH OTHER INSTITUTIONS AND PROJECTS

As mentioned in Section III. F., initial contacts have been made with institutions and projects in Costa Rica, Dominican Republic, Venezuela, Guatemala, Panama and Mexico. These contacts were made in order to strengthen the Project and provide mutual benefits in research orientation and methodology.

In addition to the activities already carried out in 1977, it is expected that the following aspects will be developed in 1978 and 1979.

1. Costa Rica: The Sugarcane Grower Association for the Atlantic Zone

   a) This Association will provide information on cooperative farmers in the Turrialba area, with whom simple research activities could be carried out. These farmers would not be involved in the survey study.

   b) At least one of the extension agents of the Association will help in the supervision of any experimental trials at these farms.

2. Venezuela: Central University at Maracay

Scientists working at this University are interested in promoting a workshop to analyze existing information in the utilization of tropical crops and crop residues in animal feeding systems. Financial help could be expected from FAO or CONICIT of Venezuela (National Council for Research and Technology). This meeting will be held probably in August 1978.

3. Mexico: Center for Sugarcane Utilization Research (Merida, Yucatan)

In January or February 1978, a veterinarian from this Center will visit Turrialba as consultant for the fistulation of animals both in the rumen and doudenum, to be used in trials concerning the utilization of starch-rich tropical crops in animal feeding.

4. Guatemala: Institute of Nutrition for Central America and Panama (INCAP)

There is interest in both INCAP and CATIE to pool information on dual-purpose cattle systems predominant in the Central American Isthmus. CATIE can provide information on Costa Rican, Panamanian and Honduran dual-purpose cattle systems. Also, INCAP is interested in sending at least one scientist for training in research methodology covered by the IDRC/CATIE Project.

V. SUMMARY

This is the First Progress Report submitted to the International development Research Centre (IDRC) by CATIE, regarding that Animal Production Systems Project (Centre File 3-P-75-0090/2). This Project received its funding in December 1976. However, it did not start operations until February 1977 when the first Research Assistant was hired. The full staff was not completed until November 1977 when a suitable Economist was found. Nevertheless, much was accomplished during the year.

With regard to the farm diagnosis, 231 farms were visited providing basic information on management and technical aspects in cropping and animal production systems. During the course of this activity, four fieldwork assistants were properly trained and are ready to start the second phase of the farm survey, the so-called dynamic diagnosis.

Research activities started in March 1977 and involved preliminary evaluation trials, with corn stalks, bean straw and sweet potato vines. It seems that with the exception of corn stalks, these crop residues can be efficiently used as basic components of rations for bovines, especially during the dry season.

Both the diagnosis of farms and the research activities are being carried out following basic frameworks, which in themselves can be considered as outputs of the IDRC/CATIE Project, since much thought analysis and conceptualization was invested in their development. The conceptual framework, the research and diagnostic schemes contain every aspect considered in the Project. Some of this information has already filtered out to other research groups outside Costa Rica, and there is interest among them in receiving a written version of these parts of this Report.

Graduate training has been accomplished with three students. These students have had no need for IDRC economic support, since they already had scholarships. In 1978, two more students in the same condition will carry out research of interest to this Project. Also, three students will be admitted by the Graduate School in March 1978 and will be granted IDRC scholarships.

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