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E M B R A P A

Brazilian Agriculture Research Enterprise

PROJECT FOR STABLISHING A CENTER FOR AGRICULTURAL
AND LIVESTOCK RESEARCH FOR THE SEMI-ARID TROPICS.

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PROJECT FOR ESTABLISHING A CENTER FOR AGRICULTURAL AND LIVESTOCK
RESEARCH FOR THE SEMI-ARID TROPICS (CTSA)

Contents

1. Introduction
2. General Limitations on Agricultural and Livestock Development in Semi-Arid Areas
3. General Philosophy of the Research Program and Operational Scheme of the Center
4. General Description of the Research Program
 - 4.1 Project for Inventories of Natural Resources and Socio-economic Conditions
 - 4.2 Project for Development of Production Systems for Irrigated Areas
 - 4.3 Project for Development of Production Systems for Dry Land Agriculture
 - 4.4 Project for Management of the Caatinga (range or grasslands)
5. Organization



1. Introduction

Beginning in the last decade the Government has been concentrating increasing efforts to reduce the economic differences between the various regions of the country. With relation to the semi-arid region there is evidence that although there are severe climatic variations this region has the potencial for reaching a satisfactory level of development. The regional agricultural growth, nevertheless, is hampered by the differences in technical knowledge which is one of the principal retarding factors and consequently there is a lack of production techniques capable of assuring satisfactory levels of production.

The recent programs and policies of the Government for the Region (II PND, POLONORDESTE, Tropical Program for the Semi-Arid Region) gave emphasis to strenthening the structure of agricultural and livestock research and the furthering of technical knowledge with the objective of establishing a better performance of the primary sector.

Considering that EMBRAPA is the principal organization for promoting agricultural and livestock research, it was its responsibility to establish a research system with characteristics consistent with the government's objectives for the Semi-Arid Region.

Within this orientation and considering the policies of Resolution No. 067/74 of May 22, 1974 EMBRAPA created the Center for Agricultural and Livestock Research for the Tropical Semi-Arid Region (CTSA) with the objective of carrying out research activities for developing technology for economic production systems for the diverse ecological areas included in their field of activity, Resolution 004/75, of January 23, 1975.

The Project for Implementation of the Research Center of the Tropical Semi-Arid Region that we present herewith was based on the information in the "Ante-Project" of said center, based on Resolution RD 018/74 of November 25, 1974 and on the conclusions of the Research Meeting held in Petrolina, Pernambuco, during the period June 30 to July 2, 1975.

2. General Analysis of Limitations on Agricultural and Livestock Development of the Semi-Arid Region

Various physical, biological and socio-economic factors have contributed to retarding the agricultural and livestock development of the semi-arid region. The scarcity and poor distribution of rainfall, the soils limitations, the lack of agricultural knowledge and inadequate management for the different sub-regions, among other things, have adversely influenced possibilities for better use of the semi-arid region.

There are a large number of limiting factors in this region and those of major significance are analyzed as follows:

a. Size and Diversity of the Area. The semi-arid region comprises about 13 percent of the national territory and 70 percent of the Northeast. Within that region there are several subregions with differing climate, vegetation, soils, water and socio-economic conditions. These regions are usually known as Agreste, Caatinga, Sertao, Cerrado, Brejo as well as the valleys with irrigation possibilities.

b. Natural and Socio-Economic Resources. Although there are several studies at the schematic and reconnaissance levels for most of the semi-arid region, there is a need for detailed studies for specific areas, especially for irrigation and drainage. It is evident from the existing studies that there are limitations in the physical characteristics, salinity and alkalinity and fertility of the soils, with greater significance on agricultural

development than on livestock development. The hydrologic resources are limited because of the irregularity of precipitation aggravated by the low water retention of the soils and the high rates of evaporation, and because of the scarcity of perennial streams and of the lack of knowledge of the availability and quality of ground water. This is in spite of the existence of a potential water storage capacity of 16.5 billions cubic meters in public and private reservoirs.

Other factors that impede development are related to the educational level of the rural, population, job offerings, buying power, basic structure, credit and commercial and market infrastructure.

c. Adaptability of Species, Varieties and Races. Although the native vegetation and the animal population have been submitted to natural selection in which they became more adapted to the diverse ecological conditions, it is necessary in improvement programs to take advantage of the introduction of new species, varieties and races for the evaluation of their adaptability in the ecology of the semi-arid region. With respect to the agricultural development, emphasis must be given to development of drought tolerance.

d. Occurrence of Disease Pests and Weeds. The study of some of these aspects is already being carried out for the semi-arid region affecting agricultural development as well as livestock. Meanwhile, there is a need to emphasize these factors in special development conditions; for example, in perennial irrigated crops where pathogens are harbored all year.

e. Agricultural and Livestock Production Systems. The available information of the current systems of production is inadequate in agriculture as well as in livestock production. The identification of the immediate needs

of the current systems of exploitation is needed relative to the level of technology employed in the region and which plays an important role in the economy. That knowledge is of great importance because on it depends the establishment of an approach in relation to the factors which hamper the adoption of more efficient systems. Consequently the systems of production should be identified within the special conditions of development embracing, therefore, dry land agriculture, swampy areas, irrigated valleys and grazing lands.

f. Infrastructure. The basic structure is deficient not only in that related to agriculture but also as related to livestock development. There is also a lack of technical assistance and credit. Irregularity in the distribution of production inputs or supplies; scarcity of access roads in certain areas; difficulties in the commercialization of agricultural and livestock products; deficiencies of storage systems, and seasonality and distribution of labor, are some of the factors that should be taken into consideration if technology is to be adequately used in the expansion of agricultural and livestock production in the semi-arid region.

3. General Philosophy of the Research Program and Operational Plan of Center

In accordance with directives of the organization, the research program of the Center will be oriented towards the creation of production systems suitable for the conditions of the semi-arid region. Within this orientation the Center will try to identify the limiting factors, beginning with the existing production systems, with the objective of elaborating future research programs and thus obtaining new and more effective production systems. The philosophy of the program and the operational plan of the center are presented as follows:

1. Inventory of the production systems in use
2. Identification of the limiting factors
3. Use of available knowledge
4. Formulating and testing of better production systems
5. Establishment of a research program
6. Analysis of the results
7. Formulating and testing new systems of production
8. Dissemination of new production systems

The adoption of systems objectives and the utilization of the human resources in the form of multidisciplinary teams will enable the Center to identify problems and set goals embracing the agricultural process as a whole and not taking each of its parts as an isolated component.

Initially, the Center, in coordination with DDT, Sistemas Estaduais, EMBRATER, using the experience of farmers and research technicians will combine accumulated knowledge for the elaboration of better production systems and then will test them at the farm level. This work will be of great importance to the Center and will result in an integrated effort of the research technician, the extension agent and the farmer, thus giving the technician direct contact with the field problems.

The Center will be characterized by its constant search for more diverse forms of cooperation and by the assistance that it will give various institutions that are carrying out agricultural and livestock research in the semi-arid region. It will join with various institutions including private initiative in the carrying out of a coordinated effort in order to avoid duplication of activities. Thus it will be possible to carry out different types of research.

This form of action of the Center does not imply that it will carry out all of the research programs for the semi-arid region, but that it will coordinate and stimulate research, principally with respect to identifying critical points in technical-scientific information that impede the formation of more efficient and effective programs.

In order to carry out the coordination function and stimulate research, the Center will obtain technicians, equipment and supplies and finances for the accomplishment of the work for which it has direct responsibility. Also, it will stimulate research by adequate means, in each case, so that other participating institutions will carry out their assigned work. In the event that the Center should need a given type of research for a specific product for the semi-arid region it will request the participation of the appropriate office of CNP, allowing the programming to be developed jointly by both centers. This way the execution of the programs could be left in charge of the Center, of the Sistemas Estaduais de Pesquisa or could be contracted with another organization.

4. General Description of Research Program

The research program of the Center consists of four projects which are determined by the physical-biological and socio-economic conditions of the semi-arid region also taking into consideration the policies and programs of the government for the region. It is significant to point out that conditions of vegetation and climate and the types of agricultural exploitation prevalent in the region permit the identification of three distinct situations as follows:

Areas which have irregularity in the quantity and distribution of rainfall and which have possibilities of producing a reasonable crop with short growing season plants;

Areas which have available surface water resources (perennial streams, reservoirs) and underground water and are intensively developed under irrigation;

Areas of grassland (caatinga) subject to great climatic variation which, except for exceptional years, are not adequate for agricultural production and for which an alternative more suitable exploitation would be livestock production.

The situation described above as well as the urgent need to know more about the ecosystems of the semi-arid region justify the creation of the four Projects which form the program of the Center and which are presented as follows:

Project for the Inventory of the Natural and Socio-Economic Resources

Project for Developing Production Systems for Irrigated Areas

Project for Developing Systems of Production for Dry Land Areas

Project for the Management of the Range or Grasslands (caatinga)

4.1 Project for the Inventory of Natural and Socio-Economic Resources

This project proposes to give continuity to the work of inventorying the natural and socio-economic resources of the tropical semi-arid region, with the purpose of determining their productive potential to be used for a developmental zoning for agriculture and livestock. The information obtained on the natural and socio-economic resources, and their limitations, together with a knowledge of the production system in use will permit a definition of potential use systems for each zone.

For the implementation of the project the CTSA will form a coordinating group with the function of defining priorities, directing, assisting, and supervising the execution of the studies in order to facilitate the integration of the inventory of various resources and their relationship to the other research projects of the Center.

The studies of this project will be directed towards the following areas:

a. Climate. Collection of all available climatic data as well as information about meteorologic and rainfall networks including distribution, frequency of observation, condition of the instruments, period of operation, etc.; analyses of consistency and qualitative evaluation of the data.

Analysis and evaluation of data including the geographic density of the observation points with the objective of making an easier interpretation of the influence of climate on the other components of the environment and on the agricultural production.

Topoclimatic studies in specified areas in which greater economic progress is anticipated. Determination of probabilities of occurrence of climatic phenomena in order to have a better utilization of soil and water resources.

b. Water Resources. Collection of all available hydrologic data as well as information about the gauging station network including distribution, frequency of observations, conditions of instruments and period of operation, etc.

Completion of the inventory in terms of studies to determine soil water deficits and the hydrologic balance and studies of the river basins.

c. Soils. Completion of the inventory and soils mapping at the reconnaissance level of all of the area included under the CTSA program.

Inventory and mapping of soils and land use capacities.

Inventory and geomorphologic mapping.

Completion of inventory of soils at the semi-detailed survey level of the potentially irrigable areas.

Characterization showing intensity and mapping of areas having problems resulting from salinity, from high sodium content and drainage.

d. Vegetation. Characterization of associations or vegetation patterns.

Characterization of native forage species and their nutritive value.

Determination of the occurrence of toxic plants for animals.

Characterization of forest species of economic potential as well as other useful plants.

Mapping of areas that need reforestation.

e. Socio-Economic Resources. Studies that relate to the factors of production such as: labor, capital and land; basic structure and its problems; commercialization and marketing; infrastructure of industrialization and processing of agricultural products.

4.2 Project for Development of Production Systems for Irrigated Areas

The investments already made in hydraulic works and the established norms for increasing the irrigated area in the semi-arid region justify the establishment of a research program for a rational utilization of soil and water resources as well as the utilization of selected plant species and of other modern inputs which are indispensable for increasing productivity.

The scarce current knowledge on the management of water, soil and cultural practices as well as species, varieties and adequate races for the irrigated areas as well as the lack of knowledge on the probable future market demand and opportunities for selling products both in the foreign and local markets contribute to the failure to obtain the objectives of the irrigation program in the Northeast, principally when consideration is given to the increased income to the farmer.

Based upon the above mentioned situation the Project for development of Production Systems will have as an objective the developing of new systems where water and soil will be used rationally in order to guarantee an agricultural development with profitable irrigation with emphasis on the following aspects.

a. Increased Water Use Efficiency. Generally the irrigated plots of the semi-arid areas demonstrate low efficiency of water use especially in relation to application to the parcel with a negative result on crop production. This is related to various aspects such as lack of knowledge of evapotranspiration, amounts and frequencies of irrigation, better information on physical soil characteristics that influence infiltration rates, and inadaptability of irrigation methods to the crops. Thus the research to increase the efficiency of irrigation is oriented so as to determine the technical-economic viability of the irrigation methods best adapted to the various cultures, observing the interactions with occurrence of insects and diseases as well as degree of mechanization, amount of water used, critical periods of the crops and frequency of irrigation based upon agro-climatic studies as well as functions of production for factors of water, fertilizers and plant density. These studies should be related with those

dealing with the availability of rainfall, including principally two points, namely: probability of occurrence and effective precipitation based upon soil capacity for water retention.

It is also important to consider the research to be realized with equipment used in irrigation and materials for canal lining and hydraulic structures at the parcel level as well as studies on drainage, salinity and irrigation water quality.

b. Mineral and Organic Fertilization, Plant Nutrition and Interactions

The development of irrigated agriculture in the semi-arid region depends, among other factors, on the solution of problems related to the low soil fertility, principally in relation to phosphate and nitrogen and in some cases potassium and microelements. The use of fertilizers in economically justifiable amounts is indispensable to agricultural development and for this it is possible to consider it necessary that a program of intensive research be established for: the determination of response curves of various cultures to nitrogen, phosphate and potassium and to critical levels of these elements; also the identification of scarcity of microelements and their correction; evaluation of the residual effect of the sources of nutrients; determination of the period and methods of application of fertilizers; selection and adaptation of varieties of Rhizobium to the soil conditions of the region; correction of acid soils and those affected by salts and sodium; the effect of organic fertilizers and the available nutrition to the plants; evaluation of losses resulting from leaching and fixation of nutrients in various soils; studies of physical, chemical and biologic modifications that normally occur in soils under intensive cultivation under irrigation and fertilization; and studies of foliar fertilization and calibration of soil analyses.

c. Introduction and Adaptation of Species, Varieties and Families.

The research developed will give special emphasis to the creation of varieties adequate for the irrigated areas having the principal objective of augmenting the productivity and also the quality of the products. All of the available germoplasm should be evaluated in the irrigated areas of the semi-arid region in order to determine their superiority or inferiority. As an example, the creation of varieties of onions of better keeping ability and of industrial varieties of tomatoes with fruit producing capacity in high temperatures and of "añoes" corn can be cited.

d. Management and Cultural Practices. In the irrigated areas the management techniques and cultural practices differ in some respects from those used in dry land agriculture even though the basic principles are the same. Modern methods of water application could be used for the crops with almost complete mechanization. The soil preparation, the control of weeds, the planting methods, systems of pruning, to cite a few examples could be carried out in conjunction with irrigation practices in such a way that a greater production could be obtained from the crops. There is still a lack of information in the field which justifies the implementation of research to develop and adopt technology. The studies should include the following aspects: determining the best methods of planting; establishing the minimum effective application of herbicides; establishing a crop rotation system so as to make rational use of the soils and to control disease; determining the time to prune or remove the crop; determining the planting season and the creation of or adaptation of technology in the use of agricultural implements.

e. Economy. Studies are necessary of future demands and opportunities

for locating markets for the products of the irrigated areas for commercializing them in the external and internal markets whether for consumption as is, or for industrial processing. Emphasis is to be given to marketing research including, among others, the grading and packaging aspects. On the other hand the technological innovations without the necessary economics of their adaption to the production system will not have practical application for the farmers. The best benefit-cost relation should be determined for each system of production.

f. Identification and Economic Importance of Pests, Diseases, and Methods of Control. The damage caused by the diseases and pests is to be evaluated with special attention to the various irrigated areas of the semi-arid region. It should be emphasized that the introduction of new systems of production or cultures and the intensive cultivation throughout the year stimulates the appearance of problems relating to pests and diseases. Special attention will be given to research on methods of chemical and biological control and especially to the development of resistant varieties. As examples, we can cite the chemical and genetic control of "mal de sete voltas" in onions; the development of varieties of tomatoes with multiple resistance to nematodes and mites; the biological control of cochineal (cabeça de prego) in citrus, etc.

g. Seeds. The climatic conditions of the semi-arid region with long dry periods, do not offer favorable conditions for the development of a large number of diseases, for reason there are ample possibilities for producing seeds of good quality and free from pathogens. It should be emphasized that almost all the demand for vegetable seeds for Brazil is supplied through importation from the United States or from Europe. In relation to the needs requirements of the market an analysis should be made for the production of

seeds such as cucurbitaceous plants (melons, cucumbers, watermelon) and solenaceous plants (pepers, tomatoes), beans, lettuce and coriander.

4.3. Project for Development of Production Systems for Dryland Areas

The research to be development for this project will be to identify a technology capable of improving the profitability of production systems used in the semi arid region where the climatic variations and particularly the irregular rainfall distribution limits the economic production of this area. Efforts will be concentrated in the regions where the agricultural and livestock production is more secure as in the Agreste which produces, among other products, cereals and milk.

A special effort will be given to the development of research for high elevation microclimas (wet areas) which with modification of the climatic factors give greater assurance of successful production.

During the program, studies will be developed to improve the current production of the semi-arid area as follows:

a. Introduction and Adaptation of Species and Varieties. All of the germoplasm available will be evaluated in the different climatic conditions of the semi-arid region so as to determine their inferiority or superiority in field tests. These trials will furnish an indication of the processes of selection to be adopted.

b. Identification and Economic Importance of Pests and Diseases and Methods of Control. The occurrence of pests and diseases of the soil, leaves and stored products constitutes one of the factors responsible for the low agricultural production of the semi-arid area.

The identification and evaluation of the damage caused by pests and

diseases to the agriculture of the region will serve as a base for implementing a research program for controlling them. It is important to point out that in the semi-arid region subsistence agriculture predominates and that use of chemical products is not always economical. For this reason, biological control through improved genetics and search for resistant varieties must be emphasized. The biologic control of "cigarrinha" of pastures and the introduction of industrial varieties of tomatoes resistant to "burning" Phytophthora infestans can be cited as examples in the rural areas (Agreste) of Pernambuco.

c. Drought Resistance. Since water shortage is the principal limiting factor on production in the semi-arid region greater emphasis should be given to the development of drought resistant varieties. Evidence of this is given by the introduction of the latent gene in corn and the polygene for this purpose.

d. Soil Fertility and Mineral Fertilization of Plants. The factors which limit the use of fertilizers in the semi-arid region are the high cost and the difficulty of acquiring them, associated with the low level of technology used in agriculture. In view of that situation, a research program will be established to determine the economic levels, time and methods of application of mineral and organic fertilizers, simbiotic fixation of nitrogen, the value and use of soils analyses and the identification of plants that require less fertilizers.

e. Methods of Land Preparation and of Planting and Cultivation. The semi-arid region presents variations with respect to soils and agricultural methods. Due to the socio-economic conditions of the rural landowners and the basic structure there is a relative predominance of manual labor. Since this is the

case, a research program will be developed that will promote technology applicable to that situation. On the other hand, taking into consideration the widespread use of intercropping, varying only in composition from one region to another, it is necessary to develop and adopt hand instruments adequate for that system.

f. Market, Commercialization and Benefit Cost Relation. All the products of the semi-arid zone will be studied as to market and commercialization. They should also be evaluated with respect to qualitative characteristics which indicate economic utility thus involving research on methods of minimizing cost.

g. Development of Conservation Practices for Better Soil and Water Use.

Because of the irregularity of rainfall it is necessary to develop research for improving the use of precipitation for optimizing the factors of production. The objective of these studies will be to catch the rain water and store it in the root zone so as to create greater moisture availability for the plants. Also research will be conducted on soil and water conservation to minimize damage from erosion. The work will emphasize the following aspects: Use of ground cover so as to retain water and reduce direct evaporation from the soil surface; making the surface permeable through the use of organic residues and/or chemical treatment; and development of techniques that will increase the capacity for water retention of the soil.

h. Topoclimatic and Microclimatic Studies. These studies will be oriented not only towards the local climate of the micro-regions of the semi-arid area but to microclimate and its interaction with soils, slopes, topography and the vegetative cover. This will permit the selection of varieties adaptable to specific conditions of each micro region based upon climatic parameters relating to the balance of water and energy, and studying climate as a whole

and not as an isolated parameter. Also it will permit the interpretation of results from experiments carried out over many years as well as the solution of problems related to cultural practices. Thus, the hydrologic balance will be determined for the micro regions as well as the micrometeorologic studies that will permit a better understanding of the agroclimatic processes. These studies should be in conjunction with work at several levels for the application of knowledge derived from micrometeorological studies for the improvement of current production systems.

i. Studies of Methods for Livestock Development. The low indices of productivity that characterize the livestock industry in the semi-arid region reflect principally the inadequate systems of management and feeding that the herds are submitted to and to a greater degree to sanitary conditions. In view of this it is considered necessary that research be accomplished for identifying better animal management practices and improved sanitary control as well as studies on the ecology of native and exotic forage crops; zoning and making a quantitative and qualitative evaluation of them; techniques for storing or conserving forage; utilization of by-products in animal feeding; mineral supplements and studies related to fencing.

j. Use of Native Plants. Some of the native plants of the semi-arid region will be evaluated as to their economic use. The studies to be made include the collection of material; identification of the frequency of occurrence in the natural conditions; observations of the material collected under cultivation; that is to say with respect to the principal fitosanitary problems, cultural conditions and marketing and industrial use. With this in mind, studies could be made of the "faveleira", "carnaubeira", "oiticica" and the "umbuzeiro", which are already being used industrially to cite a few examples.

4.4 Project for Managing the Caatinga (Grasslands)

The research of this project is to first identify technology for the rational use of the caatinga in order to increase animal production (cattle, sheep and goats) as well as to preserve the ecological equilibrium already damaged by indiscriminant use. The caatinga comprises the major part of the semi-arid region and therefore merits special attention by the Center in the programming of research.

In view of the general lack of knowledge of the caatinga, the following studies are, in principle, considered fundamental.

a. Ecological Studies of Native Forage. After the identification of native forage species, studies will be made to determine the ecological requirements of these species by using test plots where climate can be controlled using small plots in areas with widely differing ecological characteristics.

b. Forage Zoning. Make studies in order to learn the ecological requirements of the species to be cultivated so as to permit a selection of the different species for the various ecologic zones.

c. Genetic Improvement and Introduction of Exotic Forages. Promote the introduction of the greatest number possible of forage plants from ecologically similar areas, observing their adaptation to the various existing conditions of the semi-arid region, including their ability to become invaders. Also to make studies for the genetic improvement of forage plants.

d. Pasture Management. Make studies for genetic pasture improvement so as to increase production by balancing forage production and livestock numbers, by means of thinning and control of vegetative species, methods of seeding and reseeding of pastures, adequate numbers of animal species, herd distribution, watering places, grazing periods, etc.

e. Pasture Development Systems. Carry out studies for identifying techniques capable of making the methods of pasture development more efficient through the planting of the entire area, planting in conjunction with other agricultural crops and strip planting.

f. Feed Supplements During Periods of Scarcity. Develop studies of the most efficient and economical systems of supplementing with quantity the feed for the herds during periods of pasture scarcity. This could be done through studies of pasture conservation in the field (standing hay), hay, silage and wherever possible the use of irrigated forage crops.

g. Technology of Seed Production. Conduct work that will lead to the development of knowledge for the production of forage seeds through study of cultivation methods; including deficient irrigation; determining harvest time for the different species as well as the fertility periods under different conditions; and the processing and storage.

h. Fencing. For the rational use of pastures it is necessary to subdivide them into parcels which requires the use of a great number of posts. Since this material is scarce because of its constant use as fences and indiscriminate use, namely in the production of charcoal, it becomes necessary to conduct studies for the production of posts with native species or introducing other species for the formation of live fences.

i. Quantitative and Qualitative Pasture Evaluation. For a better knowledge of the forage potential of species, studies will be made that quantify the production of dry material and its nutritive value. Studies of the carrying of the caatinga in improved pastures and the grazing of the pastures merit special attention.

j. Herd Mineral Supplements. Identification of the mineral shortages encountered in the herds of the semi-arid zone under various conditions; evaluation of their importance in the productive process and carrying out studies for determining the adequate mixtures for supplementing the rations of the animals.

l. Herd Management. Carry out work for the elimination of inadequate management practices commonly used through studies for the establishment of breeding stations, herd fertility, weaning periods and castration and other management practices.

m. Toxic Plants. Make studies to determine the significance of toxic plants in pastures, as well as indicating and mapping species, ill effects on the herds and ways of providing control.

n. Improved Animal Breeding. Develop studies to identify races or degrees of cross breeding suitable to the conditions of the tropical semi-arid region through the selection of native breeds, introduction of new ones and obtaining cross breeds.

o. Reproductive Diseases. To identify and determine the level of influence of the diseases of the reproductive organs of the animals and to establish their control.

p. Parasites. To carry out studies to establish systems of adequate control of the various ecologic conditions through the identification of species and time of occurrence of infections.

q. Production Systems. Carry out studies for the identification of the more efficient animal production systems in the different ecological conditions of the semi-arid region.

5. Functional Structures

The Center will have a well balanced structure so as to be a dynamic, well organized, flexible and efficient institution that will permit a rational and integrated utilization of the human, fisical, and financial resources in order to obtain rapid and precise results. The organization chart of the Center is presented as Figure 1.

The work of the Center will be basically the carrying out of research programs that will be executed by the Technical Branch after approval by the Executive Branch. The means for carrying out the program will be provided by the Administrative Branch.

The Center will maintain contact with other institutions such as: State organizations, universities, extension agencies, and other national and international research centers for the establishment of satellite programs and to give the researchers a clearer picture of other activities acquainting them with the more recent progress in science and technology.

The satellite programs will be carried out by State research stations or others, in sub regions since the results of research by CTSA cannot always be extrapolated in their entirety to other areas. The location of these activities will be determined in a second stage when the needs are determined and technicians are available.

CENTER FOR AGRICULTURAL AND LIVESTOCK RESEARCH FOR THE SEMI-ARID TROPICS

ORGANIZATION CHART

