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Consultant Final Report
IICA/EMBRAPA-PROCENSUL II

OBSERVATIONS AND RECOMMENDATIONS ON THE CURRENT STATE OF AGRICULTURAL IRRIGATION IN BRAZIL

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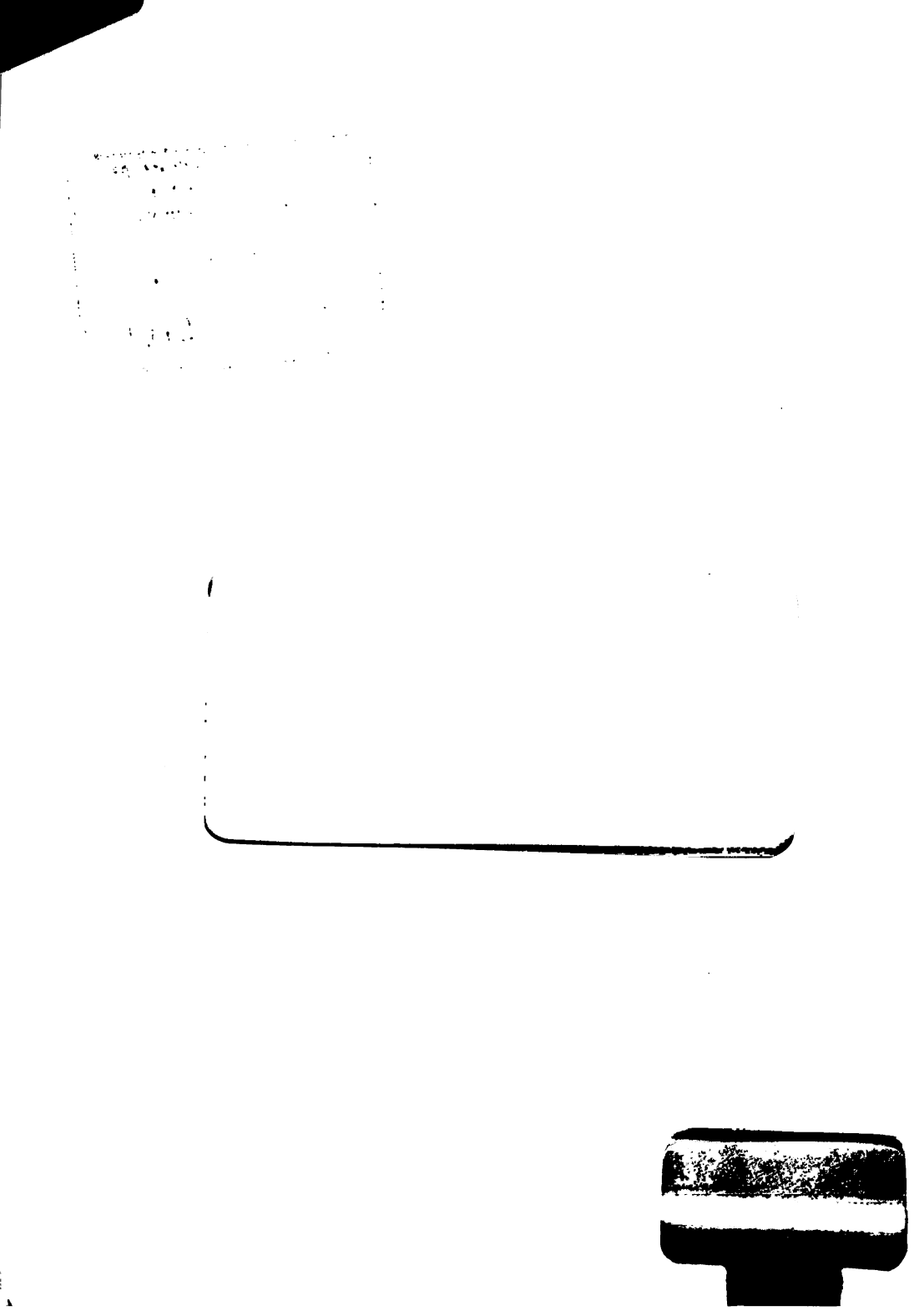

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Christopher M.U.Neale and Gary P. Merkley

Brasília, janeiro de 1989

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APRESENTAÇÃO

A reprodução e difusão dos Relatórios de Consultores, no âmbito restrito das Diretorias das Unidades do Sistema Nacional de Pesquisa Agropecuária, vinculado à EMBRAPA, tem como objetivo principal o de divulgar as atividades desenvolvidas pelos consultores e as opiniões e recomendações geradas sobre os problemas de interesse para a pesquisa agropecuária.

As atividades de consultoria são realizadas no âmbito do Projeto de Desenvolvimento da Pesquisa Agrtopecuária e Difusão de Tecnologia na Região Centro-Sul do Brasil - PROCENSUL II, financiado parcialmente pelo Banco Interamericano de Desenvolvimento - BID e a EMBRAPA conforme os contratos de Empréstimo 139/IC-BR e 760/SF-BR, assinados em 14 de março de 1985 entre o Governo Brasileiro e o BID.

As opiniões dos consultores são inteiramente pessoais e não refletem, necessariamente, o ponto de vista do IICA ou da EMBRAPA.

A coordenação dos Contratos IICA/EMBRAPA agradeceria receber comentários sobre estes relatórios.

Horacio H. Stagno
Coordenador Contratos IICA/EMBRAPA

OBSERVATIONS AND RECOMMENDATIONS

ON THE

CURRENT STATE OF AGRICULTURAL IRRIGATION IN BRAZIL

A Report Submitted to

Instituto Interamericano de Cooperação para a Agricultura

and

Empresa Brasileira de Pesquisa Agropecuária

Ministry of Agriculture, Brasília, D.F.

by

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November 1988

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1.0 INTRODUCTION

This report contains findings and recommendations on the research and practice of irrigated agriculture in Brazil. The four-week stay in Brazil by the authors was funded through the Instituto Interamericano de Cooperação para a Agricultura (IICA) for the Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), Centro de Pesquisa Agropecuaria dos Cerrados (CPAC). The authors, through the Department of Agricultural and Irrigation Engineering and the International Irrigation Center at Utah State University, were called upon by the above-mentioned institutions to carry out three main tasks:

1. To conduct a workshop on various topics related to Irrigation Technology for researchers and technicians of several Brazilian institutions;
2. To visit several EMBRAPA research stations and carry out a review of their research programs in irrigated agriculture; and,
3. To visit irrigated agricultural areas and observe the current state of irrigation technology in Brazil.

A program of visits and activities was drafted at the EMBRAPA/DTC during our first days in Brasilia and is shown in Appendix A. As a result, several EMBRAPA research centers and agricultural regions were visited, during which conversations and interviews with both farmers and research personnel were conducted. A list of contacts and persons interviewed are shown in Appendix B.

2.0 EXECUTIVE SUMMARY

Our visits to the several EMBRAPA research stations and some of the major irrigated agricultural regions of the country were gratifying and a good experience. We were able to interact with farmers, project managers and research scientists and discuss a variety of subjects related to irrigation and agriculture in Brazil.

EMBRAPA, overall, is a fine research institution. Its internal policies indicate a good vision of the future. We were impressed in most part with the quality and training of the research personnel. The established research centers we visited were usually well equipped, offering good working conditions for the scientists and other staff.

As far as irrigation research is concerned, we have identified several topics which could be pursued and which we feel would be beneficial for the development of irrigated agriculture in the country. The existing research in irrigation is proceeding, in general, at a slow pace. This situation should improve as additional scientists return from abroad and increase the cadre of experts in the field. The transfer of knowledge to the end users such as farmers and private agro-industries is being hampered, in most part, by the inefficiencies in the state and federal extension institutions. EMBRAPA could possibly enhance the transfer of technology sections at each center to counteract these deficiencies. The study of surface irrigation methods should be intensified for some of the feasible soils such as the Cerrado soils and the Vertisols. There is presently an over-emphasis towards sprinkler irrigation and center pivot sprinkler irrigation in Brazil.

The bulk of the report is divided into two main chapters containing several sections. Initially, a description of our activities is presented (Chapter 3). This chapter contains a description of our visits to the several EMBRAPA research centers and to some of the irrigated regions and projects in the country. Some conclusive statements and recommendations are made in these sections. The discussion chapter (4) contains some observations and comments on topics which we feel are important policy and research areas for Brazil. Within each section, fairly detailed discussions are carried out and recommendations are given.

A summary of the major comments and recommendations are presented in Chapter 5. These result from discussions and comments outlined in the two previous chapters.

The findings contained herein are based upon field observations and interviews by the authors at the EMBRAPA research centers as well as different locations of agricultural production. Due to the brief nature of the trip and of the specific visits in general, we in no way feel that this report is exhaustive or final in terms of observations and recommendations. However, we hope that some of the information compiled and analyzed herein will be useful for EMBRAPA in their research program in irrigated agriculture.

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3.0 ACTIVITIES DEVELOPED

3.1 VISIT TO EMBRAPA RESEARCH STATIONS

3.1.1 Centro Nacional de Pesquisa de Hortaliças

CNPH/EMBRAPA Brasília, D.F. October 11 and 17

The vegetable experiment center is located south of Brasília in an area of predominantly Cerrado soil types. Current research at the station is on plant breeding, yield improvement, consumptive use of water, and post-harvest processing and storage of produce. The CNPH coordinates the national vegetable research program (PNPH). Research work is also being performed on irrigation methods, including different types of sprinkle irrigation, surface irrigation, and sub-irrigation. The research plots are located on sloping terrain with water being supplied by pumping from a nearby stream.

Experiments for furrow irrigation with gated pipe are currently in the planning stages at the research center. The furrow slopes on individual plots will vary from 0.25% to 1.25%. The results of these tests will be used to determine appropriate slopes, furrow lengths, and discharge rates for furrow irrigation of the Cerrado soils.

It may be difficult to achieve stable discharge rates during the furrow irrigation tests since there is a single pressurized supply line for all of the experimental plots on the farm. This supply line is used to convey pumped water from the nearby stream to a concrete storage tank on the uphill end of the experimental area. It is also used to distribute water to sprinklers on the various field plots. Therefore, the starting and stopping of sprinklers laterals along the supply line will likely cause

flow fluctuations at the furrow irrigation test sites. This potential problem could be rectified by the construction of a small reservoir, or tank, from which the gated pipe would draw water by gravity. The existing head canal could probably be used for this purpose.

Surge-flow irrigation may be a promising technique on these soils since the basic intake rate is high, yet the soil texture is very clayey. Thus, the surface-sealing effect from surge-flow irrigation could improve water application uniformities over traditional continuous-flow furrow irrigation. Furthermore, water savings could be realized due to reduced irrigation time and less surface runoff. The surface sealing of these soils was apparent on corn plots irrigated with gun-type sprinklers. The large water droplets tended to breakdown the soil aggregates thereby creating a relatively impermeable layer at the soil surface due to the re-orientation and compaction of the clay particles. This resulted in a reduction of the effective infiltration rate and caused some surface ponding and runoff.

It appears also that, at the end of the dry season, water shortages could be possible in the stream that supplies irrigation water to the farm. No stream flow rates were available. Additional areas were being developed for the installation of a center pivot sprinkler system.

The CNPH has adequate facilities, equipment and personnel to carry out irrigation research, providing the apparently limited water resources are properly managed and irrigation scheduling is carried out for all fields at the center. The center would benefit from the installation of a complete automated weather station, to supply data to support water use studies on vegetable crops. A weather station does exist on the premises and is used

by another research group within the center. However, this station is located beside buildings and not within the cropped area, where it would have to be placed in order to supply reliable data for evapotranspiration studies on the vegetable crops.

Potential research topics for the CNPH irrigation scientists to pursue would include:

1. Optimal water management techniques for different vegetable crops growing on the Cerrado-type soils. This would include the study of root zone distribution in these soils under irrigation, susceptibility to water stress, actual evapotranspiration of these crops and the development or adaptation of computerized irrigation scheduling programs.

2. Surface irrigation system, design and operation for the Cerrado soils. Semi- automated or automated systems, use of surge flow, efficiency and application uniformity under these systems. Operation of these systems with several vegetable crops, optimal row spacings and mechanization techniques.

3.1.2 Centro Nacional de Pesquisa de Milho e Sorgo

CNPMS/EMBRAPA Sete Lagoas, MG October 21-22

Upon arrival at the research center we were given an overview of the past, present, and future research activities at CNPMS. Much of the current research is targeted toward solving what are seen as the principal problems confronting the continued improvement of agricultural productivity and management of natural resources. Some of the problems cited were: (1) a lack of basic soil, climatic, and water resources information; (2) inadequate use of irrigation scheduling; (3) high cost of energy (electricity) and equipment; and, (4) lack of qualified personnel. The current consequences of these particular problems are: (1) sub-optimal agricultural productivity; (2) high cost of production; and, (3) excess water application. Some of the emerging problems are seen by CNPMS to be: (1) increased conflicts for water supplies among industries, municipalities, and agriculture; (2) contamination of the environment and soil salinization; (3) obsolescence and wear of irrigation equipment and farm machinery; and (4) inability to continue financing agricultural development.

Experimental work is being done here on fertigation and application of insecticides through sprinklers. Some different fungicides are also being compared on bean crops. The chemical injection equipment is both imported and produced domestically, but the imported equipment is very expensive. The results and experience of CNPMS researchers with these experiments will be very valuable to farmers all over the country, and of course they should be made available through publications and workshops, or other forms of

training.

There is continuing work at CNPMS of much past research on the productivity effects of different fertilizer applications and different crop varieties. Corn yields, in particular, have increased significantly due to the results of such experimentation at this EMBRAPA center. Of the 300 irrigated hectares at the center, 80 hectares are used exclusively for research, and the rest is used for seed production and other income-generating undertakings. The seeds produced at the center are sold to several small companies, and the profits are used to help fund CNPMS research. The center is essentially self-sufficient in terms of automobile and tractor fuel since they produce alcohol from sugarcane grown on-site.

Of the 80 hectares used for research, there are 60 separate field locations distributed throughout the center's 2000-hectare land area. The research plots are separated in this way to avoid cross-pollination during varietal experiments with corn and sorghum. Since there is a preponderance of sprinkle irrigation at the center, there must be a large number of portable sprinkler systems with pumps that can be either moved around, or left at a particular plot. In this way, they have more flexibility for scheduling irrigations, even though there are so many separate plot locations.

Researchers at the center are also involved in comparative tests of agricultural machinery produced by different manufacturers. For example, field trials were being conducted using different brands of seed planting equipment. The results of such trials are eventually made public so that farmers can be better prepared to select equipment on the market from the different manufacturers. This is good because it stimulates equipment

development and improvement, and it provides a non-biased pool of comparative information about the available equipment options. Tests on the susceptibility of the Cerrado soil to compaction at different moisture levels and machinery treatments have also been undertaken at this center.

Overall, we were very impressed with the professionalism of the researchers and support staff at CNPMS. In spite of many significant achievements, no one that we talked to seemed entirely satisfied with the current research results, and they were striving to improve upon them and to conduct research in different topics.

3.1.3 Centro de Pesquisa Agropecuaria do Trópico Semi-Árido

CPATSA/EMBRAPA Petrolina, PE October 24-25

Our first meeting at the center was with the station director, with whom we talked about the purpose of our visit and organized a schedule of activities. This center presently has about 80 scientists, 55 of whom are EMBRAPA employees and the remainder are from cooperating institutions. The main thrust of the research carried out at the center has been directed to the utilization of resources within the semi-arid region surrounding the center. Research topics include subjects such as management of livestock (e.g. cattle and goats) in the Caatinga, forestry science, natural resource utilization, agricultural mechanization using animal traction, and irrigated agriculture.

In the area of water resources utilization, several projects are planned or are beginning. An interdisciplinary team will be studying water resource utilization within several watersheds in the northeast. The initial plan is to monitor a sub-watershed within the area of a CODEVASF irrigation project still to be developed, assessing the environmental and social impact of the project and evaluating the efficiency of water resource utilization. Other planned research comprises the estimate of production costs and the study of the production system under irrigated agriculture in the region, for different levels of irrigation technology. The production system (soil, crop and water use) will be monitored under three center pivots throughout a season. One of the pivots is located on the experiment station, a second at the Cooperativa Agricola de Cotia property and a third at Frutinor, a large farming company. In the second

year of the study, a portion of the area under the pivots would be managed according to their recommendations and results compared to the remaining area under usual agricultural practices. Crops to be investigated would be tomatoes, onions and melons. Melons at Frutinor are planted under the pivot but irrigated with drop applicators dragged by the pivot in blocked circular furrows. Melons cannot be successfully produced under sprinkler irrigation due to fungal problems that tend to develop.

We view this type of research activity as very positive because benefits such as increased yields and energy savings can be directly appreciated by the farmer or project manager, and usually the improved agricultural practices are incorporated into the production scheme of the entire farm. In this way, the technology is transferred directly. Surprisingly, not all irrigation scientists at the station were to be involved in this research.

Some of the specific field irrigation experiments we visited were:

1. Field comparisons between several trickle irrigation systems to evaluate performance, quality, durability and cost. Unfortunately none of the partial results were available or published;

2. A comparison of some furrow irrigation application methods on fruit trees, including blocked furrows, level furrows, constant inflow and cutback water applications. This research appeared to be more on a demonstration level than on a scientific level;

3. Evaluation of sprinkler irrigation performance on systems belonging to colonos at the Nilo Coelho project; and,

4. Evaluation and demonstration of a buried porous cup-type irrigation system. This type of system appears to be more adequate for small areas where water is very limited and subsistence-type trees and crops are planted.

The center owned a powerful DEC VAX computer which, as explained to us, was to be used in setting up a database of climatic, crop, and water resource information for the entire northeast region of Brazil. Though this computer is appropriate for large databases and networking, no relational database software was installed, nor was a compiler of any sort available. Only SAS (a statistical package) was available on that system. Unfortunately, the center has had problems in keeping a system analyst and operator at the location. However, this computer could become a useful asset if more software were available and if it were networked with the microcomputers available at the center. In this way, large statistical and computationally intensive problems, as well as very large models, could be run on the VAX minicomputer, while smaller data analysis jobs could be run on the microcomputers.

Overall, we think that the irrigation research effort at this center should be more active and productive. Of the five EMBRAPA research centers we visited which carry out research in irrigated agriculture, CPATSA was the only center to be located within a major agricultural region which depended substantially on irrigation for crop production. Presently, there are over 80,000 hectares of irrigated agriculture in the Petrolina/Juazeiro area. However, the scope of the research at the center does not presently reflect the importance that irrigation has in the region.

Several large and significant CODEVASF projects exist in the area, which use both hand-move sprinkler and furrow irrigation systems. In general, the colonos are placed on the sandier soils which present unique management problems under both types of irrigation systems. Some of the future CODEVASF projects will be located on Vertisols type soils which are

more appropriate for surface irrigation due to their higher clay content and lower infiltration rates. Apparently, CPATSA conducts research on another station in the region in which extensive areas of Vertisols are present. Surface irrigation research could be carried out on these soils in order to support the new CODEVASF projects..

There are also several large private farming companies in the region which use trickle irrigation on fruits for export, in addition to center pivot irrigation on tomatoes and other high-value crops. Soil conditions vary greatly in these areas which are under intensive agricultural use, and soil salinity should be a concern and definitely a major research thrust for the center.

In sum, the area of influence of CPATSA presents a very large potential for interesting and necessary research topics in irrigation engineering and agriculture. In addition, the center has the soil, water and climatic conditions to execute this research. Additional PhD level research personnel may be needed to intensify research efforts in irrigation.

3.1.4 Centro Nacional de Pesquisa de Agricultura Irrigada

CNPAI/EMBRAPA Parnaiba, PI October 27

At this center, we met with approximately fifteen scientists and discussed the research scope and priorities of the CNPAI. The CNPAI research group is fairly young, and the center itself is effectively less than one year old. Agricultural development is in initial stages in this region, and the existing and potential farmers are inexperienced in irrigation and crop production in general.

Most of the soils that will be irrigated in the two large projects being developed, are extremely sandy (85-93% sand). Thus, these soils are extremely low in organic matter and natural fertility and, nutrients and water will have to be supplied to the crops on a very frequent basis. Irrigation research and technology application in Parnaiba, under these soil conditions will involve much pioneering work. Surface irrigation is not feasible because of a combination of high infiltration rates and the absence of surface-sealing characteristics (in contrast to the Cerrado soils which do exhibit some surface sealing). Furthermore, the required frequency of irrigation and correspondingly light applications due to the low water holding capacities of the sandy soils are not particularly conducive to surface irrigation because deep percolation losses would be large. We were told that the windy period at Parnaiba is from April to November, thus coinciding with the winter, or dry season (during which irrigation is essential for agricultural production since rain is insufficient). The presence of a continuous strong wind (averaging 5 to 7 meters per second) influences the efficiency of sprinkler irrigation (in

terms of water application), causing it to be lower than what which would normally be expected. This will be particularly problematic under center pivots, unless the sprinkler heads are lowered below the lateral pipeline and lower pressure nozzles are used. During our visit, we observed a center pivot operating under a strong wind. Extensive wind drift was evident as a consequence of high sprinkler positioning. The corn crop, under this particular center pivot, showed leaves and stalks oriented in the same direction due to constant wind coming from the ocean.

Under these adverse and special conditions, the use of localized irrigation systems such as trickle, drip and microjet irrigation may be an appropriate choice, provided that the crops grown are of sufficient value to justify the equipment cost and maintenance. Some trickle irrigation test plots were visited at the CNPAI research area, and we were told that additional trials using different equipment were planned for future evaluations. The two influencing factors of sandy soils and windy conditions tend to favor localized irrigation in this area. Another factor that makes localized irrigation more attractive than sprinkle irrigation is the cost of electric energy for pumping. Electric energy availability and reliability will be a concern in this remote area, at least during the next few years. One of the pumping plants on the CNPAI research center had four large diesel engines for generating electricity in case of an electrical power failure. The possibility of using these generators in circumstances in which the cost of diesel and maintenance would be less expensive than buying electrical power was mentioned. This is relatively unique to Brazilian conditions since diesel is usually more expensive than electricity, and virtually all pumps that we saw during our stay in the

country were supplied by main electrical power networks, not by self-contained generating stations. Thus, the energy savings from using localized irrigation, compared to sprinkle irrigation, may be significant in Northern Piaui.

Two new government projects which will irrigate 20,000 hectares are now under construction at Parnaiba. The land to be irrigated has been recently cleared of natural vegetation, and the soils are extremely sandy. It was necessary to transport less sandy soils from nearby areas to provide an adequate base for the concrete-lined canals. Water will be pumped from the Parnaiba river into the main canal, and secondary pumping stations will pressurize mainlines to center pivots. The intended irrigation scheme apparently includes locating up to eight individual farmers under a single center pivot, in which each will be allocated a proportional sector of the circular area. The logistic and sociologic problems under such a scheme may ultimately render it infeasible, especially if different crops are grown under a single pivot. However, even if all farmers under one pivot plant the same crop, it would presumably need to be planted in all sectors at the same time to avoid irrigation scheduling conflicts and inefficiency of machinery operation for soil preparation, etc. The physical, climatic, operational, and sociological conditions of this irrigation project will provide ample challenges to the project management and to the CNPAI researchers.

During the visit, the Programa Nacional de Pesquisa (PNP) on Irrigation Technology was discussed with the center's technical director. A list of the recently approved projects for Brazil through this PNP was made available for discussion and analysis. Most of these new research

projects had been awarded to CNPAI due to the obvious need for extensive agricultural research in that region. The research topics involved:

1. The study of different crops (caupi bean, tomatoes, corn, soybean, cara and different fruits) under center pivot and other types of sprinkler irrigation for the soil conditions of the region;

2. The study of center pivot and conventional sprinkler systems under the local conditions;

3. The study of localized irrigation on fruit trees, and the distribution of water in the sandy soils under these types of systems; and,

4. Some crop studies involving economics of production for different crops and, crop production functions relative to water and nutrients availability.

The results of these studies will definitely be useful since there is a complete lack of agricultural experience in this region. However, this research agenda is fairly diverse and ambitious, especially considering the inexperience of the researchers and the relatively difficult agricultural conditions which exist in the Parnaíba region. Of the twenty-nine new projects awarded to CNPAI, twelve are related to the study of crops under sprinkler and/or center pivot irrigation and only two relate to trickle or drip irrigation systems. We hope this emphasis on sprinkler irrigation research at the center will result in the development of optimal management strategies for the sprinkler systems which will be installed within the nearby project being developed, as well as show that more desirable alternatives in localized irrigation might be economically and technically feasible for the soil and wind conditions at Parnaíba, and should be pursued.

The location of a national research center for irrigated agriculture in Parnaíba may not be entirely expedient, considering the technical

difficulties mentioned above. However, the center is now a reality and the large project it will support is presently being constructed. Additional Ph.D.-level researchers are needed to aid in the supervising and execution of the stated research agenda.

Due to the importance of the PNP on Irrigation Technology, we encourage the continuation of the practice, within EMBRAPA, of involving irrigation scientists from other research centers in determining research priorities and awarding research grants for irrigated agriculture in the country.

3.1.5 Centro de Pesquisa Agropecuaria dos Cerrados

EMBRAPA/CPAC October 31 - November 1.

The visit to the CPAC was carried out over a two day period. The center comprises and area of 3500 Ha and has a total staff of over 400 people of which 81 are scientists and 60 administrative personnel. On the first day we met with scientists and personnel of the technology transfer group of the center. The CPAC and CNPMS, were the only EMBRAPA research centers that we visited that appeared to have an ongoing and active training and transfer of technology program. Several extension issues were discussed which, at that point in our trip through Brazil, we had noted as a definite deficient area.

Very little is presently being done at the center in irrigation research. In the past, the research program had been quite active, with surface irrigation on wheat, evapotranspiration studies on different crops and other pertinent research. Apparently, most of the irrigation researchers had either been transferred to the Ministry of Irrigation or were abroad at graduate school. We were told that three of the center scientists were presently carrying out Ph.D studies in irrigation engineering at the University of Arizona, which has an excellent program. However, it might be of better interest for EMBRAPA to encourage scientists from the same center to carry out graduate studies at different schools, so that they can be exposed to different lines of thought and research.

The CPAC has allot to offer in terms of research capabilities. It is very well equipped and has a very good cadre of young aggressive scientists. Unfortunately, presently it is lacking in irrigation scientists. The center has adequate irrigation water supplies and a

network of canals and pipelines for different types of systems. We visited a trickle irrigation system applied to fruit trees, a center pivot which was used to grow several crops and an area for surface irrigation research.

Some of the research being done in the area of soil-water-plant relationships consisted of the study of plant root development in the Cerrado soils and the interaction, and penetration of the roots through the resistant, and sometimes compacted layer which forms on these soils under mechanization. The study of optimum moisture conditions for root penetration was being researched. This is a topic which would benefit from an interdisciplinary approach involving scientists from CPAC and CNPMS which are working on similar aspects of the problem.

The weather station at the center is automated and well equipped with several instruments and recording devices. These are very useful tools in the accurate study of crop water use in the Cerrado region.

The center has adequate computer facilities and a remote sensing laboratory with some radiometers and image processing equipment. Apparently, there is some cooperation between some center scientists and the INPE in Sao Jose dos Campos which is very positive, as the latter has been very poor in basic remote sensing research applied to agriculture and water resources over the last few years.

On the second day, we met with the station director and discussed several research issues. He gave us a short presentation on the research goals of the CPAC. He was well aware of some of the problems related to irrigated agriculture in Brazil, among which he mentioned some of the Cerrado problems such as (1) the unfamiliarity with irrigation in the region, (2) water supply and droughts, (3) soil fertility and (4)

production systems. He mentioned that the present research emphasis at the center was concentrated toward basic research in several areas, efficiency of production systems and the transfer of technology through publications and training.

In sum, the CPAC has all the conditions, resources and equipment to carry out some very valuable irrigation related research. Considering that several of the irrigation scientists from the center are either on loan, or abroad in graduate school, as well as the limited resources for purchasing equipment within EMBRAPA, more active cooperation is encouraged with scientists of other centers in terms of sharing facilities and equipment.

Joint research between CPAC and CNPH is encouraged in the area of design and operation of automated and semi-automated surface irrigation systems for the Cerrado soils. The study of new techniques such as surge irrigation is recommended as well as determining the potential areas within the Cerrado region which are suitable for surface irrigation. This will require the outlining of the necessary physical conditions, water resource availability and economic considerations required for the installation of surface systems as opposed to pressurized systems.

3.2 VISITS TO AGRICULTURAL REGIONS UNDER IRRIGATION

3.2.1 Guaira region, Sao Paulo October 13-14

The municipality of Guaira is an 80,000-hectare agricultural area located in Northern Sao Paulo state. Approximately 10,300 hectares are irrigated within this area. The area is partially bordered by the Rio Grande and Rio Pardo. A list of the crops grown in the region would include corn, soybeans, sugarcane, rice, cotton, tomatoes, wheat, beans, and others. Most of the soils are characterized by the "Cerrado" red clays, which are found throughout a large contiguous region in central Brazil. The soils are somewhat unique in that they exhibit relatively high infiltration rates (on the order of 60 mm/hr, under mechanization) in spite of the high clay content which predominates. Structurally, these soils are highly aggregated and resemble that of a sandy soil. The natural acidity of these soils (approximately pH 4.5) requires the incorporation of lime in sufficient quantities so as to increase the pH to about 6.5, a more favorable level for agricultural production. As is typically the case with clay soils, the "workable" range of soil moisture levels for mechanical tillage is relatively narrow. Machinery operations at low moisture levels are difficult because of soil hardness, and soil compaction is a potential problem at higher moisture contents.

Evidence of a resistant soil layer at about a 30-centimeter depth was found in more than one irrigated field during this brief visit to the area. Farmers and agricultural researchers in Guaira seem to be increasingly concerned with soil compaction since it restricts root growth and diminishes the natural drainage capacity in these deep soils. However, in spite of the

fact that the Guaira farmers we interviewed were aware of the soil compaction problem, they continue to till the soils at moisture levels that are higher than optimal. The principal reason for this is that the farmers do not wish to wait too long between the harvest of one crop and the planting of a new crop. Thus, if rains occur during this period between crops, the soils may be tilled under excessively wet conditions because of the time constraints in getting the next crop planted. In order to decrease the time period between successive harvesting and planting cycles, there is a current trend among farmers to use heavy discing instead of plowing, and to use larger tractors. Thus the tillage operations can be performed faster, and the cutting of crop residues, such as corn stalks, and the breakdown of soil clods are not as problematic. However, heavy disc harrows such as the ROME disc harrow are contributing to the compaction problems in the region.

The practice of sub-soiling, or chiseling, is used by some of the farmers to combat this compaction problem, but others have discontinued sub-soiling because the perceived benefit is not enough to justify the cost. One farmer said that sub-soiling only produced "grooves" under the soil surface, and did not break the hardened layer adequately. This may be partially explained by sub-soiling at relatively high moisture contents, or by failing to complete two passes at opposing angles. Another observation was that sub-soiling was actually detrimental to overall agricultural production. However, it may be reasoned that the detrimental effect of sub-soiling in such cases is due to over-application of irrigation water, thus leaching soil nutrients below the crop root zone. Another possible explanation is that water is applied less frequently than required, and

that the absence of a relatively impermeable soil layer allows water to leave the root zone into deeper strata.

Local agricultural researchers were aware of the techniques and benefits of irrigation scheduling in terms of water conservation, soil management, and agricultural productivity. However, the idea of irrigation scheduling has not yet been adopted by the farming community in general. The timing of irrigations, and the depths of application, seem to be rather arbitrary. Where sufficient water is available, it appears that farmers tend to over-irrigate their crops in order to ensure that water is not lacking in the crop root zone. The introduction of irrigation scheduling as a consistent farming practice would represent a significant improvement is the management of water, effectiveness of agricultural inputs (e.g. fertilizers, pesticides, etc.), and conservation of energy.

The rapid proliferation of center pivots in this area in recent years has contributed to the modernization of agricultural practices, and it has converted many fields from rainfed production to irrigated lands. Currently there are 154 center pivots in the Guaira region, irrigating a combined area of 8,690 hectares. Many of the earlier pivots that were designed to operate at medium and high pressures have been subsequently converted to low pressure sprinklers. The impetus for this conversion has been the rising cost of energy for pumping. According to one Guaira farmer, the portion of overall agricultural production costs which can be directly attributed to energy was on the order of 6% from 1980-84, increasing to 15% during 1985-86, and is currently in the range of 25-30%. These energy costs correspond to the price of electrical power since virtually all pumps and pivot drive mechanisms in Guaira are electrically operated.

Center pivots were introduced into the Guaira region in 1979, and the original control mechanisms for lateral alignment and locomotion were imported from the United States. Since then, the center pivots are manufactured entirely in Brazil, and they have improved both in terms of price and flexibility of configuration for the requirements of individual customers. Conversations with farmers and researchers in Guaira (and elsewhere in Brazil) have made it apparent that marketing efforts on the part of center pivot manufacturers have contributed significantly to the acceptance and use of this irrigation method. Another reason frequently cited is the lack of reliable labor available for the less mechanized forms of irrigation. The practice of applying fertilizers through center pivot systems ("fertigation") is common, as is the injection of pesticides and fungicides, etc.

One farmer claimed that the current cost of a center pivot is more than the value of the land that it irrigates. Thus, it may be preferable to buy land and "dry-land" farm it (i.e. without supplemental irrigation), rather than purchase a center pivot for an existing field. However, many people said that center pivots have been paid for through increased production in as few as one or two seasons, thereby justifying their use in spite of the high cost of pumping. Many farmers do not operate their center pivots during peak electrical demand periods because of the increased energy cost. Yet, the periods of peak electrical demand tend to coincide with the least windy periods of the day. Wind contributes to non-uniformity of water application due to wind drift - a phenomenon that was repeatedly observed during our brief visit to the region.

In sum, it was impressive to see the boom of development and production that irrigated agriculture has brought to the Guaira region, considering that these systems are privately owned by farmers. The principal contributions that research can bring to this region are improved agricultural practices in the areas of soil mechanization and conservation and irrigation water management, specifically for center pivot irrigation on the cerrado type soils.

3.2.2 Petrolina/Juazeiro Region, PE/BA October 24-25

As part of our visit to CPATSA, we were shown some of the CODEVASF as well as private irrigation projects in the region.

Projeto Bebedouro

Our first visit in this series was a tour of the Projeto Bebedouro. This project, initiated in 1966-67, has around 2000 ha of irrigated land, where about 1100 ha consists of small farmers and 900 ha for use by private enterprise. We began our visit at the main pumping station on the San Francisco river where a total of 5 pumps can operate up to a total capacity of 13320 m^3/hour. The main canal appeared to be in good condition and we were told that it was cleaned once a year. We visited some small fields belonging to colonos on the project. Asparagus was being planted. The soils had an approximately 65-70% sand content and 12% clay content. The asparagus field was being irrigated by hand-move sprinkler system. Surface irrigation is also used on other areas of this project, despite the sandy soils.

Projeto Mandacaru

The following day we were taken by two EMBRAPA scientists to visit the Mandacaru project which has an area of 370 Ha. We began our tour at the Campo Experimental de Mandacaru where EMBRAPA has some ongoing research. At this station, the main type of soils were Vertisols which are the same type as the soils at the Projeto Tourao and the soon to be developed Projeto Salitre (20000 Ha). We visited some experimental citrus production under large furrow irrigation and some vineyards under trickle irrigation. After leaving the Campo Experimental, we were taken to see the colono area of the project. At this point, the main canal was lined with black pvc plastic

The canal was in good condition, but some of the concrete turnout structures we saw were in bad condition on the field side of the canal. The colono fields we visited were being planted to melons, tomatoes, onions and grapes. The melons had a mildew problem but were at the end of the harvesting period, the quality looked good. The grapes looked outstanding. Both grapes and melons were furrow irrigated. The soils were Vertisols and the slopes and lengths of the furrows looked adequate.

At the Mandacaru project, we were able to talk to a colono which was supervising the harvest on his land. He apparently was a successful farmer as he owned a car and had two sons in college. He supported two full time workers throughout the year, and hired several more during the harvest period. His main crops were tomatoes, melons and onions. The tomatoes were grown for paste under a contract with a nearby processing company. Financing was available through a bank, after the presentation of a signed contract with the tomato paste processing company. The cooperative charged the colonos for the irrigation water and for services. Ten percent of his production went to the cooperative to pay for technical assistance, crop marketing and ditch rider services.

Irrigation water was available three times a week at the Mandacaru project. The farmer would fill out a card at the cooperative center requesting water for the desired days. CODEVASF still controlled the pumping station of this project. The pumping schedule was fixed, starting at 4:30 in the morning and ending around 5:00 pm every day. The ditch rider would start opening turnout gates between 6:00 and 7:00 am.

The Projeto Mandacaru was the most successful CODEVASF project among those we visited in the region. It was in an advanced stage of

emancipation, with most of the colonos owning their plots outright. The cooperative was well organized and efficient, offering good services to the members. It was planning to negotiate future contracts with the tomato paste companies for all the members. This would definitely be advantageous to the colonos. About the only thing that CODEVASF still controlled at Mandacaru, was the pumping station and its maintenance. Canal maintenance was carried out by the cooperative and its associates.

Projeto Curaca

This project started around 1978-79, and has an area of 2300 Ha. We visited the private enterprise section of the project; specifically a company named FRUTINOR. The company had around 500 ha under production. They owned four center pivots of 88 ha each for tomato and melon production, 30 ha of lemons, 40 ha of grapes and were in the process of doubling the area of grape production. They also owned some more land across the San Francisco river, where they were developing and additional 150 Ha of grapes for export. Most of their grape production was exported to the United States and was of excellent quality. The grapes were irrigated via trickle irrigation and the lemons by surface irrigation. Fertilizer was applied through the system.

The pivots were used mainly for industrial tomato production. Harvesting was done by manual labor or by a tomato harvester imported from the U.S. The company hired up to 400 people, depending on the harvesting schedule. They planned eventually to substitute most of the tomato harvesting labor with automated harvesting machines as they considered the labor non-reliable. The company also planted some melons under the pivots. In this case, drop hoses with energy dissipators were attached to the

sprinkler nozzles and dragged along the circular furrows which were blocked every few meters. This was done to avoid wetting the canopy of the melon plant, thus decreasing the incidence of fungal diseases. It also resulted in high application efficiencies for the irrigations.

FRUTINOR had on site, a consultant from their marketing partners in the U.S. which helped them with production management and quality control. The production manager for FRUTINOR was a dynamic individual who was aware of the importance of research for optimal crop production. He had experimented with new crops such as Passion Fruit (Maracuja) and was carrying out research to optimize irrigation on lemon trees. Though they were aggressively pursuing profits, the company was carrying out some good agricultural and irrigation practices. The help of an experienced consultant was obviously creating positive results. Irrigation scheduling was being carried out on the grapes and tomatoes. The irrigation water was supplied by CODEVASF which operated and maintained the entire canal system. Some of the larger farms had there own reservoir from where they could pump water for irrigating the grapes in case of a water shortage in the main canal.

Nilo Coelho

This project started around 1985-86 and has a planned area of 15000 Ha, with the area divided into parcels for colonos, small and large private enterprises. We visited an area which was under sprinkle irrigation. Each plot of land belonging to a colono was supplied with a hookup point for the portable aluminum piping. At the time the colonos claimed the land, they received two laterals with risers and sprinkler heads to work with. On one plot we visited, the colono was present along with two workers which

were hand hoeing a cucumber field. The cucumber plants were wilted from water stress and the farmer said he would irrigate them next morning. The soils were very sandy. This particular colono had built a small house on part of his non-irrigated claim land. He used this house as a base to eat meals from, and rest during the day. Most colonos, however lived in houses in the agro-vilas which were built as part of the project. This was mentioned to us as a problem, as some colonos live up to 5 km from their plots. However there are social and economical benefits for having the agro-vilas so it is arguable as to which system is better.

It was apparent that maintenance was a problem with the sprinkler systems on this project. We observed broken sprinkler heads, leaky riser joints and leaky pipe joints. Most of these problems were probably caused by mis-handling of the equipment over time, coupled with possible low quality of the equipment itself. Though each field had its own water meter and valve, the cooperative was charging for the water according to the area of the plot and not according to the water use by each colono. Thus, there is no incentive to be efficient in irrigation water use. We observed extensive wind drift on a particular system during an afternoon irrigation, which was probably causing non-uniform applications. The same system had several bad leaks at pipe joints.

Another source of inefficiencies and non-uniformities of application is the sometimes large fluctuations in pressure in the main pipeline. This causes the sprinklers to work outside of their design pressure resulting in inefficient spray patterns. The pump house we visited was pressurizing a main line for 80 fields of approximately 7 hectares each. There were six pumps installed in parallel, pumping out of a small reservoir into a 70 cm

diameter (approximately) steel pipeline. There appeared to be some pressure sensing devices installed probably to control the shut-off of the pumps as the pressure increases. The large fluctuations in pressure are due to pumps turning on and off as a result of the random demand for water at the colono fields. It was mentioned that the colonos start irrigating anywhere from 7:00 to 10:00 am. No scheduling was being carried out on these fields.

Comments:

It was obvious that the advent of irrigated agriculture has brought a greater wealth to the Petrolina/Juazeiro region. Most of the projects we visited had what appeared to be thriving agro-vilas. In addition, other small settlements have been established around these projects which house most of the agricultural labor that work on, either the colono plots or the private sector farms.

The success of some projects relative to others is a result of many factors some of which were not evident to us due to the short nature of the visits. Some of the factors that contribute towards the overall project outcome are: (1) the careful selection of colonos based on prior agricultural experience, (2) the quality of the soils in terms of fertility and physical structure. It appeared that the colonos usually ended up in the more sandy and less fertile soils of a particular project. Thus, colonos that usually have no prior irrigation experience encounter the most difficult conditions for irrigated agriculture. (3) The design concept of the project. In the past, the projects were mostly designed for surface irrigation. This resulted in the use of these systems on sometimes very sandy soils, leading to inefficiencies and low yields due to leaching of nutrients or, water stress. The present thrust seems to be towards

sprinkler irrigation systems, which in the case of the sandy soils, makes sense. However, inefficiencies due to operation and maintenance of these systems needs to be corrected. In addition, an irrigation scheduling scheme needs to be studied and put in place in order to decrease the pressure fluctuation problem within the main pipeline system.

The two more successful projects visited were the Mandacaru and Bebedouro projects. These happen to be the older projects with greater operational experience, situated on more fertile soils and where the selection of colonos was based on their previous agricultural experience. The Nilo Coelho project is situated on shallow and very sandy soils which poses several management difficulties for the inexperienced colonos. In the rainy season, it suffers from drainage problems due to the shallow topsoil. In addition, it is a relatively new project.

It is our opinion, that CODEVASF should not disregard surface irrigation as an alternative for their new projects. The type of irrigation system to be used in a new project should be selected on an engineering criteria, considering the soil types, natural slope of the soils, availability and source of the irrigation water, crops to be planted etc. In addition, economic considerations should be taken into account, such as the availability, reliability and cost of electricity for pumping, infrastructure and maintenance costs for different types of system, the building of dams for both hydropower and irrigation purposes etc.

We view the CODEVASF new policy of emancipation and privatization of the existing irrigated areas and projects as very positive. The success of this policy will depend on the feasibility of the project with regards to the some of the topics mentioned above. In addition, if the cooperatives

are active and organized, and are able to provide the necessary services such as technical assistance and marketing of the agricultural products at good prices, the privatization will be fulfilled successfully.

3.2.3 Jaiba Irrigation District November 3

The Jaiba Irrigation District, located on the São Francisco River in Northern Minas Gerais state, was created to speed up the process of emancipation of the Project Jaiba, from the Companhia de Desenvolvimento do Vale do São Francisco (CODEVASF). The first phase of the Jaiba project is now under way, in which some 22,000 hectares will be irrigated in the project area. The project goal is to eventually bring 80,000 hectares into irrigated agricultural production, and the existing main conveyance and pumping infrastructure has already been designed and constructed with sufficient flow capacity to meet this goal. Consequently, the main canals and pumping stations are of much larger capacity than the current irrigated area requires - at this time the two main canal reaches are operated as both conveyance and water storage facilities. But this will change as more irrigated area is developed within the project lands, and the operational demands imposed upon the main system (i.e. canals, flow control structures, and pumps) intensify incrementally.

During our 6 hour stay at Jaiba, we had the opportunity to visit the two main pumping stations (EB1 and EB2) as well as certain reaches of the main canal. EB1 will have the capacity of pumping up to 80 m^3/s with pumps of 10 m^3/s and 5 m^3/s capacity. Nine pumps were already installed in this pump house. All structures were new and well built. The EB2 pumping station will have the capacity 65 m^3/s with 15 pumps installed. Presently

only 4 pumps are installed in this pump house. Pumps in EB1 can be manually turned on or controlled with a PC computer from the control room. The intention of the district (and CODEVASF) is to control the pumps at the EB2 pump house from the main operation center in EB1 via remote control. In addition, they are studying the automation of certain structures in the main system.

Operational considerations will determine to a large extent the ability of the main system to meet its anticipated performance in delivering irrigation water to the multiple downstream turnout locations. The expected performance can be measured in terms of delivery reliability, responsiveness to changing irrigation demands, and hydraulic stability. Maximum benefit can be derived from the main system when its operation is not a constraint to on-farm irrigation practices and agricultural production. Corresponding investments in main system operation are, therefore, justified because of the large expenditures on design and construction. Another significant justification for main system operational investments will be the relatively large costs associated with energy for pumping at several locations within the project area. It will be expedient to formulate an operational plan for the irrigation district before the irrigation demands fully develop.

Automation is one alternative that is currently being considered for the pumping plants; however, other less-expensive alternatives exist. One of these alternatives would be the application of transient hydraulic modeling to operational decision-making and main system water management. The operational plan that is ultimately devised and implemented should enable a flexible delivery scheduling to the irrigated areas, rather than facilitate the operators' job of regulating the canals and pumps by imposing

rigid water deliveries on the farmers. With flexible delivery scheduling the main system can be essentially removed as a constraint to on-farm agricultural practices.

Pumping costs associated with the operation of the EB-1 and EB-2 stations on the main canal may become very high when the district is further expanded to meet its design goals. The large requirements for electrical power will be a major part of the operational costs, and the location of the district with respect to the power supply will complicate the availability of electricity. This is because the irrigation district is presently at the end of the power supply lines which originate in central Minas Gerais State. Operational coordination between the pumping plants and other hydraulic infrastructure will be essential to minimize the required use of the pumps, and consequently minimize the associated cost. Such coordination may be achieved through an expert system that takes into account the various factors affecting pump operation.

We visited the nearly-completed "F-Area" of the irrigation district. It is an area that will accommodate some 342 colonos, each of whom has already been assigned a 5-hectare plot of land. Planting is scheduled to begin for the first time in November of this year. The area will be irrigated exclusively by hand-move sprinklers, and these will be supplied by buried mainlines. The mainlines will be pressurized using four pumping stations that will draw water from the two lateral canals that extend into the F-area. Since the sand content of the soil in this area is relatively high, it is probably appropriate that sprinkle irrigation will be used. These sandy soils are also lacking in organic matter and some essential plant nutrients. One concern, should be the use of the sprinklers in the

area by the colonos since the colonos are essentially inexperienced in farming and irrigation practices. The agronomic and soil and water management advice provided through CNPMS/EMBRAPA in Sete Lagoas, MG will be very valuable to the success of the farmers, especially during the first few years of production. As in many of the other Brazilian agricultural areas that we visited it may be advantageous to irrigate at night in order to conserve water. The commonly high temperatures and the presence of wind will undoubtedly contribute to application non-uniformities and wind drift losses, particularly during the day time. The implementation of an irrigation scheduling program for the "F-area" colonos would reduce water use and increase water use efficiency if the operational scheme takes into consideration the maintenance of optimum working pressures within the sprinkler mainline system.

Apparently there is no shortage of potential colonos to occupy the newly-developed agricultural lands at Jaiba. As such, the next phase of the project will probably have farm plots allotted before the completion of the construction. Some of the planned areas for the next phase of the project will have soils of higher clay content than those which exist in the F-area. Thus, it may be preferable to employ surface irrigation methods rather than pressurized systems (e.g. hand-move sprinklers). With surface irrigation the pumping costs would be reduced, or perhaps eliminated altogether, in the on-farm areas. Furthermore, the application efficiencies could be as high or higher than those obtained with inefficiently used sprinkler systems, and vegetable crops could be grown without causing mold problems associated with crop wetting. The climate at Jaiba seems to be

supportive of vegetable and other high-value crops that would tend to make the irrigation district more self-sustaining.

In all, the size and construction of the existing structures at Jaiba were impressive. The project would have benefitted from a comprehensive planning process in the past which may have avoided such a large capital investment up front. The electric energy and maintenance costs of such a large infrastructure will have to be subsidized in the future, until all areas are developed and the full potential of the project is realized.

3.3 WORKSHOP ON IRRIGATION TECHNOLOGY

A workshop on irrigation technology was organized for our second week in Brasilia, sponsored by EMBRAPA/DTC and the CPAC. It was scheduled to initiate immediately after a workshop on agrometeorology also organized by the DTC. The program for the presentations is shown below. On the average we had around 15 participants on each of the days. The participants worked for several institutions among which were EMBRAPA, EMBRATER, CODEVASF, PRONI and Ministry of Irrigation. Some good discussions were carried out among participants and instructional staff, on several of the subjects presented. The informal, workshop format encouraged discussions and feedback from the participants.

The instructors were Dr. Christopher Neale and Dr. Gary Merkley from Utah State University, Dr. Carlos Oliveira from the CNPH and Dr. Jamil Macedo from the CPAC.

WORKSHOP SOBRE TECHNOLOGIA DE IRRIGACAO

PEROIODO: 19-20 outubro de 1988
LOCAL: Dia 19/10, no Auditorio do CENARGEN
Dia 20/10, na sala 309, ao lado da sala do Diretor Derli.
Sede da EMBRAPA.
PROMOCAO: DTC/CPAC - EMBRAPA

PROGRAMA

Dia 19/10/88 - 4a. feira

11:00 - 12:00 -	Irrigacao por aspersao - Sistemas e Desenvolvimentos Recentes.
12:00 - 14:00 -	Almoco
14:00 - 15:30 -	Nivelamento a raio laser Sistema "Cablegation" de Irrigacao por Superficie Automatizado
15:30 - 15:45	Intervalo
15:45 - 17:00 -	Avaliacao de Sistemas de Irrigacao por Superficie
17:15 - 17:45 -	Continuacao e Discussao
17:45 - 18:30 -	Irrigacao por superficie com vazao Intermitente "Surge Irrigation"

Dia 20/10/88 - 5a. feira

08:30 - 10:00 -	Simulacao e Programacao de Canais Principais em Sistemas de Irrigacao
10:00 - 10:15 -	Intervalo
10:15 - 12:00 -	Continuacao e discussao
12:00 - 14:00 -	Almoco
14:00 - 16:00 -	Manejo de Irrigacao
16:00 - 16:15 -	Intervalo
16:15 - 17:30 -	Aplicacoes de Sensoramento Remoto em Irrigacao
17:30 - 18:30 -	Caracterizacao de uma topo-hidro se quencia de solos na area do DF

Apresentadores: Dr. Christopher Neale
Dr. Gary Merkley
Dr. Carlos Oliveira
Dr. Jamil Macedo

4.0 DISCUSSION

4.1 Surface Irrigation

Surface irrigation remains a viable alternative to pressurized systems for many of the agricultural areas in Brazil. In general, soil types and topographies are such that irrigation by surface methods can be successfully exploited. For example, in the 204 million-hectare region of Cerrado soils in Central Brazil, the use of surface irrigation has good potential in some areas despite the high infiltration rates of these soils. Yet, the disproportionate emphasis on pressurized irrigation systems (particularly center pivots) in recent years in Brazil has caused a relative lack of attention to the non-pressurized alternatives. This is apparently true in terms of both research and farming practice.

There are numerous potential advantages to using surface irrigation in Brazil. One of the principal advantages over pressurized irrigation systems is lower pumping costs, and in some cases the elimination of pumping costs. Presently, energy costs due to pumping are 25-30% of the total agricultural production costs, thus the savings realized with surface irrigation systems would be significant. Irrigation hardware costs for surface irrigation systems are generally much less than sprinkler hardware, especially in the case of large self-propelled sprinkler systems such as center pivots and linear move systems. Furthermore, hardware maintenance costs tend to be less with surface irrigation systems.

The application efficiencies and distribution uniformities attainable with a well-designed and operated surface irrigation system can be as good, or better, than those achieved with sprinkler systems that are poorly

maintained and operated. For example, application efficiencies using level basins can be on the order of 90-95%, with the only appreciable losses occurring due to deep percolation near the field inlet. Furrow irrigation with well-designed slopes, furrow lengths and flexible inflow rates can be efficient if application rates are properly managed. Wind drift and evaporation losses (i.e. evaporation of water droplets before they reach the ground) can be substantial with sprinkle systems. This was evident on many of the center pivots that we visited in different areas, especially when the sprinklers were mounted above the lateral pipeline. Wind drift losses lower the application efficiency even when most of the drift is contained within the irrigated area due to the non-uniformities it causes. These types of losses are essentially non-existent with surface irrigation.

Some degree of automation is also possible with surface irrigation systems. For example, simple automatic supply valves are available for basin irrigation, and "Cablegation" (Kemper et al., 1985) can be used to automate gated pipe systems for furrow irrigation. Surge-flow irrigation systems can be partially or fully automated using gated pipe and pneumatically-controlled valves. The surge-flow irrigation technique could be very appropriate for the Cerrado soils since they have high basic infiltration rates yet, due to the high clay content, the surface seal would possibly lower the infiltration rates. Field research should be carried out to determine the feasibility of this technique on the cerrado soils.

Land leveling would be a prerequisite to surface irrigation in many areas. The rolling topography of the Cerrado region, in addition to the deep and relatively uniform soils which prevail, would not present problems for leveling operations. The initial cost of leveling would generally be

high, but the periodic maintenance would be low. A secondary benefit to land leveling is improved erosion control against rain and possible over-application of irrigation water. Erosion is an increasing problem on many farmed areas of Cerrado soil, especially due to the reduction in infiltration rates from those of virgin soil, caused by mechanization.

Each of the different on-farm irrigation techniques, and their variations, can be appropriate under specific physical, economic, and sociologic conditions. Thus, the real advantages and disadvantages of a particular irrigation method should ideally be considered according to the site-specific conditions which exist at a given location. Therefore, the use of large self-propelled irrigation systems is appropriate under some conditions, but it should not necessarily be equated to "modern" or state-of-the-art irrigation practice. Surface irrigation remains the predominate water application method for irrigated agricultural production in the world today. This is the case for both developed and developing countries. As such, the merits of applying water by surface methods should be objectively evaluated in Brazil, and it should not be dismissed as an outmoded form of irrigation.

4.2 Management of Irrigated Agriculture

One of the problem areas that became evident during our visit to the Guaira region was the relative lack of proper agricultural management under the center pivots. Farmers, in general, are using some of the same practices with regards to soil management and mechanization, soil fertilization, pesticide applications, crop varieties, planting densities, etc., under the pivots as they would with dryland farming during the rainy

season with no irrigation. The center pivot thus becomes a "rain generator" and not a system which applies water to meet crop needs.

As a result of some of these agricultural practices, productivities of irrigated agriculture at the field level (which are already low) are beginning to decrease under many center pivots in the Guaira region. In general, yields of irrigated crops in the region have been higher than in the dryland case, but have never been optimal to start with. If we assume that most agricultural practices under the pivots are similar to those carried out during the rainy season in fields with no irrigation systems, the increased yields observed under irrigation for crops such as corn and beans, for example, are a result of favorable weather conditions and the water availability and timely applications provided by the pivots. However, average corn yields under a pivot in Cerrado-type soils has been around 5000 Kg/ha, which is very low if compared to average irrigated corn yields in the United States (8600 kg/ha national average, some counties with production over 10000 kg/ha). Average dryland yields for corn in the Cerrado soils has been around 3000 kg/ha (5580 kg/ha in the United States). Thus, if we consider the increased cost of production under a pivot due to electricity alone (which now accounts for as much as 30% of the production costs), it has become uneconomical to plant corn (and some other crops such as wheat) under center pivot sprinkler irrigation. It is evident that new recommendations for plant nutrients and fertilizers are needed for irrigated crops in order to substantially increase yields and benefit from the optimal moisture conditions for plant growth that an irrigation system can provide if properly used. New strategies regarding pest and disease management need

to be developed in light of the different production costs and increased potential yields.

The intense use of the land in the Guaira region and other regions with Cerrado-type soils will result in problems in the future if agricultural practices are not changed. With the advent of irrigation, at least two and sometimes three crops are being produced in a year. This has resulted in a great increase on the mechanical work applied to the top soil layer. The excellent aggregated structure, characteristic of the Cerrado soils, can be destroyed by the over use of heavy disk plows and harrows. With mechanization, the percent of dispersible clay particles in the soil increases changing the infiltration properties of the soil. These clay particles could migrate down under sprinkler irrigation and deposit on the resistant layer contributing to the formation of a compaction layer in the soil. Due to time constraints that farmers have in soil preparation (if they intend to plant three crops a year), these practices are sometimes carried out in non-optimum soil moisture conditions. As a result, either a compaction layer can form if the soil is too wet, or very large hard clods are formed if the soil is too dry, which leads to additional passes of the disc harrow in order to prepare the seed bed. Another observed detrimental practice to soil conservation is the lack of incorporation of organic matter in the already nutrient-deficient Cerrado soils. Some farmers which produce three crops a year will burn the plant material left over from a corn harveat, for example, due to the lack of time available for incorporation of this organic matter. However, other farmers are aware of the problem and are experimenting with green manure crops for incorporation (e.g. Mucuna).

In general, few farmers that own center pivot systems allow enough time for the soil to remain fallow.

Crop rotation is another management aspect that is not being followed by many farmers. In most instances, the farmers in the Guaira region were aware of the need for proper crop rotation, however, the selection of crops was usually based on a cost/profit analysis which depended on the minimum price policy set by the federal government. This factor leads to sometimes inadequate rotation of crops which puts an additional strain on the soil and crops with respect to diseases. Some reports of nematode problems were noted.

Irrigation scheduling for timing and/or for the estimation of application depths is seldom used in a practical sense in Brazil. In most areas we visited, it was observed that if water was abundant, the farmers tended to over-irrigate, thus wasting energy and water. Some research carried out by a group from the Instituto de Pesquisa Tecnológico (IPT) of São Paulo under a center pivot planted to beans showed that by timing irrigations using tensiometers, yields were increased from 2000 kg/ha to 2900 kg/ha. The proper timing of irrigation events and the application of the necessary depth of water to refill the root zone of the crop (taking into consideration the efficiency of the irrigation system) will result in the maintenance of optimum moisture conditions for plant growth in the soil. Irrigation scheduling will generally result in energy and water savings, an important aspect in light of the recent increase in electric energy costs for pumping in Brazil. The application of only the sufficient amount of water to replenish what has been removed by evapotranspiration will probably result in lower losses of fertilizer nutrients due to leaching

in the Cerrado-type soils (exhibiting high infiltration rates). Optimum moisture conditions in the root zone will also decrease the incidence of soil-borne crop diseases. In view of these diverse problems, it is necessary to research production agriculture under irrigation and extend results to farmers as soon as possible. The research should be of an interdisciplinary nature viewing the soil, crop and water environment as an inter-related system. The objectives should be to maximize yields and returns while maintaining good soil conservation practices. The research should address the following issues:

- Mechanization practices on the Cerrado soils under irrigation.
- Conservation practices, minimum tillage, direct planting, etc.
- Management of water and nutrients in the top 25 - 30 cm layer of the soil above the resistant layer as opposed to a deeper root zone for several crops. Which is a better option for the cerrado soils, and what mechanization and irrigation practices would be needed (and feasible) for each case?
- Management of fertilizer, insecticides and herbicides for several crops. Study the timing and application rates via sprinkler systems.
- Methods of scheduling irrigations appropriate to the location and sophistication of the farmer. The application of fertilizers and chemicals through the system should be a consideration in the optimal timing of the irrigations.
- Development of strategies for pest, disease and weed control taking into consideration costs and increased potential yields of irrigated agriculture.
- Development of crop varieties and genetic material best suited for irrigated agriculture. Study of optimum plant densities, etc.
- The simulation of crop growth and yields with respect to water, nutrients and climatic inputs would be a useful tool in studying the adaptation of crops to the different soil and climate conditions in Brazil.

Some of these questions were being addressed by soil and irrigation scientists at the CNPMS. They mentioned that corn yields of 10000 kg/ha

had been obtained in research fields at the center. They also had been working with some private farmers giving suggestions on management practices for corn production. In these cases, yields were approximately 8000 kg/ha. Research carried out at CPAC has also shown corn yields of over 10000 kg/ha on the Cerrado soils. Therefore, it is evident that careful management can increase production. It is our opinion that scientists from CPAC and CNPMS should form an interdisciplinary team and work towards implementing a systems approach to solve the most pressing production issues.

4.3 Agricultural Extension

EMBRAPA researchers have conducted excellent experimental work in the areas of soils, crops, irrigation, and pest management (in addition to many others). Much of the experimental results have appeared in various scientific and technical publications, both domestically and abroad. It is also evident that communication within EMBRAPA and between the different research centers has been relatively good, and that EMBRAPA researchers maintain contacts with foreign scientists who perform related research. Overall, it is our impression that good quality research is being conducted and published by EMBRAPA, and that the EMBRAPA researchers are well aware of parallel and related experimental work in different countries.

Nevertheless, application of agricultural research findings outside of EMBRAPA centers seems to be unnecessarily delayed. The agricultural producers in Brazil are, in general, not taking advantage of a large part of the research knowledge that exists within EMBRAPA. Most of the farmers are not in a position to benefit directly from the technical publications by EMBRAPA researchers, and the "field days" at EMBRAPA's centers, though

important and should be continued, are not enough to transfer this knowledge to the agricultural community at large. The field days, in which experimental results are on display, are more useful for persons from funding institutions, extension and industry than for the farmers themselves.

In order to more successfully direct EMBRAPA's research findings toward improving agricultural production under favorable long-term soil and water management practices (the ultimate goal of EMBRAPA activities), it will be necessary to intensify agricultural extension services to farmers. Although agricultural extension may not be within the scope of EMBRAPA's work, it is certainly in EMBRAPA's interest as an organization that supports Brazilian agriculture. Through successful agricultural extension, the excellent work produced by EMBRAPA will be put into place, thus establishing increased recognition for the benefits of continued agricultural research.

It has been apparent that numerous Brazilian farmers are continuing to employ dry-land farming techniques to irrigated agriculture, including tillage practices that often augment soil compaction problems in many areas of the country. This can be explained to a large degree by the relatively recent introduction of irrigation on lands that were previously farmed under rain-fed conditions, or that were being farmed for the first time. In the newly developed areas, such as those under CODEVASF administration, the farmers (or colonos) have essentially no experience in irrigated agriculture. These farmers will learn about appropriate agricultural practice with time; however, this process can be accelerated and streamlined through the action of a more aggressive and efficient agricultural extension service. The large investments in irrigation infrastructure and in

agricultural research in Brazil certainly justify a corresponding extension effort to make effective use of knowledge that already exists, and to integrate these resources into significant agricultural improvements at the farm level.

Agricultural Extension in Brazil does not benefit from the combined teaching, research, and extension effort which exists within the U.S. Land Grant university system, and which has contributed so much to the agricultural development of that country. The Brazilian national extension service, EMBRATER, is a separate institution within the Ministry of Agriculture. The fact that it is a separate entity from the research institutions like EMBRAPA has some decidedly positive connotations. Presently, however, there appears to be a missing link which is preventing many of the EMBRAPA research results from reaching the end users. This appears to be a result of the level of communication between EMBRAPA scientists and extension field personnel in general. EMBRATER is more effective in some areas of the country than in others. The effectiveness of extension services at the state levels varies from state to state within the country and is subject to local policies and budgeting processes. EMBRAPA, since its conception, has pushed for the training of its scientists both in Brazil and abroad. This has resulted in a cadre of well-trained scientists which, in most instances, have the necessary resources to develop creative and useful research of high quality. The solution at first, may not be joining EMBRAPA and EMBRATER into one institution, but in increasing the scientific knowledge and training of the EMBRATER personnel so that communication can occur on similar levels. Meanwhile, EMBRAPA could intensify its contribution towards the transfer of technology process by

encouraging active and aggressive groups for this purpose, at each station. New technologies such as video and microcomputers are very useful tools which can be taken advantage of by EMBRAPA to enhance and optimize the transfer of knowledge to both the extension personnel and to the end users such as farmers and agro-industrial groups.

The importance of this process must be stressed by the upper levels of the administration within EMBRAPA. The successful application of EMBRAPA's research results at the farm level can be a very powerful and positive promotional vehicle. Such application will contribute to the continued development of Brazilian agriculture and enhance the visibility and importance of agricultural research in general.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Overall we were very well impressed with EMBRAPA and the development and research goals of the institution. EMBRAPA has realized the importance of properly trained people, as well as the need to supply their scientists and personnel with adequate research facilities, equipment and resources. The policy of training research personnel at the Masters and Ph.D level should definitely continue. It is also very important to supply adequate resources and equipment for these scientists once they return from their studies. In this way, EMBRAPA can fully benefit from the new ideas and techniques that many of these researchers bring from abroad and are eager to apply to the Brazilian conditions.

Irrigation research in Brazil is still in an early phase of development. This is due to the relatively new importance that irrigated agriculture has received on a national level. Irrigation techniques are new to Brazil which has never had an extensive tradition in this area. Much research has been carried out in other countries in irrigation engineering and crop production, that could be adapted to the Brazilian social and economical conditions. Many topics however, would require careful field experimentation under some of the specialized conditions found in the Cerrado and Northeast regions.

We feel that EMBRAPA is presently at a turning point with regards to irrigation research. Many of the scientists that have been studying this topic abroad are returning, which will contribute to the formation of a critical mass of research personnel. Due to the extent of the country and its research needs, as well as limited resources under the present economic

situation, the cooperation and joint research among these scientists will be fundamental.

Several topics were discussed within this report. A summary of some of the findings and recommendations we feel are relevant to EMBRAPA are presented below:

On Research:

- Study of irrigated agricultural production as a system, involving soil conservation, mechanization practices, soil fertility, disease and insect control, irrigation system and practices, crops being planted etc. This research would better be accomplished through and interdisciplinary team of researchers from several EMBRAPA centers. The research would include the management of production agriculture under center pivot irrigation systems.

- Development and adaptation of automated or semi-automated surface irrigation systems and practices for both the Cerrado type soils and the Vertisols soils. The Cerrado research could be done jointly by the CPAC and the CNPH while research on the Vertisols could be done at the CPATSA.

- Introduction of computerized irrigation scheduling at all the EMBPAPA centers which work with irrigation research. Install automated weather stations at each of these centers to support the effort. Instrumentation should provide all parameters for the calculation of reference evapotranspiration with the Penman equation.

- Intensify research with all types of irrigation systems at the CPATSA research station. Concentrate new research on surface irrigation in support the new CODEVASF projects to be developed on Vertisols type soils. Initiate a comprehensive study of salinity in the region and develop irrigation and drainage practices for its control. Optimize use of the VAX computer system available at the CPATSA by purchasing software for it and networking it to the PC computers. Hire additional Ph.D level staff for the CPATSA research center to carry out research on irrigation system engineering.

- Encourage the research of trickle and drip irrigation systems on the sandy soils of the CNPAI. Study appropriate crops to support the project as well as methods to optimize the growth of these crops under sprinkler and trickle irrigation.

- Hire additional Ph.D level researchers for the CNPAI. Preferably researchers that have experience in modelling infiltration processes and the transport of solutes in soils.

- Development of crop varieties and genetic material best suited for irrigated agriculture. Study of optimum plant densities, climatic conditions etc.

- Work with other government agencies in developing a common database of water resources for the country, including the study of stream and river flows, small watersheds, precipitation and general climatic parameters used in agriculture and irrigation.

On General Issues:

- Continue the training of Ph.D level researchers abroad. Encourage these researchers to obtain experience on irrigation system engineering, modelling and simulation with microcomputers.

- Continue the practice of peer review of research proposals within the EMBRAPA system.

- Implement a policy that encourages EMBRAPA scientists to publish research results in internal publications as well as peer reviewed journals. Reward scientists that are productive, and publish quality work.

- Stress more interdisciplinary research among the centers that work with similar topics.

- Encourage an active transfer of technology/extension group at all research stations to coordinate the transfer of EMBRAPA's research results to the extension service personnel, private industry and farmers. Make use of the latest video and graphics technology to aid in this task.

- Work with CODEVASF on forming an interdisciplinary team of professionals from both institutions to support the planning of new irrigation projects in the country In this way, the opinion of several experts on the subject could be expressed and discussed, hopefully avoiding some of the mistakes of the past and incorporating new ideas, technologies and management practices.

- Encourage cooperative agreements between EMBRAPA centers and Brazilian Universities with M.Sc. and Ph.D programs in irrigation engineering. In this way, graduate students could benefit from the involvement of EMBRAPA scientists on their committees and could jointly do research on EMBRAPA stations under their supervision. This would provide additional low cost professional research staff and would enhance the research output of these centers.

6.0 REFERENCES

Cablegation Systems for Irrigation: Description, Design, Installation and Performance. W. D. Kemper, D. C. Kincaid. USDA-ARS-21, February 1985

Appendix A

Consultant Itinerary

Date	Place	Time	Method of Transportation
Oct 08	Leave Logan, Utah	0630	Airplane, Car
Oct 09	Arrive São Paulo, SP	1030	
Oct 10	Leave São Paulo, SP	1400	Airplane
	Arrive Brasília, DF	1530	
Oct 12	Leave Brasília, DF	1700	Car
	Arrive Uberlândia, MG	2200	
Oct 13	Leave Uberlândia, MG	0730	Car
	Arrive Guaira, SP	1000	
Oct 14	Leave Guaira, SP	1900	Car
	Arrive Uberlândia, MG	2130	
Oct 15	Leave Uberlândia, MG	1030	Car
	Arrive Brasília, DF	1530	
Oct 20	Leave Brasília, DF	1900	Airplane, Car
	Arrive Sete Lagoas, MG	2200	
Oct 23	Leave Sete Lagoas, MG	0830	Airplane, Car
	Arrive Petrolina, PE	1400	
Oct 26	Leave Petrolina, PE	0830	Airplane, Car
	Arrive Parnaíba, PI	2100	
Oct 28	Leave Parnaíba, PI	1030	Airplane, Car
	Arrive Brasília, DF	1800	
Nov 03	Leave Brasília, DF	0640	Airplane
	Arrive Jaíba, MG	1000	
	Leave Jaíba, MG	1700	
	Arrive Brasília, DF	1900	
Nov 07	Leave Brasília, DF	1330	Airplane
	Arrive São Paulo, SP	1500	
	Arrive Rio de Janeiro, RJ	2245	
Nov 08	Arrive Los Angeles, CA	0730	

Appendix B
Interviewed Persons and Agencies

Elmar Wagner, Chefe DTC	EMBRAPA/DTC
Adhemar Brandini, Assessor	EMBRAPA/DTC
Antonio Carlos Guedes, Chefe	EMBRAPA/CNPH
José Flávio Lopes, Pesquisador	EMBRAPA/CNPH
Carlos Alberto da S. Oliveira, Pesquisador	EMBRAPA/CNPH
Osmar Carrijo, Pesquisador	EMBRAPA/CNPH
Carlos Magno Campos da Rocha, Chefe	EMBRAPA/CPAC
Elias de Freitas Junior, Pesquisador	EMBRAPA/CPAC
Eduardo Delgado Assad, Pesquisador	EMBRAPA/CPAC
Ariovaldo Luchiari, Jr., Pesquisador	EMBRAPA/CPAC
Osmar Niccolini, Pesquisador	EMBRAPA/CPAC
Antonio F. Bahia, Chefe	EMBRAPA/CNPMS
Morethson Resende, Pesquisador	EMBRAPA/CNPMS
Evandro Chartuni Mantovani, Pesquisador	EMBRAPA/CNPMS
Barbara Mantovani, Pesquisadora	EMBRAPA/CNPMS
José Carlos Cruz, Chefe Adjunto Técnico	EMBRAPA/CNPMS
João Carlos Garcia, Chefe Adjunto Apoio	EMBRAPA/CNPMS
Enio Fernandes da Costa, Pesquisador	EMBRAPA/CNPMS
Lairson Couto, Pesquisador	EMBRAPA/CNPMS
Luis Mauricio Cavalcante Salviano, Chefe	EMBRAPA/CPATSA
Aderaldo Souza Silva, Pesquisador	EMBRAPA/CPATSA
Carlos Alberto Oliveira, Pesquisador	EMBRAPA/CPATSA
Jose Monteiro Soares, Pesquisador	EMBRAPA/CPATSA
Edson Lustose de Fosidio	EMBRAPA/CPATSA
Clemente Ribeiro dos Santos	EMBRAPA/CPATSA
Carlos Fonseca Lopes, Gerente Local	EMBRAPA/SPSB
Vitor Hugo de Oliveira, Chefe	EMBRAPA/CNPAI
Washington Luiz de Carvalho e Silva, Chefe Técnico	EMBRAPA/CNPAI
Horacio H. Stagno, Coordenador Contratos	IICA/EMBRAPA
Jader Fernandes de Carvalho, Assessor Especial	CODEVASF
Waldo G. Espinoza, Manejo de Solos e Aguas	IICA/CODEVASF
Levy Souto, Engenheiro	CODEVASF
Evandro Parreiras, Assessor	CODEVASF
Carlos Antonio Landi Pereira, Gerente Executivo	Dist. de Irr. Jaiba
Joao Ramos de Oliveira, Coordenador de Producao	Dist. de Irr. Jaiba
Nivaldo Barbosa	Dist. de Irr. Jaiba
Juscelino Antonio de Azevedo, Assessor	PRONI
José Lins de Albuquerque Filho, Assessor	PRONI
Arlindo Bonifácio, Engº Agrônomo	EMBRATER
Ady Raul da Silva, Engº Agrônomo	PROVARZEAS/PROFIR
José Silvério da Silva, Engº Agrônomo	PROVARZEAS/PROFIR

Antonio de Oliveira Lima, Fazendeiro	Guaira, SP
Laércio Lourenço Lelis, Fazendeiro	Guaira, SP
Mauricio Sakai, Fazendeiro	Guaira, SP
Antonio Barbosa, Fazendeiro	Guaira, SP
A. Celso Barbosa, Fazendeiro	Guaira, SP
Lupercio Geraldo Lourenco Lelis, Eng. Agronomo	IAC, Guaira, SP
Jose Aparecido Silverio dos Santos	IPT
Mauro Xavier	PROAGRO, SP
Oswaldo Reichert, Salesperson	DAN-MATIC, SP
Peter John Griffee, Technical Manager/Ag & Forestry	GRUPO ULTRA, SP
Pedro Harper Cox	FRUTOS DO VALE, PE
Luiz Freire, Manager	FRUTINOR, BA
Robert Verloop, Agricultural Advisor	FRUTINOR, BA
Pedro Luiz de Freitas, Engª Agrônomo	EMBRAPA/SNLC Solos
Nabil Joseph Eid, Dr. Eng.	Univ. de Brasília

Appendix C

List of Abbreviations

ABID	- Associação Brasileira de Irrigação e Drenagem
ABRAI	- Associação Brasileira para a Agricultura Irrigada
BA	- Bahia State
CEPAR	- Centro de Pesquisa e Apoio para o Produtor Rural
CNPAI	- Centro Nacional de Pesquisa de Agricultura Irrigada
CNPH	- Centro Nacional de Pesquisa de Hortaliças
CNPMS	- Centro Nacional de Pesquisa de Milho e Sorgo
CODEVASF	- Companhia de Desenvolvimento do Vale do São Francisco
CPAC	- Centro de Pesquisa Agropecuária dos Cerrados
CPATSA	- Centro de Pesquisa Agropecuária do Trópico Semi-Árido
DF	- Distrito Federal
DTC	- Departamento Técnico e Científico
EMBRAPA	- Empresa Brasileira de Pesquisa Agropecuária
IIC	- International Irrigation Center, Logan, Utah
IICA	- Instituto Interamericano de Cooperação para a Agricultura
IPT	- Instituto de Pesquisa Tecnológico do Estado de São Paulo
MG	- Minas Gerais State
PE	- Pernambuco State
PI	- Piauí State
PROFIR	- Programa de Financiamento para Aquisição de Equipamentos de Irrigação
PROINE	- Programa de Irrigação para Nordeste
PRONI	- Programa Nacional de Irrigação
PROVARZEAS	- Programa Nacional de Várzeas
SP	- São Paulo State
SPSB	- Serviço de Produção de Sementes Básicas
USU	- Utah State University, Logan, Utah

Programa II. Geração e Transferência de Tecnologia

O Programa de Geração e Transferência de Tecnologia é a resposta do IICA a dois aspectos fundamentais: (i) o reconhecimento, por parte dos países e da comunidade técnico-financeira internacional, da importância da tecnologia para o desenvolvimento produtivo do setor agropecuário; (ii) a convicção generalizada de que, para aproveitar plenamente o potencial da ciência e da tecnologia, é necessário que existam infra-estruturas institucionais capazes de desenvolver as respostas tecnológicas adequadas às condições específicas de cada país, bem como um lineamento de políticas que promova e possibilite que tais infra-estruturas sejam incorporadas aos processos produtivos.

Nesse contexto, o Programa II visa a promover e apoiar as ações dos Estados membros destinadas a aprimorar a configuração de suas políticas tecnológicas, fortalecer a organização e administração de seus sistemas de geração e transferência de tecnologia e facilitar a transferência tecnológica internacional. Desse modo será possível fazer melhor aproveitamento de todos os recursos disponíveis e uma contribuição mais eficiente e efetiva para a solução dos problemas tecnológicos da produção agropecuária, num âmbito de igualdade na distribuição dos benefícios e de conservação dos recursos naturais.

INSTITUTO INTERAMERICANO DE COOPERAÇÃO PARA A AGRICULTURA

O Instituto Interamericano de Cooperação para a Agricultura (IICA) é o organismo especializado em agricultura do Sistema Interamericano. Suas origens datam de 7 outubro de 1942, quando o Conselho Diretor da União Pan-Americana aprovou a criação do Instituto Interamericano de Ciências Agrícolas.

Fundado como uma instituição de pesquisa agronômica e de ensino, de pós-graduação para os trópicos, o IICA, respondendo às mudanças e novas necessidades do Hemisfério, converteu-se progressivamente em um organismo de cooperação técnica e fortalecimento institucional no campo da agropecuária. Essas transformações foram reconhecidas oficialmente com a ratificação, em 8 de dezembro de 1980, de uma nova convenção, que estabeleceu como fins do IICA estimular, promover e apoiar os laços de cooperação entre seus 31 Estados membros para a obtenção do desenvolvimento agrícola e do bem-estar rural.

Com um mandato amplo e flexível e com uma estrutura que permite a participação direta dos Estados membros na Junta Interamericana de Agricultura e em seu Comitê Executivo, o IICA conta com ampla presença geográfica em todos os países membros para responder a suas necessidades de cooperação técnica.

As contribuições dos Estados membros e as relações que o IICA mantém com 12 Países Observadores, e com vários organismos internacionais, lhe permitem canalizar importantes recursos humanos e financeiros em prol do desenvolvimento agrícola do Hemisfério.

O Plano de Médio Prazo 1987-1991, documento normativo que assinala as prioridades do Instituto, enfatiza ações voltadas para a reativação do setor agropecuário como elemento central do crescimento econômico. Em vista disso, o Instituto atribui especial importância ao apoio e promoção de ações tendentes à modernização tecnológica do campo e ao fortalecimento dos processos de integração regional e sub-regional.

Para alcançar tais objetivos o IICA concentra suas atividades em cinco áreas fundamentais, a saber: Análise e Planejamento da Política Agrária; Geração e Transferência de Tecnologia; Organização e Administração para o Desenvolvimento Rural; Comercialização e Agroindústria, e Saúde Animal e Sanidade Vegetal.

Essas áreas de ação expressam, simultaneamente, as necessidades e prioridades determinadas pelos próprios Estados membros e o âmbito de trabalho em que o IICA concentra seus esforços e sua capacidade técnica, tanto sob o ponto de vista de seus recursos humanos e financeiros, como de sua relação com outros organismos internacionais.

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Responsáveis pela reprodução: Jadir José dos Santos e Murillo Sodré da Silva.

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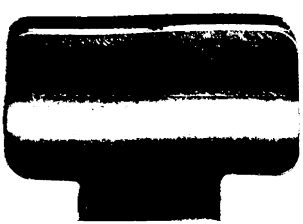

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