United Nations Educational,
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Interregional Technology Transfer Encounter in Northeast Brazil

15-25 April 1985

Major Regional Project on the Utilization and Conservation of Water Resources in the Rural Areas of Latin America and the Caribbean.

Major Regional Project on the Rational Utilization and Conservation of Water Resources in Rural Areas of Africa (South of the Sahara).

Final Report

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INTERREGIONAL TECHNOLOGY TRANSFER ENCOUNTER IN NORTHEAST BRAZIL

Major Regional Project on the Utilization and Conservation of Water Resources in the Rural Areas of Latin America and the Caribbean and Major Regional Project on the Rational Utilization and Conservation of Water Resources in Rural Areas of Africa (South of the Sahara).

I N D E X

S U M M A R Y

The Encounter covered technology transfer as an essential part of the rural development process from the conceptualization and strategy stage, the research process and its applications on the farms via a diffusion process through rural extension services and its operation in the field, to the marketing and impact on the quality of life. Moreover, parts of the event were recorded in a number of video tapes to be condensed in a short program to preserve this experience as a document to explain this technology transfer process. It is the intention to make this audiovisual document available to the countries represented in the Encounter and to Unesco, UNICEF, IDB and all other countries and organizations that express their wish to obtain this audiovisual material.

What was observed during the Encounter through Northeast Brazil was an impressive demonstration of efforts, in different technological fields, to search for an integrated response on "how rural populations in semi-arid regions of the world should adapt and live in harmony with the harsh conditions of their environment". Besides this, an impressive rural extensionist structure was seen at work in the field to provide technical assistance and continuous support to what now amounts to almost half a million small farmers. The conclusive impression one is left with, is that with the large spectrum of alternative and complementary low-cost technologies developed to harmonize with the semi-arid environment, life in such regions can be substantially improved without exorbitant financial investments.

This was the first such technology encounter to which another continent was invited. Africa was chosen for several reasons:

a) Several of the technologies presently being implemented in Latin America and the Caribbean originated in Africa centuries ago.

b) Geologic, ecologic, climatologic and cultural aspects are frequently comparable between the two continents.

c) To stimulate the interchange of technical experience and know-how among the third world countries which frequently have similar problems.

INTERREGIONAL TECHNOLOGY TRANSFER ENCOUNTER IN NORTHEAST BRAZIL

I. INTRODUCTION

1. Unesco's contribution to the International decade for Drinking Water and Sanitation are the Major Regional Projects on the Rational Use and Conservation of Water Resources in the Rural Areas of Latin America and the Caribbean, Africa (South of the Sahara) and the Arab States. The first one, the Major Regional Project on the Use and Conservation of Water Resources in the Rural Areas of Latin America and the Caribbean (henceforth called MRP/LAC), was responsible for the elaboration of the ideas of interregional technology transfer.

Within the scope of MRP/LAC in November 1982 a technical visit to NE Brazil was organized in collaboration with EMBRAPA (Empresa Brasileira de Pesquisa Agropecuaria) and EMBRATER (Empresa Brasileira de Asistencia Tecnica e Extensao Rural) for a number of South American specialists who expressed their interest in the new low-cost water-related technologies which EMBRAPA presented in the meeting in March 1982 in Mexico City for the launching of the Unesco MRP/LAC where its objectives and guidelines were formulated.

2. When during the VI Session of the Intergovernmental Council of IHP (Paris, 22-30 March 1984) the positive results of this technical visit were mentioned, Mr. N.B. Ayibotele of the Water Resources Research Institute of Accra, Ghana and former President of the IHP Bureau, expressed the interest of his African colleagues in becoming acquainted with this low-cost technology. The final report on this IHP Council meeting mentions: "Interregional collaboration was suggested to exchange experience gained in regions with similar climatic and water use conditions. In this respect the Council took note of the invitation extended by the delegation of Brazil to African specialists to visit Northeast Brazil in order to study the implementation of appropriate water management techniques in the context of the Major Regional Project. Participants of the African region welcomed this invitation."

3. Returning from the Council meeting in Paris Mr. Christiaan Gischler, General Coordinator of MRP/LAC in UNESCO/ROSTLAC, discussed the forthcoming "Interregional Technology Transfer Encounter in Northeast Brazil" with Mr. Raymundo Fonseca Souza, Director of EMBRAPA. Mr. Francisco de Lima e Silva, President of COBRAPHI (Brazilian National IHP Committee) was informed on the outcome of the discussions and when his approval of the Encounter came suggesting to negotiate the matter in detail with EMBRAPA/CPATSA (Centro de Pesquisa Agropecuaria do Tropico Semi Arido), Mr. Gischler met Mr. Renival Alves de Souza, Director General of EMBRAPA/CPATSA in January 1985 in Petrolina (State of Pernambuco) to discuss all the aspects of the Encounter.

4. Unesco in collaboration with CPATSA/EMBRAPA in Petrolina, under the umbrella of COBRAPHI, announced in January 1985 the celebration of the International Technology Transfer Encounter in Northeast Brazil from 15 to 25 April 1985, in which the programme schedule was worked out day by day according to a telex received from Mr. Renival Alves de Souza of CPATSA.

5. While in Petrolina Mr. Gischler again visited the experimental station of CPATSA and noticed the great progress achieved compared with his first visit in November 1982. The technologies were classified under six headings:

I. Rural cisterns filled with water captured from roofs, paved road surfaces, and small protected natural catchments.

II. Crescent-shaped dams storing surface runoff in small reservoirs for watering cattle and livestock, complementary irrigation, minimizing evaporation losses.

III. Subsurface dams, with ordinary plastic lining up to the bedrock, in small shallow sedimentary basins, storing groundwater (which otherwise would disappear downstream) rendering the surface area cultivable.

IV. Agriculture in drying up river beds, lakes and storage reservoirs.

V. Rainwater harvesting in situ by ploughing with coulters that shape the lands to be cultivated in such a way that even in semi-arid regions the concentration of scarce rainwater guarantees good dry farming results.

VI. Low-cost irrigation systems with hoses, perforated hoses (cheap drip irrigation) and porous pots and capsules.

6. All these techniques have been tried out and improved systematically in the experimental stations for several consecutive years. At present many techniques are sufficiently tested and have been submitted to water efficiency and financial evaluations. Now they are in the process of being diffused via EMBRATER to the small farms of NE Brazil covering an area exceeding 1.500.000 km^2 with 35 million inhabitants, mostly rural.

7. The semi-arid area of NE Brazil receive an average annual precipitation of 200-1500 mm falling in 3 to 5 months per year in the period November-December-January-February-March (but three months later in the State of Sergipe). This means the tropical semi-arid zone with summer rains in the Southern hemisphere. So the Encounter would take place in principle after the rainy season when the various rainwater harvesting techniques can be observed in operation. The geomorphology of the area is composed of an undulating basement rock abrasion surface with "inselbergen" and isolated shallow depressions filled up with local mostly sandy detritus material of the basement. In certain parts this surface is covered with extensive thick permeable sandstone deposits forming dry plateaux. The natural vegetation consists of more or less dense savannah and thorn brush.

8. An important progress has been made since the first technical visit of 1982, when the individual technologies had not yet been properly integrated in an entire low-cost package for the small farmers of NE Brazil. The new rural development scheme based on this kind of technologies has now obtained large loans (over ten billion dollars, also to purchase lands to be distributed among rural families without land) for further research, diffusion of information, training of extension workers and application of the techniques by small farmers adapted to the small individual plots. This total complex of research results on integrated water management for the semi-arid tropics of Brazil provides in the following order of importance water for man, animal and plant, and is now ready to be transferred to various African and Latin American countries with similar social, climatic and physiographical conditions. For this reason emphasis has also been placed on the strategy aspect next to the purely technical aspect of the technology transfer.

9. MRP/LAC collaborators from Argentina, Bolivia, Chile and Peru were requested to show the results of the ongoing Latin American technology transfer, with all its small adaptations to the various areas in their respective countries, in the form of words, slides and audiovisual material, demonstrating the feedback function to Northeast Brazil of the technology transfer.

10. The Interregional Technology Transfer Encounter was organized and financed jointly by Unesco, CPATSA/EMBRAPA, EMBRATER, EMATER-PE and EMATER-SE (the latter two being the Empresa de Asistencia Tecnica e Extensao Rural of the States of Pernambuco and Sergipe).

11. Mr. Christiaan Gischler of UNESCO/ROSTLAC acted as general coordinator of the Encounter. Mr. E. Amevoh, General Coordinator of MRP/Africa, organized the participation of the African delegates. Mr. Carel de Rooy representing UNICEF/Nigeria collaborated closely with the general coordinator of the Encounter providing all the translations from English and French into Portuguese and Spanish and viceversa. Mr. Nelson da Franca of the Division of Water Sciences of Unesco contributed in the elaboration of the final report of the Encounter.

II. DESCRIPTION OF THE ENCOUNTER FROM 15-24 APRIL 1985

12. Thirty specialists in rural water development and related fields from Africa (Ivory Coast, Kenya, Mauritania, Nigeria, Tanzania, Togo and Zimbabwe) and Latin America (Argentina, Bolivia, Brazil, Chile, Dominican Republic, Ecuador, Mexico, Paraguay, Peru and Venezuela) attended the Encounter, as well as representatives of Unesco, UNICEF, Inter-American Development Bank and World Water International Magazine. The names and addresses of the specialists, representatives of international agencies and World Water appear in Annex I (of these two thirds were invited by Unesco). Other African countries like Angola, Cape Verde, Ethiopia, Ghana, Guinea-Bissau and Mozambique were invited by Unesco to participate in this Encounter, but did not send in time names of candidates to be invited.

13. The main objective of the Encounter was to study the implementation of appropriate low-cost water management techniques utilized in NE Brazil in the context of MRP for technology transfer to Africa and other Latin American countries, and to evaluate the impact of these technologies on the quality of life of the rural population which should be the essence of rural development. An intensive succession of detailed expositions and overviews in experimental stations (see also the list of documents distributed in Annex II), followed by technical visits to private and cooperative plots where these techniques were implemented, separated by bus drives over many hundreds of kilometers in a bus especially reserved for the occasion, provided the participants with a clear picture of the cultural, socioeconomic, physiographic and climatological setting of this technology. At the same time the representative of FAO/CESPAC (Centro de Servicios de Pedagogía Audiovisual para la Capacitación) of Peru recorded many details of the event in audiovisual form covering in total a period of three hours, from which a well-edited program will be condensed for diffusion.

14. The region (see map on next page) contains 35 million inhabitants which is almost one third of Brazil's population (130 million). Yet it presently contributes only 10% of Brazil's GNP as compared with 35% in 1872. Almost 75% of this region is semi-arid with shallow rocky soils which have a low water retention capacity and little organic matter; as well as high erosion potential. Evaporation is in the order of 2000 mm/year, average temperatures vary from 23 to 28°C. These characteristics combined with persistent climatic instability which is expressed more in its irregular rainfall pattern than rainfall scarcity, form an obstacle to the stabilization of food production in the area.

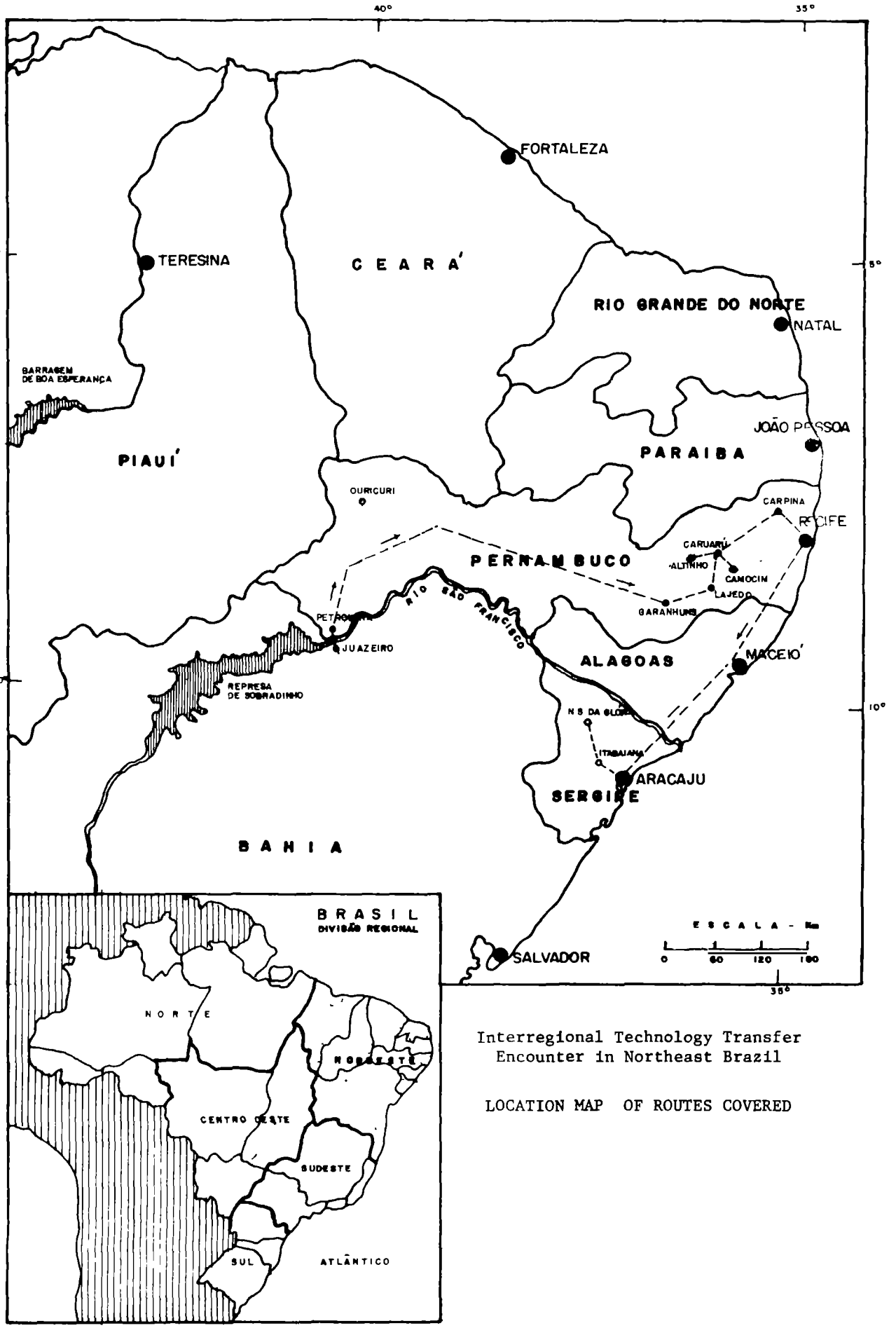
This climatological pattern indicates the need to implement strategic low-cost alternatives which will allow the optimal utilization of existing rainfall resources. Thereby the high risk of agricultural exploitation in rainfall dependent areas can be reduced. Presently, with the traditional techniques, the average small farmer obtains a successful harvest only once in every ten years. In other words, the risk he takes when planting his crops is 90%. In this region 84% of the rural properties have less than 100 hectares according to EMBRAPA/CPATSA.

Work programme in Petrolina and surroundings (15 to 17 April)

15. Mr. Renival Alves de Souza opened the Encounter in the auditorium of the CPATSA/EMBRAPA installations in Petrolina and welcomed the participants. Afterwards Mr. Gischler thanked the Brazilian authorities for the preparation and organization of the event and expressed on behalf of the Director General of Unesco and especially of Mr. Gustavo Malek, Director of UNESCO/ROSTLAC, his happiness with the attendance of so many countries. Then the participants introduced themselves one by one. In succession the following presentations took place.

16. "Characterization of the region and the livestock and agricultural research for the development of the Brazilian Semi Arid Tropics (SAT)" by Mr. Renival Alves de Souza.

He pointed out that because of the intensive rains after five years of drought the tour program had to be changed and had made the planned visit to the States of Ceará, Rio Grande do Norte and Paraiba impossible.



Interregional Technology Transfer
Encounter in Northeast Brazil

LOCATION MAP OF ROUTES COVERED

Everybody working in semi-arid regions should admit that this also is one of the irregular situations characteristic of such areas, where there is either too little or too much water.

Within the Northeast the semi-arid region presents the most alarming situation. After years of innumerable initiatives of development efforts through conventional irrigation projects, construction of barrages, infrastructures and creation of various special programs for agriculture, the situation of the farmers was worse than ever. Ironically it can be noticed that only the most simplistic methods and ideas could increase production.

The irregularity of the rains that fall in a limited amount of intensive showers, the high evaporation rates, the shortage of soil and water and, most serious of all, land tenure structure characterized by the "latifundio-minifundio" relationship, cause the main problems for survival. With reference to land tenure structure, 1978 cadaster data showed that of 1200000 properties 80% were classified as "minifundios" and 20% as "latifundios"; while analysing the acreage of the same number of properties, it was found that of the total usable land occupied by those properties being 90 million ha, 74% were occupied as "latifundio". Due to low income rates that the regional agriculture offers, a large migration took place from the rural areas to the urban centers, as can be seen in the following table.

Urban and rural population of NE Brazil

Census	Urban	Rural	Total	% Total of Brasil
1960	7516500	14665380	22181380	31,6
1970	11752977	16358950	28111927	30,1
1980	17586646	17275443	34855469	29,2

Source: FIGBE, Anuario Estatistico do Brasil, 1982

The population increase in the urban centers during those 20 years was of the order of 140% while the rural population increased hardly 18%. Taking into account that the most risky small land holdings ("minifundios") keep 55% of the rural population occupied and are responsible for 80% of the food production including fruit and horticulture, the fixation of small farmers to their lands is fundamental. CPATSA/EMBRAPA studying the local conditions worked out the package of appropriate technologies (as mentioned in para. 5 of this report) in order to diffuse them among the small farmers to make them more independent of capricious climatic conditions and improve the reliability of the production of their lands, and with this the quality of life.

17. "Evaluation of the natural and socioeconomic resources of the Semi Arid Tropics" by Mr. Antonio Carlos Schifino.

"The Use of the natural and socioeconomic resources of the Semi Arid Tropics and the integrated production system for the Semi Arid Tropics" by Mr. Manoel Abilio de Queiroz. N.B. The combined treatment of natural and socioeconomic resources shows the effective integrated strategy.

"Support project for the small farmers (Projeto Nordeste)" by Mr. Manoel Abilio de Queiroz.

Presentation of audiovisual material on livestock and agricultural research of the Semi Arid Tropics.

Visit to the library and remote sensing and soil laboratories. Here an explanation was given on how a practical land use map was composed on the basis of geologic, soil vegetation and climatic data, combined with remote sensing and radar imagery which in the hands of an extension worker would provide him with a practical tool for the actual land use with a combination of selected low-cost techniques.

18. Under the title of UNESCO/MRP/LAC experiences in Latin America the following presentation took place:

The representative of Argentina summarized the MRP subprojects co-ordinated by his country:

- reverse osmosis and the low pressure Argentine membranes
- porous capsule irrigation for reforestation
- manual on conservation and management of water resources at farm level in Latin America
- artificial recharge.

The representative of Bolivia explained the background introduction and methodology of the "Modelo de La Paz" and the projects coordinated by his country (as shown in Annex III).

The representative of Chile presented his video on "CONAF/SERPLAC and UNESCO/ROSTLAC activities in the IV Region of Chile" demonstrating the projects (a) cloudwater collection [Camanchacas], (b) small reservoirs and terraces, (c) erosion control with infiltration ditches on steep slopes and yessour dams (a technique imported from Tunisia) to slow down runoff in erosion gullies and force the water to drop the sediment load behind the dams, providing little by little lands for cultivation, (d) porous pot irrigation fed by windmill-pumped groundwater.

19. In the same category two days later, in a spare moment between the field visits, the representative of FAO/CESPAC of Peru presented the "Use of audiovisual systems as support of rural development" introducing practical instruction by visual aids under the motto:

"What I hear I forget;
What I see I remember;
What I do I know."

As an illustration he demonstrated three productions prepared by CESPAC: one on the didactic support of audiovisual material and two programs made in collaboration with MRP/LAC (porous pot irrigation in Brazil and recuperation of pre-Columbian terraces in Peru).

A long-time MRP collaborator from Paraguay explained the various technological innovations they have developed within the Institute of Basic Sciences of the National University of Asunción:

a) Low-cost wheelbarrow with conveniently mounted car-type wheel transporting lightweight loads like a drum filled with 200 liters of water over small unpaved distances.

b) The inclined microturbine 5 kw saving the construction of a massive concrete foundation.

c) Low-cost mega anemometer type of windmill, for slow but continuous pumping with slow wind velocities.

d) The small (make-it-yourself) low-cost pump with capacity to lift water from 15 meters depth and even more.

e) How to calculate a spherical substructure for a windmill providing a space with homogeneous wind velocity to prevent vibration, speed up wind velocity and replace steel infrastructure of windmill.

20. Field visits. The CPATSA experimental station was visited where the participants could examine in the field the soil and water management techniques adapted to the Semi Arid Tropics. This program was coordinated by Messrs. Aderaldo de Souza Silva and Paulo Cesar Lima.

- Systems of rainwater harvesting "in situ", its application with various configurations in pilot plots with different crops, demonstration of mechanical devices, like ploughs with modified coulters with animal traction and tractor.

- Rural cisterns composed of rainwater collection area, filter, covered cistern, pump. Sometimes a roof, if sufficiently large, or road cover may serve as collection area. N.B. The pump being the most expensive element might be replaced by the cheaper and more accessible Paraguayan prototype.

- Underground barrage with plastic lining combined with rural cistern on the basis of communicating vases.

- Porous pot irrigation test fields examining distance between plots, plants per pot, etc.

- Porous capsules, their confection and baking with temperature control, etc.

- Crescent-shaped dams for collection of surface runoff for watering animals for "salvation" irrigation, allowing the crops to be regularly irrigated during the growing season, irrespective of long intervals between the rainstorms during the "rainy" season.

- The experimental unit of animal production, explaining their dependency on more or less frequent watering according to the various species, by Messrs. Clovis Guimaraes Filho and Luis Mauricio Salviano.

- Runoff inducement trial for agriculture, by Mr. Pram Sharma, demonstrating the effects of vegetation on runoff efficiency and erosion. The original "caatinga" vegetation of the Semi Arid Tropics with runoff of 0.028% is the best water regulating, soil conservation agent.

- Experimental plots with alternative plantation of crops (like beans and maize) for better nutrition cycling, insolation and water supply, by Mr. Severino Pessoa.

- Visit to integrated production system, by Messrs. Luiz Henrique de Oliveira Lopes and Aderaldo de Souza Silva, showing the functional integration of the techniques.

At the end of the Petrolina programme a private property called "Milho Novo" was visited where the various techniques could be seen in operation at farm level, explaining the financial gain versus investments, credit grant, family budget, etc.

21. On 18 April the journey by bus from Petrolina to Garanhuns was undertaken allowing the participants to obtain a global idea of the "Sertão" and "Agreste" landscapes of the State of Pernambuco. Due to the heavy rains the normally yellow-brownish countryside was greener than ever, rivers were observed in valleys which normally are dry even in the rainy season.

From Garanhuns onwards the general coordination by Mr. Aderaldo de Souza Silva was taken over by Mr. Ebis Dias Santos of the EMATER-PE coordinating unit for NE Brazil. He had organized visits to farms and cooperatives in close collaboration with the local rural private extension groups of the States of Pernambuco and Sergipe. In succession the following properties were visited in the eastern part of the State of Pernambuco:

1st property: Sitio Cagado, district of Lajedo
Owner: Joao André Pereira. Area : 8 ha.
Main techniques used: CPATSA-type rural cistern, "Amazon" well, manioc planted in double rows*/, goat raising and dairy farm, fruit trees.

2nd property: Sitio Taquara, district of Caruaru
Owner: Antonio Pedro da Silva. Area : 6 ha.
Main techniques used: Concrete water tanks, crescent-shaped dams, caldrons, hose irrigation with home-made sprinklers, oleaginous crops (pepper, small onions, coriander, beetroot), flowers, bananas, manioc planted in double rows*/.

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*/ This was done differently from what is usual in Africa.

3rd property: Sitio Porteiras, district of Altinho
Owner: Elpidio Monteiro da Silva. Area : 32 ha.
Main techniques used: CPATSA-type rural cistern, crescent-shaped dams, porous pot irrigation, hose irrigation with home-made sprinkler, "xique-xique" irrigation, water melons, fruit trees, multi-purpose cultivator and plough, alternative millet and bean cultivation, pig raising for family consumption, cow dairy.

4th property: Farmers' cooperative, district of Camocim de Sao Felix
28 tenant families. Area : 40 ha.
Main techniques used: Soil conservation practices, hose irrigation, main crops: cabbage and pepper.

5th property: Sitio Mundé dos Cabrais, district of Camocim de Sao Felix
Tenant: Heleno Jose da Silva. Area : 2 ha.
Main techniques used: Contour furrow, crop rotation, fertilization, vegetation cover.

6th property: Sitio Mundé dos Cabrais, district of Camocim de Sao Felix
Tenant: Camilo Lelis Moraes. Area : 1,5 ha.
Main techniques used: Contour furrow, fertilization, vegetation cover, demonstration of sowing and transplantation schemes.

22. As the last item of the working program in the State of Pernambuco a visit was made to the Training Center of EMATER-PE "CETREINO" in Carpina. The Director of the Center, Mr. Roberto Gilson da Costa Campos, received the members of the Encounter in the auditorium and explained the organization and functioning of his training center, one of the best of this kind in the country, probably without equivalent in other Latin American countries. All technicians and administrative personnel of the rural extension service undergo here a two-month intensive pre-service period. The Center also trains farmers, housewives, youngsters and even entire families of the rural areas. For this purpose the Center provides full board and lodging for groups and individuals and disposes of classrooms, library and a set of specialized field units conducted by experienced professionals.

The participants to the Encounter visited the units of irrigation, drinkwater supply, combined cultivation systems, soil conservation, animal traction for multipurpose cultivators, ferrocement silos for storage and conservation of staple food, animal husbandry, etc.

Afterwards the Technical Director of EMATER-PE, Mr. Antonio de Souza Lira, gave a comprehensive picture of the organization of the State's extension service network and the operation of the diffusion system for technology transfer to the farmers. He gave much attention to community participation via focal point communities (to where all technologies are transferred with the purpose of being passed on to neighbouring communities),summarizing that technology transfer only reaches its final objective (improving the quality of life) if this technology becomes firmly assimilated in the cultural background of the receiving rural community.

Finally visiting the adequate accommodation facilities of the Center several Encounter participants from Latin America expressed their desire to send rural technicians from their respective countries to follow this well-balanced technical and social oriented training course in the modern spirit of the extension strategy of NE Brazil. The representative of the Inter-American Development Bank mentioned that the Bank operates a program which could finance such a request if the CETREINO authorities would agree to train foreigners.

23. On 20 April the participants arrived in Recife, capital of the State of Pernambuco, where a free Sunday was spent (21st April). On 22 April, the journey from Recife to Aracaju (650 km) was made through the coastal humid "mata" region, well known for its traditional cultivation of sugar cane in large "latifundios"; some of them have distillery plants for alcoholic drinks and larger plants where alcohol fuel is produced. In the evening the group arrived in Aracaju, capital of the State of Sergipe.

24. In the State of Sergipe the Encounter participants were received by the State Secretary of Agriculture, Mr. Edmilson Machado de Almeida, in the administrative center "Governador Augusto Franco" of EMATER-SE. The State Secretary and the President of EMATER-SE, Mr. Roberto Alves, described the physiographic and climatic conditions of the State. The semi-arid area had suffered seriously under the drought conditions of the last five years. They explained the innovative technology transfer strongly promoted by the Governor of Sergipe, developed in collaboration with EMBRATER to break the vicious circle of the drought, destroying also the conventionally planned, socially non-integrated efforts*/, by studying rural reality more in depth in order to know its needs,modify its attitudes and create a dialogue through an active participation program of the extension service and the rural community. As an example he mentioned that during the drought 700 water tankers were continuously exploited by the State to provide the rural population with the necessary water. Now 7.000 rural cisterns had been constructed to solve this problem once and for all. And the construction of cisterns goes on.

25. In continuation, during 23 and 24 April a number of hydraulic works, cooperatives, properties and rural industries were visited which illustrated the "innovative methodology" in the project "Chapeu de Couro" (Leather Hat) covering the semi-arid areas of 13038 km^2 with 68% of a total rural population of 435.000 inhabitants.

- A visit was made to Poçao de Ribeira where a dam is under construction with storage capacity of 16.5 million m^3 for introduction of sprinkling irrigation and re-allotment of land in an area of 1.125 ha of permeable sandy soils to improve the rational use of the soil and develop fish culture for the establishment of 375 families in 3 ha plots.

- Colonization project of barrage of Jacarecica with storage capacity of 6.5 million m^3 for the irrigation of 260 ha. This project is for the benefit of 130 families with 2 ha plots.

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*/ Socially non-integrated efforts are those not made in close collaboration with the farmers.

- The Marcela dam completed in 1956 with capacity of 2.1 million m^3 for irrigation and fish culture with 120 ha irrigated lands at both sides of the dam providing 60 families with land that produces about 7600 tons of horticulture for the local market and the capital Aracaju. As an example the properties of Messrs. Gerino da Silva (5,8 ha) and Genario Antonio de Carvalho (6 ha) were visited. Both irrigate by sprinkling a part of their land (2,8 ha) under intensive production of horticulture: pepper, onion, tomatoes, sweet potatoes, cabbage, etc. They obtain the water by pumping electrically from the Marcela dam, which cost them a considerable amount of money.

- The community of Caraibas. Here 129 families are applying irrigation mainly in the basis of artesian or electrically pumped water wells. Mr. Joao Francisco da Cunha with a property of 9,6 ha cultivates tomatoes, pepper, manioc, peanuts, etc. and has some livestock, with one artesian well with yield 24 m^3/hour and two water reservoirs with total capacity of 78 m^3. Mr. Antonio Severiano de Menezes with 12.6 ha, of which 9 ha under exploitation, has two artesian wells producing respectively 2000 1/h and 1500 1/h and two water reservoirs for the irrigation of horticulture.

- A visit was paid to the manioc flour ("farinha") rural industry belonging to the Fazenda Santo Isidoro with 442 ha, of which 144 ha. with manioc divided in 46 plots. The factory can produce 5000 kg/day in full production.

26. The next day in the more arid zone of Sergipe various farms were visited where different techniques are being applied through EMATER-SE (cisterns, crescent-shaped dams, biodigestors, porous pot irrigation). Also the economic financial explanation of the exploitation was given as well as the planning of the crop rotation.

At any place during the entire trip the visits to the various experimental stations and properties were introduced by the advising extension worker in question and/or the owner or tenants of the land, giving an overview of the exploitation scheme. This was followed by an intensive discussion with the participants on the various details covering the labour force either contracted or provided by the family, the new technologies that had been introduced, the availability of water and its most functional applications, the access to bank credits and their amortization, the proportion of subsistence versus commercial crops, livestock, family budget, etc. Essential parts of the discussion and the operation of the techniques were recorded in the local setting by the CESPAC representative on a high quality Umatic tape to preserve it as a document to explain this technology transfer process.

Annex IV, prepared by Mr. Carel de Rooy (UNICEF/Nigeria), presents a brief description of technologies observed, and summarized information on animal-drawn ploughs (cheaper and more realistic for small farmers), rural economy strengthening and income generating crops/plants, livestock development and an alternative source of energy.

III. FINAL MEETING OF THE ENCOUNTER IN ARACAJU, SERGIPE (25 APRIL 1985)

27. At the end of the field visits the final (half) day of the Encounter, 25 April, was reserved for discussions, formulation of conclusions and recommendations and the drafting of the final report, guided by Mr. Nelson da Franca of the Unesco Division of Water Sciences.

28. The first presentation was made by the representative of the Inter-American Development Bank, Mr. Hernán Lafourcade, who explained the support that IDB is giving to the Semi Arid Tropics of Brazil according to the following concepts:

- Improve and increase respectively the quality and quantity of scientific research in NE Brazil. Five universities have been selected for the research.

- Application of the investigated technologies in the rural areas according to a listed 54 lines of research, among which

water resources
drought-resistant plants
animal production
soil management
agro industries
rural education
socioeconomic studies.

He also explained the procedure to be followed in order to obtain the support of IDB. The request should be based on technical and socio-economic justification and should be given priority by the government.

29. The second presentation was made by Mr. Hernán Contreras from Venezuela, who explained the introduction of an ecological and conservationist culture to the concept of development, using a model for the evaluation of the quality of life consisting of 5 factors and 32 variables.

30. During the Encounter the participants had prepared in anticipation of this final session some conclusive texts to which some applauded statements in speeches during the dinner offered in Aracaju by the authorities of the State of Sergipe were added. These quotations reflect all that was seen and heard during the previous days after having covered in total a distance of almost 3000 km through NE Brazil mainly in the States of Pernambuco and Sergipe.

"The Encounter enabled the participants to identify themselves fairly well with the task of the extensionist in the minimum of time."

"In the semi-arid areas the understanding of the importance of water, its uses and rational management provides the key to change the 'quality of life' in the rural areas."

"Integrated rural development should be based on an open dialogue between professionals and rural communities with the extensionist as its interpreter."

"The example of the extensionists in NE Brazil has allowed the participants to understand the complexity of their task being more than can ever be compensated by a salary. The Brazilian example serves as an effective model to plan the massive extension service training in other countries. The audiovisual pedagogy is an important means to reach this objective."

"It was realized that various old traditional techniques originated in the Old World had been developed, adapted and updated in the New World, and were now again available to be returned to the Old World in their new form."

"Research for the rural areas should be problem-oriented."

The declarations of the participants prepared in two English and Spanish texts appear in Annex V in their original language.

31. As last point of the meeting various recommendations presented were discussed, revised and approved in the form in which they appear in Chapter IV of this report.

32. Having reached the end of the Encounter, Mr. Christiaan Gischler thanked the Brazilian organizers of the event for their hospitality and excellent organization. He also extended his gratitude to Mr. Carel de Rooy, representative of UNICEF, for his extraordinary cooperation by translating in the different languages all that was said, and the participants for their constructive participation.

In the name of the participants Mr. Carlos Fernández Jáuregui of Bolivia thanked and congratulated Mr. Christiaan Gischler for the efforts made to implement the Major Regional Project and the success so far obtained in the different projects.

IV. RECOMMENDATIONS

The following recommendations were adopted by the meeting:

1. Continue and accelerate in the Latin American countries and Africa possibilities of interchange of experiences and South-South technology transfer. This should be done by bilateral cooperation or through international organisms within the framework of the Unesco Major Regional Project.

2. Request Unesco to promote a workshop in Africa with representatives of the countries present during the April 1985 Encounter in Brazil as well as other interested countries. The objective would be to analyse in detail the observed experiences and thereafter program recommendations for future activities based on the latter.

3. Request the financial organizations such as the Inter-American Development Bank, the African Development Bank, the World Bank and others involved in integrated development projects to allocate part of their credits to finance projects of this kind within the framework of MRP. This would have a positive multiplying effect due to the horizontal technology transfer.

4. Request Unesco to continue stimulating the use and proliferation of experiences obtained in several Latin American and Caribbean and African nations.

5. Request the Latin American countries to support the Second Major Regional Project meeting to be sponsored by Unesco in 1986. Its venue will be La Serena, Chile.

6. Continue to intensify the studies on development and adaptation of alternatives, low cost and non-conventional technologies aimed at benefiting the peasants and reducing their dependence on sophisticated technologies not accessible to all rural areas, which are after all the fundamental pillar of most Latin American and African countries.

7. Study the possibility of intensifying integration within the Major Regional Project of the different United Nations agencies, namely Unesco, UNICEF, FAO, UNDP, CEPIS (PAHO/WHO) and ECLA, as well as regional bodies such as ECA and OAS.

8. Promote the generation of national mechanisms that allow a real integration of the basic and applied research, the rural extension and the traditional technologies, to obtain an adequate feedback to the needs of the rural sector.

9. Request Unesco to establish a directory of human resources and projects working within the philosophical framework of MRP.

Annex VI presents comments of the African and Latin American participants on the Interregional Technology Transfer Encounter in Northeast Brazil.

Annex I

LIST OF PARTICIPANTS

1. ÁFRICA

COTE D'IVOIRE / IVORY COAST / COSTA DE. MARFIL

Vincent P. LOKROU
Directeur General
Bureau d'études Techniques des Projects Agricoles - BETP
Ministere de l'Agriculture et Eaux et Forêts
04 BP 716
Abdijan
Tel. (225) 32-32.09

KENYA

Justus M. KABUGA
Head, Food Crop Production
Departament of Agriculture
Ministry of Agriculture and Livestock Development
P.O. Box 30028
Nairobi
Tel. 72.00.30/9

MAURITANIE/MAURITANIA

Nema OULD TALEB
Directeur adjoint Protection de la Nature
Ministere du Developpment Rural
B.P. 170
Novakchott
Tel. 5.20.20 poste 377

NIGÉRIA

Bunu SHERIF MUSA
General Manager
Chad Basin and Rural Development Authority
Federal Ministry of Agriculture, Water Resources and Rural Development
Dikwa Road
P.M.B. 11 30
Maiduguri, Borno State
Tel. (076) 23.20.15

TANZANIA

H. MWINYIGOHA
Director of Irrigation
Irrigation Division
Ministry of Agriculture and Livestock Development
252 Regent Estate
P.O Box 9192
Dar - es - Salaan
Tel. 44294

TOGO

Felix Komla EMOE
Directeur General du Genie Rural
Ministère Amenagement Rural
B.P. 1643
Lome
Tel. (228) 21.02.92

ZIMBABWE

Donald Saunders DELL
Permanent Secretary
Ministry of Energy and Water Resources and Development
Drill Hall Complex, Blox 3
Salisbury Street
Private Bag 7712, Causeway, Zimbabwe
Harare
Tel. 70.78.61
Telex. IRRGHEAD, HARARE

2. AMÉRICA LATINA / LATIN AMÉRICA

ARGENTINA / ARGENTINE

Osvaldo Emílio CAPPE
Profesor Adjunto
Facultad de Ciencias Agrarias
Catedra de Hidrologia Agricola
Universidad Nacional de Cuyo
Alte Brown 500, Chacras de Coria
Mendonza
Tel. (61) 96.04.31
Telex. 55217 TTAMZ AR

BOLIVIA

Carlos Fernandez JAUREGUI
Director del Instituto de Hidraulica e Hidrologia - IFF - UMSA
Presidente del Comité Nacional del PHI
Ciudad Universitaria Cota - Cota
Casilla de Correo 699
La Paz
Tel. 79.57.24/5
Telex. SHERATON CABIN

BRASIL / BRAZIL

Empresa Brasileira de Pesquisa Agropecuária - EMBRAPA
Centro de Pesquisa Agropecuária do Trópico Semi-Árido - CPATSA
Br 428, Km 152 (Petrolina/Lagoa Grande) Zona Rural
Caixa Postal 23
Petrolina, Pernambuco
Tel. (081) 961-4411
Telex. (081) 1878
. Renival A. DE SOUZA (M.Sc. Solos/Chefe Geral/Ramal:36)
. Edson LUSTOSA DE POSSÍDIO (M.Sc. Irrigação/Chefe Adj.Técnico / Ramal:145)
. Pedro MAIA E SILVA (Chefe Adj.Apoio / Ramal:139)
. Manoel ABÍLIO DE QUEIROZ (Ph.D. Melh.Plantas/Coord. Proj.Nordeste/Ramal: 196)
. Aderaldo DE SOUZA SILVA (M.Sc. Manejo de Solo e Água / Ramal: 163)
. Francisco ZUZA DE OLIVEIRA (B.Sc. Difusão de Tecnologia / Ramal: 214)
. Clóvis GUIMARÃES FILHO (M.Sc. Manejo de Rebanho /Coord. PNP - 030 / Ramal:189)
. Adrovile FERREIRA LIMA (Ph.D. Fitotecnia / Coord. PNP-033 / Ramal: 162)
. Antônio CARLOS SCHIFINO (M.Sc. Geografia / Coord. PNP-027 / Ramal: 130)
. Luiz Henrique DE OLIVEIRA LOPES (B.Sc. Fitotecnia / Ramal 199)
. Maria Cira PADILHA DA LUZ (B.Sc. Documentação / Ramal 149)
. Luiz Maurício SALVIANO (M.Sc. Nutrição Animal / Ramal 155)
. José BARBOSA DOS ANJOS (M.Sc. Mecanização Agrícola / Ramal 182)
. Malaquias DA SILVA AMORIM NETO (M.Sc.Climatologia / Ramal 168)
. Paulo César LIMA (M.Sc. Silvicultura / Ramal 220)
. Severino PESSOA (M.Sc. Fitotecnia / Ramal: 142)
. Severino GONZAGA DE ALBUQUERQUE (M.Sc.Ecologia de Pastagem / Ramal 156)

Empresa Brasileira de Assistência Técnica e Extensão Rural - EMBRATER
SAIN - Setor de Áreas Isoladas Norte - Parque Rural
Brasília - DF
Tel. (061) 274-4650

. Ebis DIAS SANTOS (Assessor em Irrigação e Drenagem NE)

. Ezenildo XAVIER COSTA (Coordenador Projeto Nordeste / Semi-Árido)

Empresa de de Assistência Técnica e Extensão Rural do Estado de Pernambuco - EMATER/PE
Rua João Lacerda S/N (Cordeiro)
Recife - Pernambuco
Tel.(081) 228-4622

. Roberto Gilson DA COSTA CAMPOS (Diretor-Presidente)

. Antônio DE SOUZA LIMA (Diretor Técnico)

. José CABRAL DE VASCONCELOS (Coordenador de Operações)

. Celson Almir DE MELO CRUZ (Assessor de Irrigação)

. Manoel FILGUEIRAS (Coordenador Regional de Garanhuns)

. Genil GOMES DA SILVA (Coordenador Regional de Bonito)

. Antônio FERREIRA FILHO (Supervisor Regional de Bonito)

. Hildebertp RODRIGUES DA SILVA (Supervisor Regional de Bonito)

. João Evangelista C. DOS SANTOS (Extensionista Local de Camocim de São Felix)

. Zaldo ATAÍDE DE LIMA (Extensionista Local de Camocim de São Felix)

. Antônio PEREIRA BORBA (Coordenador do Centro de Treinamento da EMATER/PE)

. Nilson FERREIRA DA SILVA

. Fernando BRAYNER DA SILVA (Coordenador Regional de Carpina)

. Ulisses ARRUDA CAVALCANTE DE MELO AZEVEDO (Assessor Regional de Carpina)

. Claudemir MONTEIRO DE VASCONCELOS (Assessor Regional de Carpina)

Empresa de Assistência Técnica e Extensão Rural do Estado de Sergipe - EMATER/SE
Centro Administrativo Governador Augusto Franco - Br.235 - Km 4
Caixa Postal 297
Aracaju-Sergipe
Tel. (079) 222-7416
Telex. (079) 2209

.Edimilson MACHADO DE ALMEIDA (Secretário de Estado da Agricultura)

. Roberto ALVES (Presidente)

. Paulo CARVALHO VIANA (Diretor Técnico)

. Geraldo FERREIRA SOBRINHO (Coordenador de Operações)

. Jodemir Antônio PIRES DE FREITAS (Supervisor Regional)

. Ronaldo Luiz DANTAS (COHIDRO)

. Zélia ALVES AMADO (Assessora Estadual)

. José HOLANDA NETO (Assessor de Metodologia)

. Maria ANgélica ANDRADE FREITAS (Supervisora Regional)

. Maria das Graças SILVA (Assessora Regional)

. José Laertes RABELO BARRETO (Supervisor Regional)

. Orlando MONTEIRO (Embrapa)

CHILE

Guido SOTO ALVAREZ
Director Regional IV Region
Corporación Nacional Forestal - CONAF
Cordovez, 281
La Serena
Tel. 21.42.55 y 21.11.24

DOMINICAN REPUBLIC / REPÚBLICA DOMINICANA

José Daniel PEÑA GERALDINO
Jefe Division Conservacion y Mejoramiento
Depto Distritos de Riego
Instituto Nacional de Recursos Hidraulicos - INDRHI
Centro los Heroes
Apartado 1407
Santo Domingo
Tel. 533- 70.00
Telex. 3460559 - INDRHI

ECUADOR

Eduardo FIGUEROA GARCIA
Director General de Medio AMbiente
Direcion General de Medio Ambiente - DIGEMA
Ministerio de Recursos Naturales y Energéticos - MRNE
Sta. Prisca nº 223
Quito
Tel. 57.07.67
Tlex. 2271 - MINREC ED

Rodrigo CALERO HIDALGO
Ing.Agr. Planificador (Técnico de Desarrollo Cientifico y Tecnologico)
Direcion de Desarrollo Rural - DDR
Consejo Nacional de Ciencia y Tecnologia - CONACYT
Av. Patria y 10 de Agosto
Edf. Banco de Prestamos, oficina 801
Casilla Postal 60028
Quito
Tel. 55.01.60

MÉXICO

Mario VILLAREAL PULIDO
Director de Planeacion y Estudios
Programa de Desarrollo Rural Integrado del Tropico Humedo
Comision del Plan Nacional Hidraulico
Secretaria de Agricultura y Recursos Hidraulicos
Baja California 104 Col. Roma
Mexico , DF
Tel. (5) 564-0686

PARAGUAY

John A. FITZPATRICK
Investigador del Instituto de Ciências Básicas - IBC
Universidade Nacional de Asunción
Casilla de Correo - 1039
Asunción
Tel. 50.15.17

Juan Carlos BERNIE
Direcion de Aguas para el Chaco
Departamento de Aguas para el Chaco - DAPCH
Ministerio de Defensa Nacional
Avda. Mariscal Lopez y Vice Pte. Sanchez
Asunción
Tel. 20.49.87

PERU

Nelson VILLAVICENCIO PALACIOS
Pedagogo Audiovisual - Sociólogo
Centro de Servicios de Pedagogia Audio Visual para la Capacitación - CESPAC
Calle Osa Mayor 118 Urb. 205 (Granados,Monterico)
Lima
Tel. 36.89.02

VENEZUELA

Maria S. de PEREIRA
Ingeniero de la Division de Información e Investigación del Ambiente
Ministerio del Ambiente y de los Recursos Naturales Renovables - MARNR
Avda. Intercomunal Cabudare, Sector Carabali
Barquisimeto, Lara
Tel. (051) 53-24.26

Hernan CONTRERAS MANFREDI
Consultor privado en Recursos Naturales y Calidad de Vida
Parque Central - Edificio Tajamar - Apartamento 11 F
Apartado 81, Correo Carmelitas
Caracas
Tel. (02) 573-8596

3. ORGANISMOS INTERNACIONALES Y REGIONALES

UNESCO - United Nations Educational, Scientific and Cultural Organization

. Nelson DA FRANCA RIBEIRO DOS ANJOS
Programme Specialist
Division of Water Sciences - SC/HYD
7, Place de Fontenoy
B.P. 3. 07 Paris
75015 - Paris, France
Tel. (1) 568.39.96
Telex. 204461 F

. Chistiaan GISCHLER
Hidrologo Regional y Coordenador General del Projecto Regional Mayor de Latino AMerica y Caribe - PMR/LAC
Oficina Regional de la UNESCO para America Latina y el Caribe - UNESCO/ROSTLAC
Bulevar Artigas 1320
Casilla 859
Montevideo, Uruguay
Tel. 41.18.07
Telex. UY 22340

UNICEF - United Nations Children's Fund

Carel DE ROOY
Senior Hydrogeologist (Water Supply officer)
Water and Sanitation
11 A Osborne R D. (IKoyi)
P.O.B. 1282
Lagos, Nigeria
Tel. 60.35.40 -4

BID - Banco Interamericano de Desarrollo

Hernan LAFOURCADE
Ingeniero Consultor BID/Brasil
Praia do Flamengo 200, 21 andar
20.000 Rio de Janeiro, Brasil
Tel. (021) 205-33-32

4. OBSERVADOR / OBSERVER

Gwynne POWER
News Editor
World Water Magazine
553/561 Water St.
Liverpool, UK
P.O. Box 124 Liverpool L 69 2LQ
Tel. (051) 236-11.55
Telex. 628761 BULTEL G.

Annex II

DOCUMENTS PRESENTED

IIa. Documents distributed by EMBRATER

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. Calagem do coqueiro - EMATER-SE
. Broca do tronco do coqueiro - EMATER-SE
. Combata a verminose - EMATER-SE
. Conservar o solo é conservar a vida - EMATER-SE
. Preços mínimos de feijao - EMATER-SE
. Agua de boa qualidade para sua familia - EMATER-SE
. Prevençao no uso de agrotóxico - EMATER-SE
. Inseticidas caseiras - EMATER-SE
. Reflorestar é conservar - EMATER-SE
. Algaroba, leucena e sabiá - EMATER-SE
. Defender a natureza é defender a vida - EMATER-SE
. Conservaçao do solo - EMATER-SE
. Programaçao do intercambio - EMATER-SE

- Folhas soltas sobre:
. Frutas e verduras - EMATER-SE
. Materia orgânica - EMATER-SE
. Combata a cochonilha da palma forrageira - EMATER-SE
. Conservaçao do meio ambiente - EMATER-SE
. Uso do filtro - EMATER-SE
. Como retirar amostra de solo - EMATER-SE
. Todo dia é dia de mandioca - EMATER-SE
. Conservaçao do solo - EMBRATER

- Cartazes sobre:
. Conservaçao de solo - EMATER-SE
. Agrotóxicos - EMATER-SE
. Conservaçao do Meio Ambiente - EMATER-SE
. Dia do produtor rural - EMATER-SE

- Material de divulgaçao do Estado de Sergipe-ENSETUR
. Sao Cristovao
. Laranjeiras
. Calendário oficial de eventos
. Aracaju no bolso
. Aracaju sal historia e tradiçao
. Parque da cidade

MAJOR REGIONAL PROJECT ON THE USE AND CONSERVATION OF WATER RESOURCES IN THE RURAL AREAS OF LATIN AMERICA AND THE CARIBBEAN IN BOLIVIA

(MRP/BOLIVIA)

Introduction

As a result of the launching of the Major Regional Project on the Use and Conservation of Water Resources in the Rural Areas of Latin America and the Caribbean (MRP/LAC) which would take place in March 1982 in Mexico City under the sponsorship of UNESCO/ROSTLAC, the Bolivian National IHP Committee (CONAPHI-Bolivia) invited all Bolivian institutions to submit projects on the subject; a first selection of these was made, and Messrs. Carlos Arze and Floreal Gracia were entrusted with their presentation in Mexico City. It was a pleasant surprise to see how the different countries, especially Brazil, were developing projects of much interest for application in Bolivia.

Description of the area

Bolivia is divided into seven traditional physiographic provinces which are classified according to their morphology and structure:

A-1. Western volcanic mountain range
A-2. Central-West mountain range
B. Altiplano
C. Sub-Andean
D. Plains
E. Brazilian Pre-Cambrian shield
F. Serranías chiquitanas.

Climatology of the area may be classified (according to Koppen) in:

A. Tropical climates (AF and AW)
B. Dry climates (BSwh', BSwh and BSwh)
C. Temperate climates (Cwb and Cwa)
D. Cold climates (EB and ET)

Temperature according to isotherms (Water balance, CONAPHI-Bolivia):

Altiplano	8 - 10°C
Valleys	12 - 16°C
Plains	24 - 26°C

Precipitation according to isohyets (Water balance, CONAPHI-Bolivia):

Altiplano	100 - 500 mm
Valleys	900 - 1200 mm
Plains	1300 - 1700 mm

Evapotranspiration, according to Thornthwaite:

Altiplano	650 mm
Valleys	870 mm
Plains	

Elevation above sea level:

Altiplano	3700 - 4000 m
Valleys	2000 - 3000 m
Plains	Less than 1000 m

Information is also available on the following:

1. Population growth (by province)
2. Illiteracy rate (by province)
3. Languages spoken (by province)
4. Work conditions
5. Housing characteristics
6. Source of water supply
7. Water disposal systems
8. Electric power availability.

Framework for technology transfer within MRP/Bolivia

In the face of the interesting and enormous technological wealth available in Latin America and the Caribbean, Bolivia considered the convenience of establishing a framework for this subject, under the sponsorship of UNESCO/ROSTLAC and the cooperation of Mr. Christiaan Gishler. The result of this action was the "Modelo de La Paz", the objective of which is to establish a development area on the basis of technology which is socially, economically and technologically appropriate to the environment, so that the technology can be applied and used in an objective way for the benefit of the users and with the participation of the local communities. In this way MRP/Bolivia found its final shape and at present is composed of the different institutions and experts working on the subject at national level.

Projects

In agreement with the framework, it was established that the pilot sites for the application of the "La Paz Model" would be two areas: one in the altiplano, the community of Huaraco, and the other in the valley, the community of San Pedro (Chuquisaca); taking into account the physical, social and economic environment a series of technological alternatives appropriate to each of them have been proposed, as follows:

a) Irrigation project: application of irrigation in arid and semi-arid zones

i) clay pot and porous capsule irrigation
ii) clay pot drip irrigation
iii) irrigation by hoses

For the application of the above mentioned methods the following methodology was established:

- construction of an oven at the Instituto de Hidráulica e Hidrología-IHH (La Paz, Bolivia)
- construction of a turntable for the elaboration of elements at the IHH
- construction of a greenhouse at the IHH
- ceramics courses for workshops and technicians of IHH
- applications in pilot areas

b) Project on windmills: water supply for human consumption and irrigation. For the application of the project the following steps were taken:

- construction of a wind tunnel
- study of the different arms for local conditions
- construction of rotor prototypes
- construction of pylon and transmission prototypes (IHH)
- construction of pumps (IHH)
- optimization of pump performance
- elimination of "bottlenecks"
- construction of an aerial pump prototype IHH-1
- application in a pilot area

c) Project for water decontamination by Schoenoplectus Tatora. For the elimination of Lead, Manganese, Zinc and Copper on the basis of a typical plant of the Titicaca Lake. The following methodology was applied:

- First phase: laboratory study of behaviour of totora towards these minerals with respect to absorption and time
- Second phase: construction of a hydraulic model as a prototype of treatment plant (IHH)
- Third phase: construction of a prototype plant and optimization of measurements on the basis of atomic absorption.

d) Project on the use of native products. For the clarification of turbid waters and its treatment for human consumption:

- peach pits (pericia vulgaris)
- dried beans (vicia faba)
- pips of opuntia vulgaris
- La Paz earth

The following method was applied:

- First phase: laboratory study of muddy and colored water
- Second phase: pilot experiences (IHH-IIS)
- Third phase: methodology for application and diffusion of the method

e) Project on chlorine and fluor dosifiers. For disinfection of water for human consumption:

- use of waste materials
- safe and simple system
- design of a prototype and its calibration (IHH-IIS)
- methodology for application and diffusion

f) Project on biodigestors. For provision of energy, biofertilizers and environmental sanitation:

- studies on biogas and its technique
- studies on biofertilizers and its technique
- construction of a prototype and research on its application (IHH)
- project on its diffusion

g) Project on Lorena stoves. For the optimization of the use of firewood and erosion control:

- studies on the technology
- construction of a prototype (IHH)
- projects on its diffusion

h) Project on solar heater. For the provision of hot water for human use:

- studies on the technology
- construction of a prototype and research (IHH)
- project on application in pilot area

i) Project on solar distiller. For the elimination of salt content in water:

- studies on the technology
- construction of the prototype (IHH)
- design of a distillation plant

j) Project for control of erosion. For prevention of erosion and reforestation of the area with simple low-cost works. Methodology applied:

- study of the area
- design of protection works
- application of crescent-shaped dams, small dams for collection of runoff water, small dry spillways, infiltration ditches

k) Project on home-made clay filters. For the filtering of water for human consumption. On the basis of available information on clay it was decided to make clay filters using the clay pot technology:

- design of elements
- design of the prototype (IHH)
- application of the prototype

1) Rainwater harvesting from roofs. For water supply in places where water source is distant:

   - translation into Spanish of the Manual produced by WASH in English
   - preparation of a workshop in the community
   - diffusion of the technology

m) Courses for diffusion of appropriate technologies. Taking into account the philosophy of the Modelo de La Paz, a series of programs, courses and seminars were carried out for the diffusion of the technology at different levels:

   - government officials (decision-making level)
   - technicians in specific areas of knowledge
   - social workers
   - communities

   This activity was carried out in the following Departments of Bolivia:

   - Chuquisaca
   - Tarija
   - Cochabamba
   - La Paz

   And finally public exhibitions were held of the techniques presently known and developed.

n) Other projects. For the execution of the project detailed above, the following previous research work was required:

   1. Inventory - diagnosis of water resources in Bolivia
   2. Water balance of Bolivia (4 main basins)
   3. Snow inventory of Bolivia
   4. Hydrogeological map of Bolivia
   5. Visits of national technicians to other projects abroad
   6. Collection of documents on the subject.

Background information (Bolivia) on Technology Transfer Encounter in NE Brazil (15-25 April 1985)

UNESCO/MRP	Contribution to the International Decade for Drinking Water and Sanitation: launching of MRP/LAC. First meeting in Mexico City in March 1982: participation of Messrs. Carlos Arze and Floreal Gracia.
UNESCO/ROSTLAC and EMBRAPA/EMBRATER	Technical visit to NE Brazil to visit EMBRAPA projects related to water. Second meeting in Petrolina in November 1982: participation of Mr. Edgar Michel.
INTERGOVERNMENTAL COUNCIL OF IHP	It was suggested to establish contacts with regions with similar climate and water uses. Third meeting in Paris in March 1984: Bolivia sent information.

UNESCO ROSTLAC and EMBRAPA/CPATSA under the sponsorship of COBRAPHI

Meeting in Northeast Brazil, 15-25 April 1985.
Participation of Mr. Carlos Fernández Jáuregui.

* * *

TECHNICAL ASPECTS OBSERVED DURING THE ENCOUNTER

TECHNOLOGIES OBSERVED

1. Rainfall Harvesting: By means of Induced Runoff and Storage.
   a) For human beings (catchment and cistern)
   b) For livestock (small earthen dams with induced runoff area)
   c) For agriculture (same as b)
2. Use of Contour Ploughing: Along humid belts or receding water levels in valleys, surroundings of dams, rivers and lakes with the objective of using the humid soils for agriculture after the rainy season.
3. Subsurface Dams: To transform dry river beds into humid zones and thus enable technology 2. to be used.
4. "IN SITU" Rainfall Collection: Consisting of contour ploughing in order to attenuate the effects of irregular rainfall by increasing the water storage in soil.
5. Unconventional Irrigation Methods: Including the usage of clay pitchers and capsules.

   All these technologies with exception of capsules are currently being tested and used on production scale throughout the north-east of Brazil.

BRIEF DISCRIPTION OF TECHNOLOGIES

1. Rainfall Harvesting

1.1 Rural Cistern (for human use): The development of this system was based on the fact that:

   a) Not much water is stored in the shallow over-burden of most areas in the north-east Brazil. This consequently is a serious constraint for the construction of hand-dug wells.

b) As previously stated, about 36 billion m^3 of rainfall is lost annually to the sea in the form of runoff.

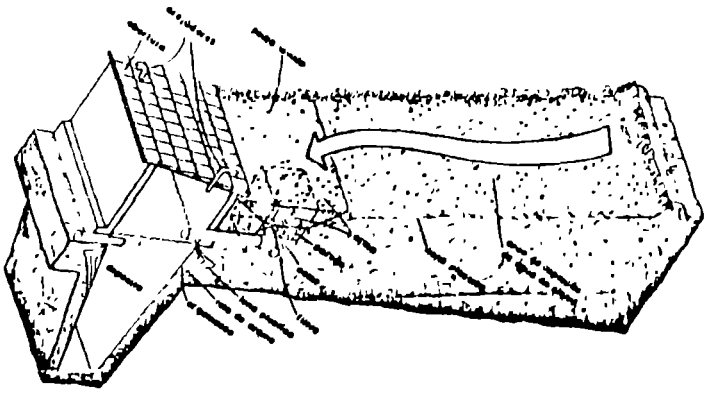
CPATSA therefore developed a cistern consisted of a catchment area, a filter system and a storage tank (see fig.1). The "CAPTSA CISTERN" costs in the order of US$ 600 and is normally used by families of 10 to 15 persons. The sizes of the catchment and storage tank vary according to:

i) "Runoff coefficient" of material used (for catchment)

ii) Average rainfall of the area

iii) Amount of water required.

The catchment area can be covered with anything from polythene, cement and sand, bricks to just soil. These materials have runoff coefficients which under similar slopes vary from 90% to 2% (0.9 to 0.02) respectively.



.Modelo esquemático de uma cisterna modelo CPATSA com área de captação no pró prio solo.

Fig.1

The filters are made of gravel, charcoal, coarse sand and fine sand from bottom to top. The storage tanks can take any form in

principle even though the circular (cylindrical), is more efficient. A trapezoidal/rectangular shape is the most commonly used in plastic lined cisterns because it enables better stabilization of the walls. Plastic, wire mesh and cement/sand lining is the most popular due to its relatively low cost. (Fig. 2).

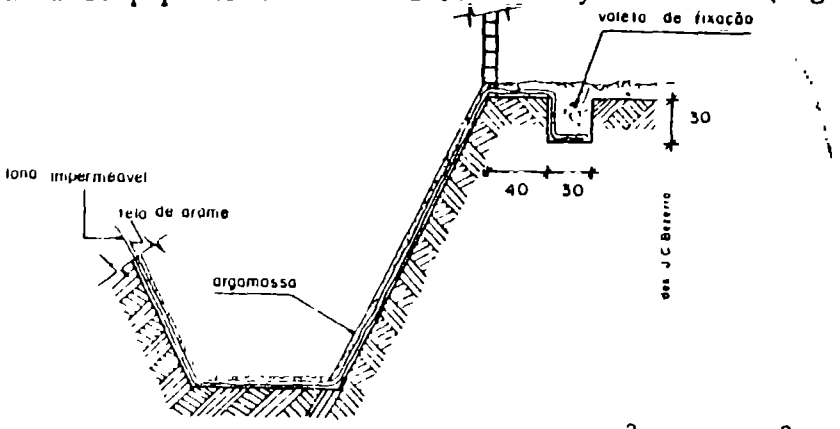
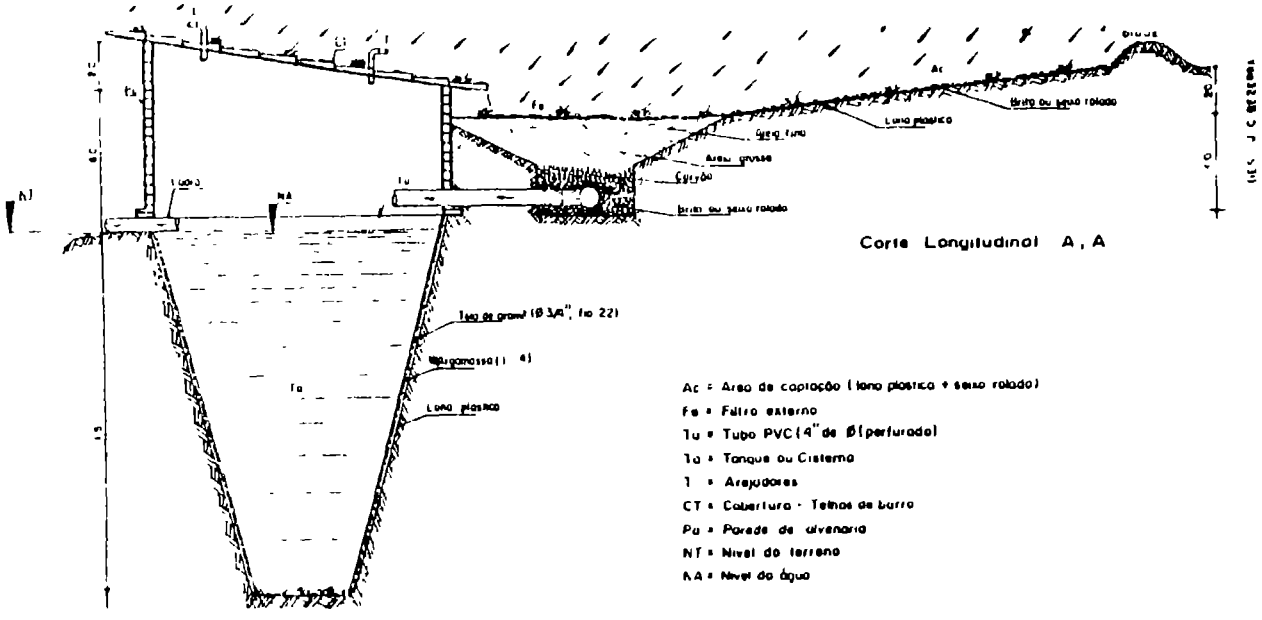


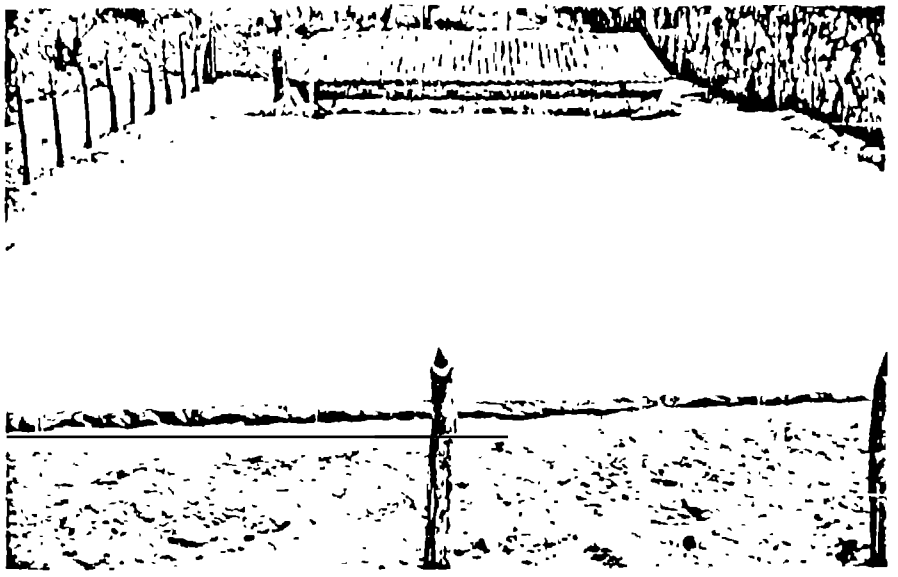
Fig. 2

Cistern capacities range from 15 m^3 to 100 m^3 , the total cost of the system respectively varies from US$ 370 to US$ 920 for average rainfall rates of 400 mm.



Corte longitudinal A,A de cisterna rural com área de captação no próprio solo e capacidade para 30 m^3.

Fig.3



Cisterna modelo CPATSA

Fig.4

1.2 Earthen Dams for Animal Husbandry and Irrigation: Earthen dams are traditional in the north-eastern region of Brazil, presently, 100,000 exist, storing a total of 25 billion m^3 of water .

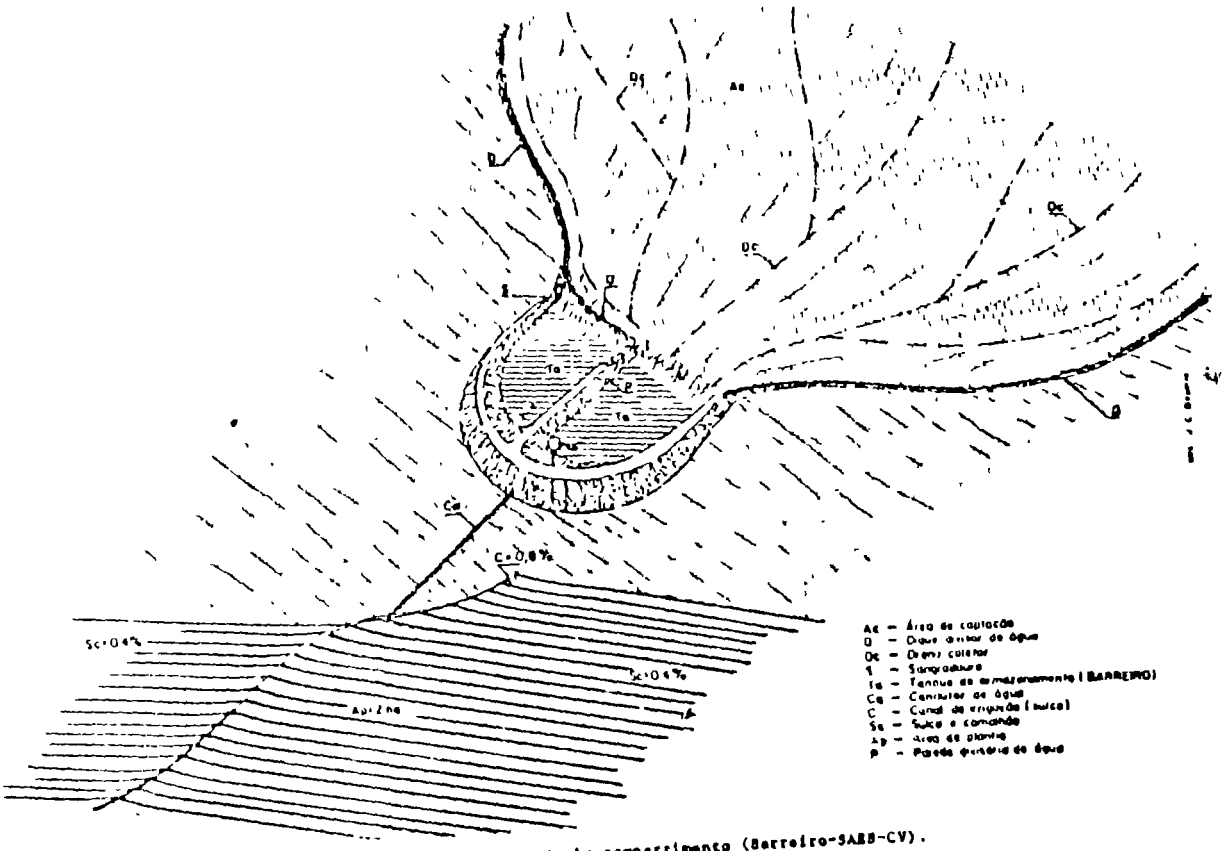
If one observes LANDSAT SATELITE images of specific areas, this becomes quite evident. Several problems have however occured with the use of "traditional dams" in the past:

- salinization of water due to evaporation
- drying up rapidly
- filling up with sediments.

CAPTSA has, through research, developed an earthen dam with innovations consisted basically of:

a) Adequately dimensioned catchment, storage and irrigation areas.

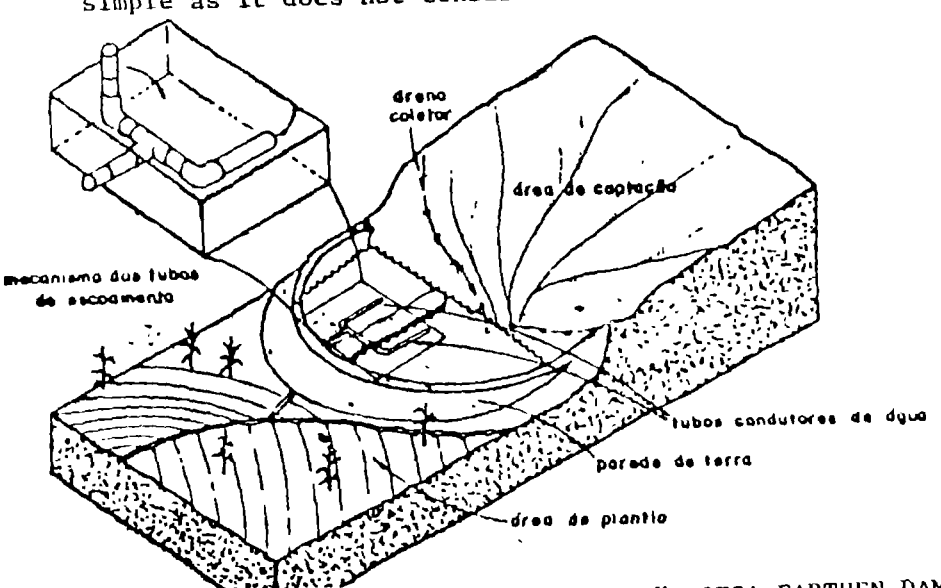
b) A system which reduces evaporation losses and consequent salinization by increasing the volume/surface area ratio.



Reservatório de terra com duplo compartimento (Barreiro-SAAB-CV).

Fig.5

c) Adequate in-built outflow system which is kept cheap and simple as it does not consist of valves. (Fig.6)



The surface area of the catchment in the "CAPTSA EARTHEN DAM" is in the order of 3 hectares, the slope should be equal to or larger than 2%.

Preferably, the catchment area should be chosen in soils which are shallow, rocky and thus unsuitable for agriculture. This reduces the risk of erosion and also allows a better runoff which can be increased by artificial handdug drains where necessary.

The storage area or dam site is located at the convergence of the drainage system and normally has a surface area of 0.2 - 0.4 hectares with a capacity of about 3,000 m^3.

The area to be irrigated should be as close as possible to the dam so that water distribution costs can be minimized. Normally, 2 hectares are taken with slopes ranging from 0.5 to 5% and soil depth of atleast 0.5m with a good water retention capability.

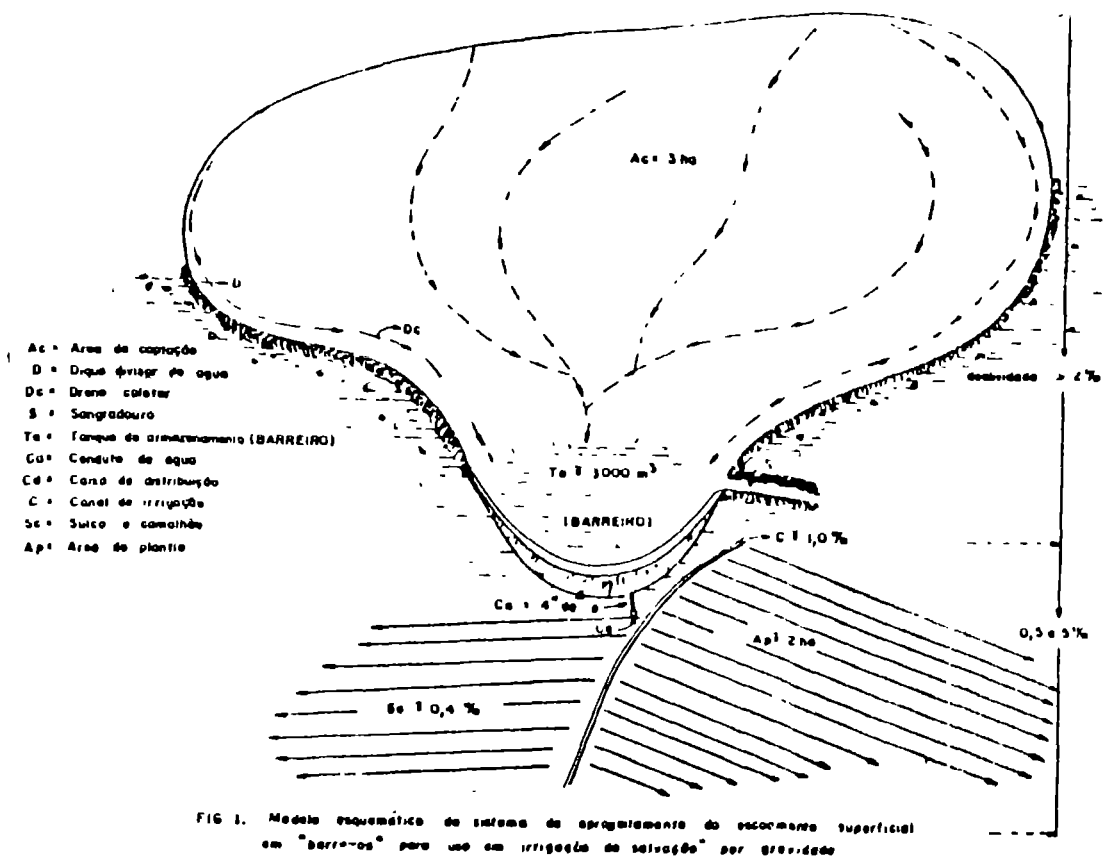
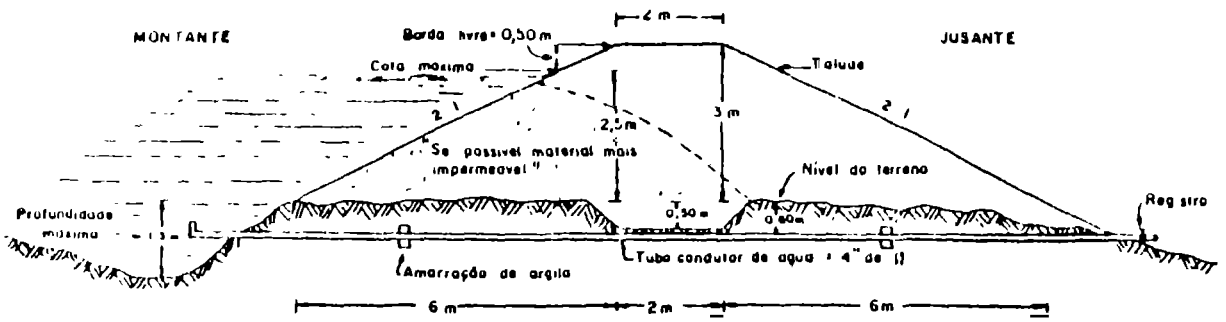


FIG 1. Modelo esquemático de sistema de aproveitamento do escoamento superficial em "barreiros" para uso em irrigação de salvação por gravidade

Fig. 7



Modelo esquemático do dimensionamento da parede do barreiro e locação do tubo condutor de água.

Fig.8

The system described above is adequate for areas with:

- average rainfall varying from 200 to 600 mm/year
- water deficits in the order of 100 mm (1,000 m^3/ha).
- evaporation and infiltration losses of 50% and catchment area runoff coefficient of 20% (0.20).

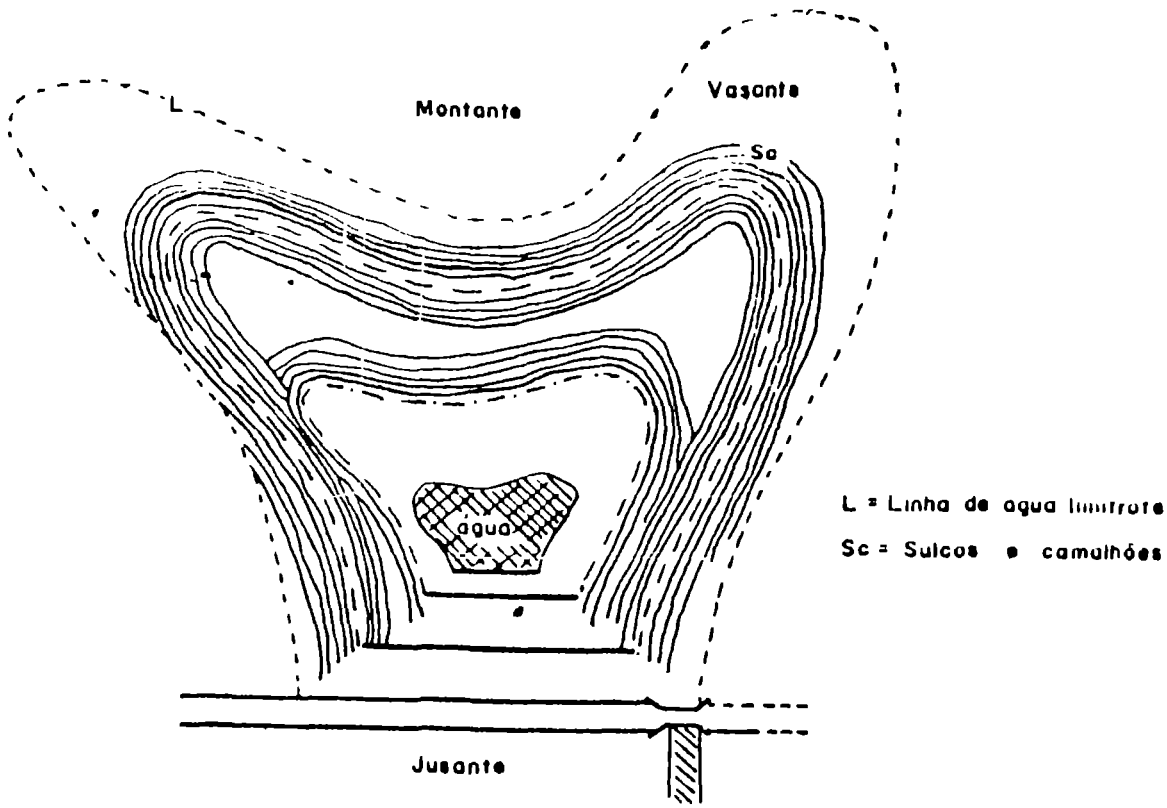
The cost ranges from US$ 2,000 to US$ 3,000.

2. Contour Ploughing In Humid Zones : This methodology too is traditional and responsible for the yearly survival of over 6 million people in north-east Brazil. It has however been improved by CPATSA which has by means of a simple technique substantially increased agricultural outputs on the border of receding rivers, lakes and dams. The improvements provided by CPATSA consist of:

a) Marking of the margins of the receding water level with sticks.

b) Ploughing (producing furrows) by hand or animal drawn ploughs using the sticks as a reference for centering after the water levels have receded.

c) Making use of complementary irrigation by using small 3.5 HP water pumps.



Modelo esquemático do sistema de vazantes de açudes

Fig.9

Experience has shown that this system increases output by almost three times, while the capital investment needed (US$ 500) can be paid off at the end of the first year. Corn output has for example increased from 1500t/ha to 4,000t/ha.

3. Subsurface Dams: Sub-surface dams are built to retain the groundwater flow in river beds that dry up during the dry season. Their implementation ultimately enables the use of the method described above (Contour Ploughing in Humid Zones), as well as the use of "sub-irrigation or irrigation of plant root systems."

About 10 to 20 such dams exist in north-east Brazil presently.

Some are old "surface water" dams which have filled up with sediments.

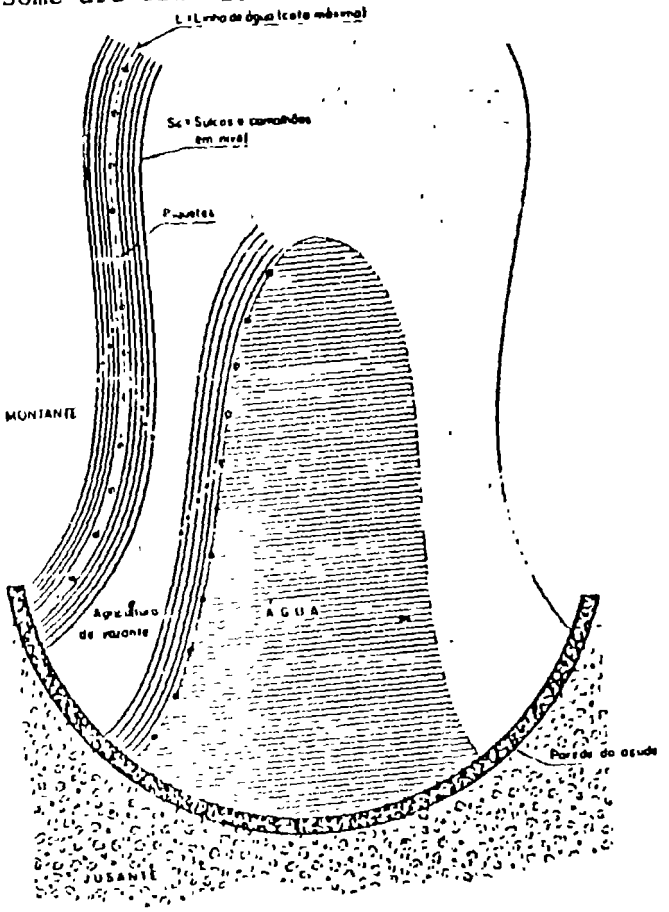
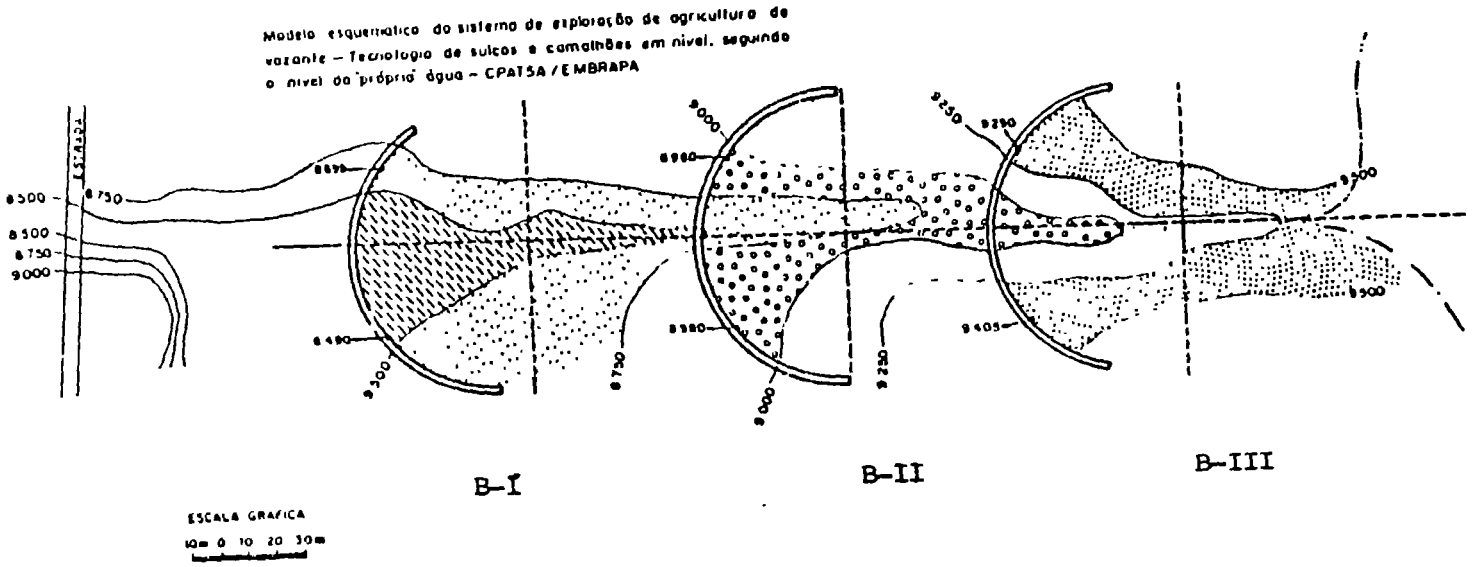


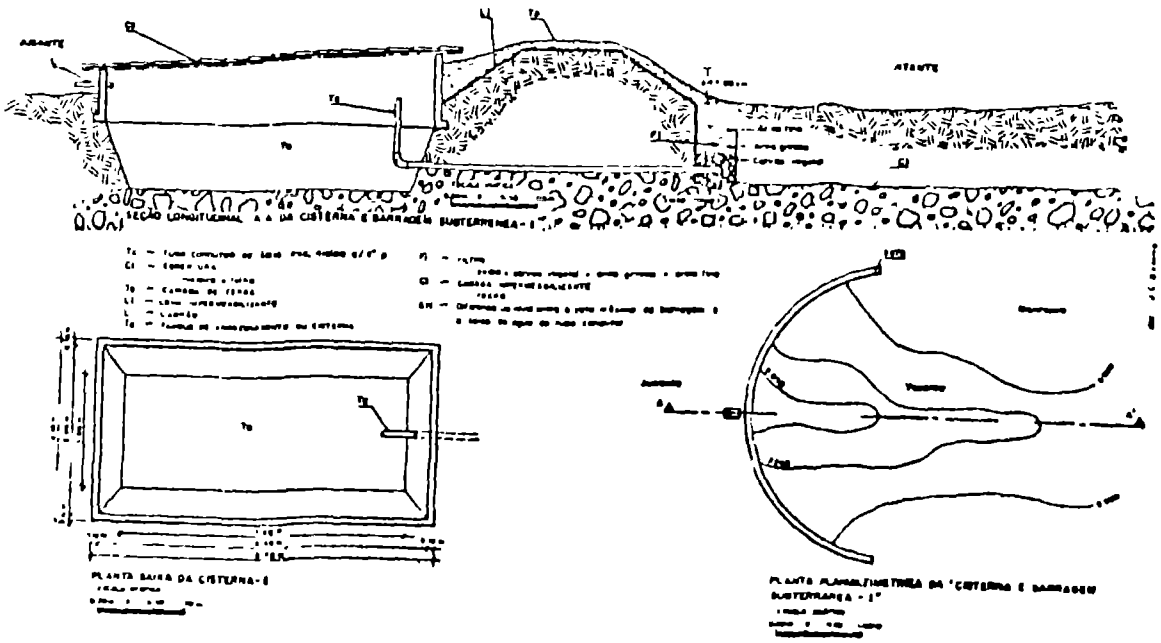
Fig.10



. Planta planialtimétrica das barragens subterrâneas tipo CPATSA (SAES-RS).

Fig.11

CPATSA recently built three such dams in a row. All with cores made of plastic sheets anchored to the underlying basement rock. Hereby less earth movement is involved and thus construction costs are reduced. These dams have a capacity of storing over 4,000 m^3 of surface water and 500 l/m^3 soil of groundwater. This allows food production in almost 2.5 ha. Besides this, a drinking water cistern can be built down stream from it (Fig.11) The cost of implementation per dam is in the order of US$ 400.



. Seção longitudinal de uma barragem subterrânea tipo CPATSA (SAES-83).

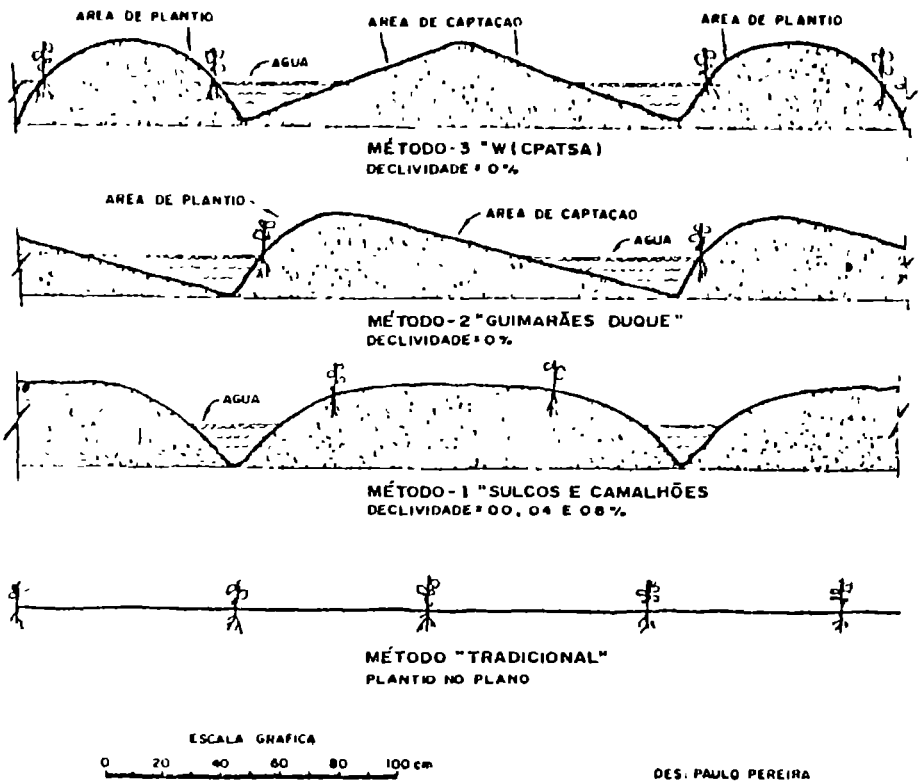
Fig. 12

4. "IN SITU" Rainfall Harvesting : Conservation of water in the soil is one of the pre-dominant problems in agricultural development of the region due to its irregular rainfall pattern.

Intensive research has been undertaken since 1979 in this field. The preliminary conclusions indicate that deep (contour) ploughing increases infiltration of rain water in the soil. Several ways of

ploughing the soil are being investigated with the objective of optimizing the use of available rainfall.

Fig. 13 indicates different ways of ploughing the soil as compared with the traditional method where ploughing is not involved.



- Métodos de captação de água de chuva "in situ" (1, 2 e 3) adaptados a culturas anuais pelo CPATSA para o Semi-Árido brasileiro.

Fig. 13

Method 3 (Fig.13) developed by CPATSA is called "the W Method" and offers many important advantages:

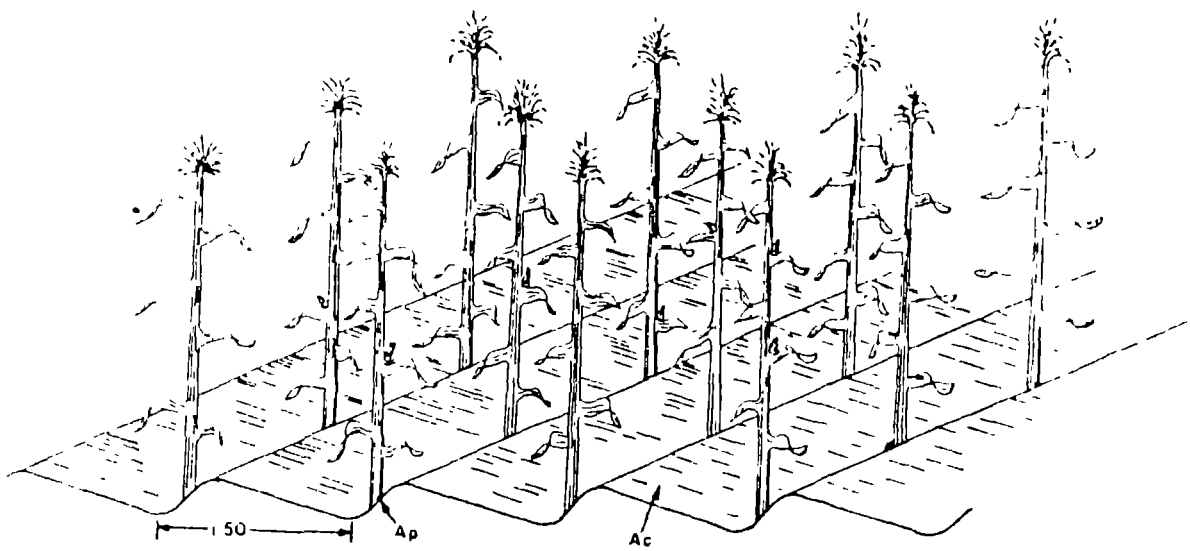
a) There is a distinct difference between the planting area and the catchment. This enables the compaction of the latter to increase rainfall runoff.

b) One can plant in double rows.

c) In function of the planting area's width one can select an arrangement for different types of crops.

d) The simetric form of the system facilitates mechanization by tractors or animal drawn equipment.

e) One can space according to choice.



- Esquema do sistema de captação de água de chuva "in situ"

Fig.14

Recent results indicate that a productivity increase ranging from 40 to 500% can be obtained by using this method for the plantation of beans. It is believed that if this method is generally adopted, food production in north-east Brazil can be doubled within the next 10 years.

5. Unconventional Low Cost Irrigation Methods:

5.1. Partially Closed Furrows: This method based on traditional technology is characterized by partially closing furrows (contour ploughed) at the

ends and thus retaining water within them for longer periods. Among the main objectives one can enumerate:

a) Reduction of water losses through surface runoff

b) Increase of distribution efficiency.

c) Uniformity of productivity along the furrows.

Water is retained by installing V notches (See Fig. 15) at the end of the furrows. The latter can be built from zinc sheets.

The implementation cost for furrows spaced at 1.2 m from each other ranges from US$ 60 to US$ 90/ha depending on the material used in producing the V notches.

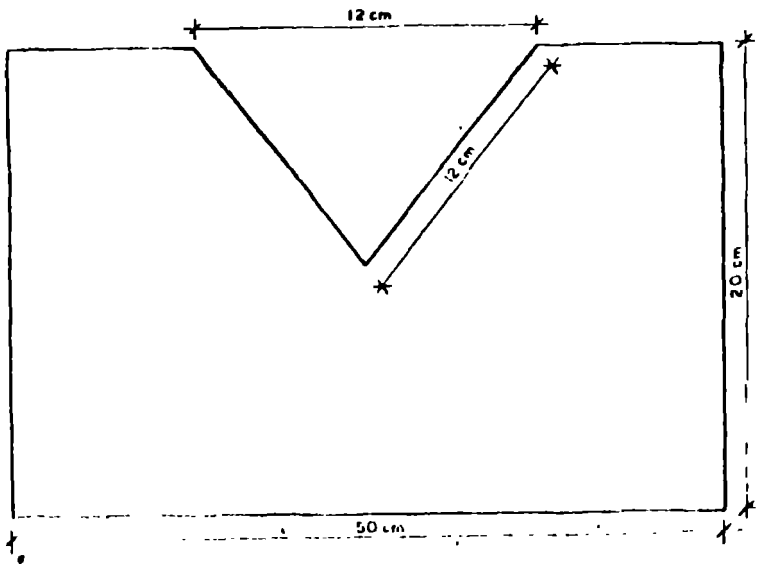


Fig. 15

5.2 Hose Irrigation Method : This method involves conducting of water by means of rigid PVC pipeline and distributing it by means of flexible PVC hoses. It is ideal in:

a) Areas with small springs of limited discharge rates.

b) Areas with topographical constraints for conventional irrigation (except drip irrigation).

c) Use of family labour.

d) Annual or perennial cultures

e) Water rich in solid matter

If no source of water by gravity is available, a small water pump can be considered.

The system consists of a main pipeline, a secondary pipeline, a distribution hose (normally 1¼", 25 m of the transparent flexible type) and distribution points. The method is recommended for:

- short, closed, levelled furrows (melon, water melon, tomato, beans, corn, sorghum, onion, etc.,)
- micro catchments (for fruit trees in general)
- manual sprinkling irrigation (cash crops)
- sprinkler (all plants with the exception of fruit trees).

The following table indicates the capital investment cost for the above-stated considering, water available with or without mechanized pumping on a 2 ha. plot of land

CAPITAL INVESTMENT OF HOSE IRRIGATION METHOD FOR A 2HA PLOT

Source of water Type of irrigation method	With water pump US$	Without water pump US$
Short closed furrows	3,166	1,071
Micro catchments	2,765	1,149
Manual sprinkling	3,036	1,199
Sprinkler	4,898	-

Aproveitamento de Recursos Hídricos Escassos no Semi-Arido Brasileiro: Tecnologias de baixo custo (Silva A.S, de Lima L.T., Soares J. M., Maciel J.L.)

5.3. Clay Pitchers : This technology, originally from north- Africa, was rediscovered recently, after which Mondal (1974 and 1978) proved that small vegetable plants (curcubita sp.) can grow around clay pitchers with little quantity of water (17 mm/ha 800 pitchers) during a period of 70 days. In 1977 similar experiments took place in Iran with both normal and saline water. Recent experiences in Upper Volta and Senegal have shown that vegetables can be grown making use of pitchers with a capacity of 15 litres. Eight pitchers were used for each 10 m^2. In Brazil the very common and traditional clay pitchers have been modified to be used for irrigation. The innovations consist of increasing porosity to 22% and changing the production procedure. This is done by not smoothing or polishing the internal and external surfaces and by adding porous materials such as, cow dung, saw dust or simply sand to clay.

The methodology is very simple; its main objective is to provide plants with minimum water requirements not implying necessarily in maximization of output. It also reduces labour. Preferably, the method should be applied to small scale (family) vegetable production.

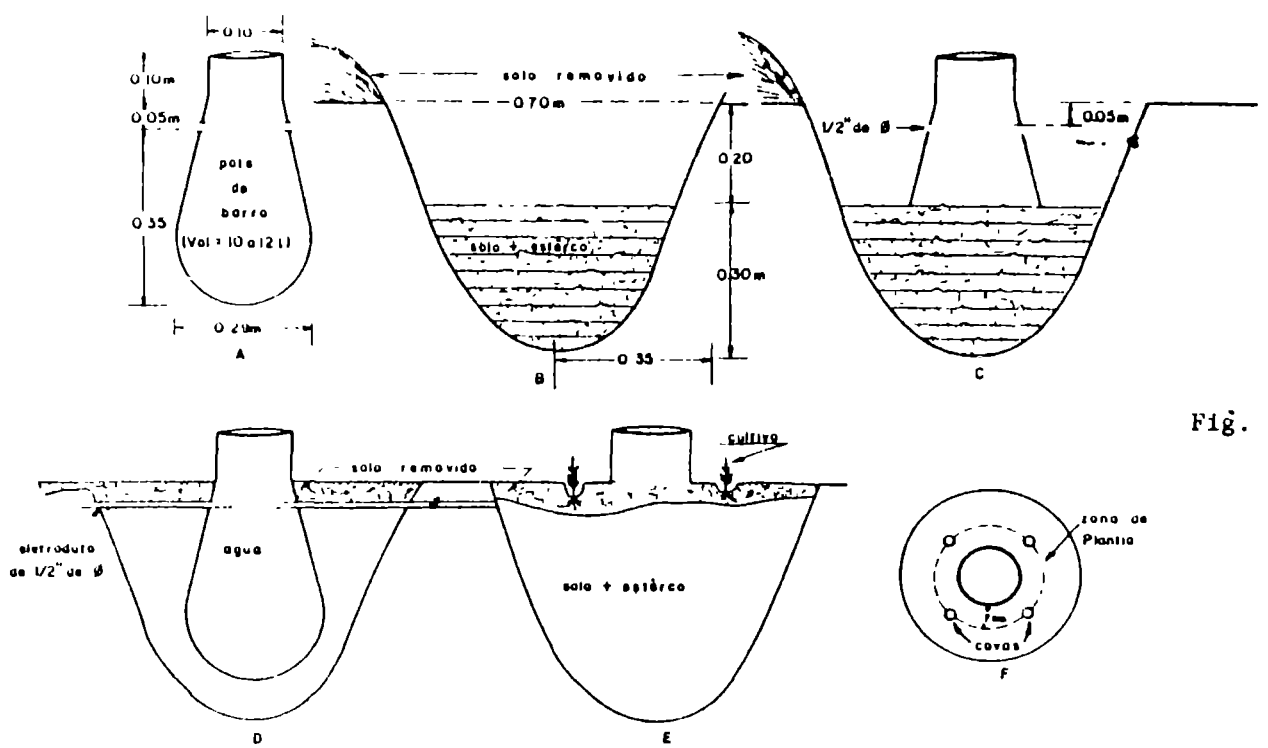
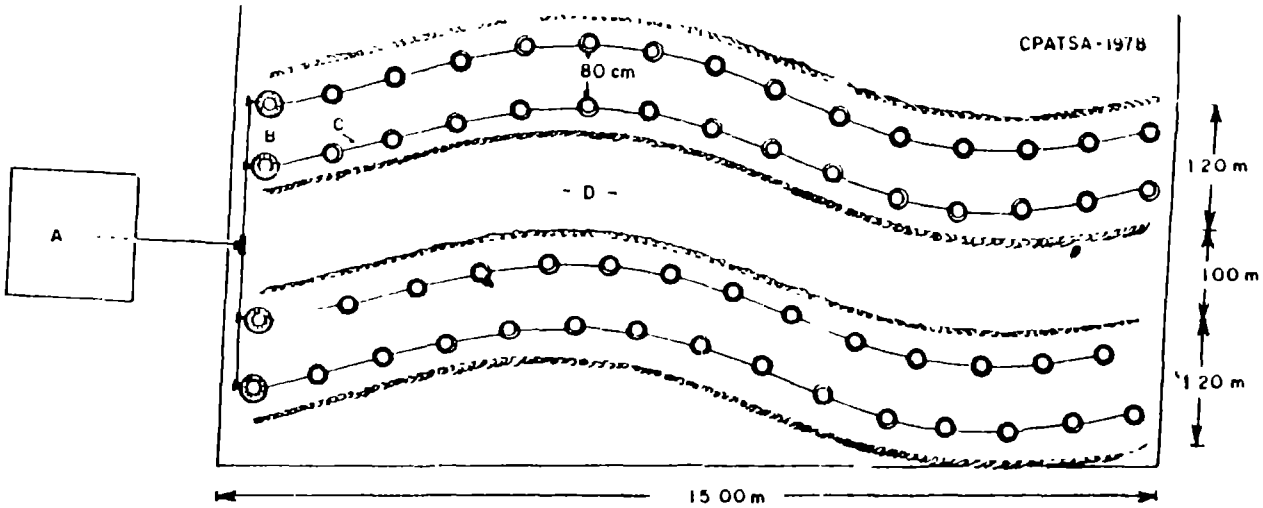


Fig. 16



A - Reservatorio com capacidade para 4 m^3
B - Linha principal de abastecimento
C - Linha secundário de abastecimento
D - Area de cultivo com potes espaçados de 100 x 0 80 (potes)

Sistema de irrigação por potes de barro para pequenas hortas

Fig. 17

Water used for irrigation must be of good quality as this will prolong the life span of the system. Groundwater is ideal because normally it has no solid nor organic matter in suspension.

Pitchers can be refilled individually or when inter-connected by hoses from one single water deposit.

Presently, one "irrigation adapted" 12 l pitcher costs in the order of US$ 0.5 in Brazil.

ANIMAL DRAWN PLOUGHS - CHEAPER AND MORE REALISTIC FOR SMALL FARMERS

An animal drawn ridge - blade was developed by CPATSA. This equipment attached to a wheeled tool carrier is used in planting, harvesting systems (Lal. H., Souza A., Rocha Porto E. and Matias da Costa A.E. - 1984). Its operational capacity varies from 0.16 to 0.47 ha/hour in function of the furrow spacing. The "in situ" rainwater harvesting system consists of alternating narrow and broad ridges ploughed on contour.

The broad ridges of triangular shape serve for rainwater harvesting while the narrow ridges serve as planting zone with furrows in between both for water storing.

The ratio between the water harvesting area to the planting zone is maintained in the range of 2:1. This ploughing technique has raised crop output by 47% according to preliminary studies undertaken by CPATSA.

RURAL ECONOMY STRENGTHENING AND INCOME GENERATING CROPS/PLANTS

Scope:

Another field of research which has captured considerable attention from CPATSA, EMATER and other institutions is the implementation of certain potential income generating crops and plants in north-east Brazil. This will ultimately and hopefully also contribute to improving the standard of living in this impoverished region. Some of the species considered are: algarobeira (prosopis juliflora), sisal (agave sisalana), guar (cyanopsis tetragonolobra) and jojoba.

Algarobeira (Prosopis Juliflora): According to Pimental Gomes (1961), the natives of South America ate the beans of the prosopis juliflora tree when the first europeans arrived in the "New World." This plant was in that time apparently quite common in the extensive semi-desert and desert regions of Ecuador, Chile and Argentina.

Several Brazilian experts believe that due to its resistance to drought and comparatively high nutritional value, the "algarobeira" can decisively contribute to the strengthening of the livestock and agricultural economy of the north-east" (Vieira Nobre, F. - 1979).

Over US$ 50 million is currently being invested for reforestation through several projects to cover 4.5 million ha. with this tree. This is understandable as the algarobeira can generate:

a) 2 - 8t/ha/year of fruits (beans) and

b) 100 - 120 m^3/ha/year (after 5th year) of lumber. One hundred kg. of its fruit (algaroba) generates 46.4 kg. of sugar or 27.7 l of alcohol. As fodder it is comparable to alfafa. A recent study by Prof. A. Newton Negreiros of the Federal University of Rio Grande do Norte - UFRN, shows that algaroba can also directly contribute to decreasing the widespread nutritional deficiences of the rural population.

Sisal (Agave Sisalana)

Very resistant to drought, this plant is used for many purposes:

- Organic fertilizer
- Fodder for animal feeding (by-products)
- Paper industry
- Carpet, rope, sack industry
- Alcohol and wax production
- Construction industry (isothermal filters, brick making and roof tiles).
- Homemade handicraft

Approximately 1.3t/ha. can be produced (Lima Ramos G. - 1983) The selling price in north-east Brazil is in the order of US$ 200 - 300/t. The "AGAVE" can be grown on very poor soils; usually unsuitable for food production. Its cultivation and processing is labour intensive all year round which therefore makes it a plant of strategic importance to generate income in rural areas.

Guar (Cyanopsis Tetragonolobra)

Guar, a leguminous plant, is presently being activated on millions of hectares in dry zones of India, Pakistan, Australia and U.S.A. Its long deep roots allow it to adapt well to dry climates with irrgular rainfall patterns, preferably on soils with medium to sandy texture. In areas with rainfall ranging from 450 to 700 mm/year its cultivation is best. One can however grow guar with rainfall of 200 mm/year.

Traditionally this plant was used as fodder for animals and food for humans. During the last decades however, its industrial utility was discovered when out of the seeds a substance called "galactoman" was extracted. This substance is used in several industrial sectors such as:-

- Oil
- Food
- Textile
- Paper
- Pharmaceutical
- Dairy products and
- Mining

Experiments by Pessoa de Aguiar Filho S.(1982) in Petrolina (CPATSA) showed that over 1.7 t /ha of seeds can be produced in average (2 years experiments on 4 plots).

Due to the diversified applicability of this plant, it is also seen as a potential income earner in the near future.

Jojoba

Another controversial crop is the jojoba, seen as a potential substitute for sperm whale oil and for a lubricant to replace depleting fossil fuel reserves (Yermanos D. M. 1979). Native of California - USA, Jojoba is known to scientists for its drought resistance and versatile liquid wax extractable from its seeds.

Jojoba grows on soil of marginal fertility; needs little water, withstands salinity, does not need fertilizers, is apparently not afflicted by major diseases or pests, it is low-labour intensive and its oil can be extracted like other oil seeds. It has still other advantages,

such as its potentiality for erosion control (long roots), and longevity.

Jojoba can yield 3500 kg/ha. while its minimum price seems to be in the order of US$ 0.30/kg of seed. Very good jojoba plants have grown in areas with precipitation in the range of 250 to 380 mm/year. It is thus an interesting crop to be considered for the development of semi-arid rural areas.

LIVESTOCK DEVELOPMENT

Cattle

The carrying capacity of the natural vegetation (caatinga) of north-east Brazil is of 1 head of cattle/ha. In order to enable the breeding of more cattle both for beef and dairy production, research has been carried out to implement various types of imported and autoctonous drought resistant pastures. Hereby cattle graze on natural vegetation during the rainy season and are placed on pastures when starting to loose weight during the dry season. This procedure allows animals to maintain or even increase their weight during the year.

Because the carrying capacity of pasture is approximately 10 times larger than the "caatinga" only a small portion of the total area has to be developed for this purpose, if only improvement but no large expansion of the sector is envisaged.

Goats, Sheep and other small animals

For very small land owners a special programme by EMATER is being undertaken whereby goats or sheep are "given" out to peasants. The latter are consequently obliged to return to the rural extensionist institution (EMATER), an equal number of animals received after a given period. The returned animals are then re-passed by EMATER to another

rural family. This system aims at rapidly providing very poor families with an improved nutritional status whereby milk is regularly provided to their children, and eventually meat may become part of their diet. Breeding of chickens and rabbits is also stimulated for similar purpose. Another extensive program exists for the introduction of fish in fresh water reservoirs. This too contributes to improving the nutritional level of rural populations, besides reducing the breeding of mosquitos.

AN ALTERNATIVE ENERGY SOURCE

Besides the already well known use of alcohol, (ethanol) which revolutionized the energy sector in Brazil, another alternative and readily accessible energy source is rapidly gaining ground, especially in rural areas: bio-gas. Different bio- digestors were shown at an EMATER training centre in Pernambuco State. The "Indian type" a "Chinese type" and a locally developed bio-digestor which requires more capital investment for its implementation but has the advantage of requiring very little water to operate. "Indian type" bio-digestors were observed in Sergipe State in production within rural communities, operating with cow manure. As a by-product of methane gas a very nutrient rich liquid comes out, it is used as a fertilizer (bio-fertilizer). With a small bio-digestor, one family can supply the household with energy for lighting and cooking purposes. The government provides special credit for the implementation of such energy sources on rural properties. Even small water pumps were seen running on methane instead of petrol. In some communities joint efforts have resulted in implementation of bio-digestors to light the schools, churches, and child care centers.

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Annex Va.

Declaration
by the African participants

Interregional Technology Transfer Encounter in Northeast Brazil

The African participants at the above mentioned encounter wish to extend their profound gratitude to the UNESCO Regional Coordinators for Africa and Latin America for making it posible for them to participate in the said Encounter.

During the Encounter and the tour through NE Brazil, the participants have gained useful experience in the creative nature of Brazilian people in adopting very simple but functional methods of agricultural development under semi-arid conditions. It was observed that the techniques of rain water harvesting for farming as well as for domestic water supply for rural communities have given sound alternatives for human survival in a drought situation. The African participants have therefore concluded that the experiences gained in Brazil could readily be applied to other areas of the world where similar climatic conditions exist. They have also confirmed that the Encounter has created a very good chance for transfer of technology from one region to another.

Finally, the African participants wish to also place on record their appreciation to the UNESCO, UNICEF and Brazilian members of the team who made the Encounter a success. Particular thanks go to the officials from COBRAPHI, EMBRAPA/CPATSA, EMBRATER, EMATER/PE and EMATER/SE for their untiring efforts during the tour to the various places.

Participants	Country
1. Vincent P. LOKROU	Ivory Coast
2. Justus M. KABUGA	Kenya
3. Nema OULD TALEB	Mauritania
4. Bunu SHERIF MUSA	Nigeria
5. H. MWINYIGOHA	Tanzania
6. K. EMOE	Togo
7. Donald S. DELL	Zimbabwe

Dated, Aracaju (SE), 25th April 1985

Annex Vb.

Declaration
by the Latin American participants

Encuentro Interregional de Transferencia de Tecnología en el Nordeste de Brasil, 15-24 de abril de 1985

Los participantes latinoamericanos en el Evento de Transferencia de Tecnología, realizado en el Nordeste de Brasil en abril de 1985, en representación de Argentina, Chile, Ecuador, México, Paraguay, República Dominicana y Venezuela, agradecemos por medio de lapresente a las Instituciones Brasilenas:COBRAPHI, EMBRAPA/CPATSA, EMBRATER,EMATER/PE, EMATER/SE y al Proyecto Regional Mayor para el Uso y Conservación de los Recursos Hídricos en América Latina y el Caribe, coordinado por UNESCO/ROSTLAC, por la posibilidad que se nos ha brindado de compartir sus actividades de investigación y extensión, lo cual tendrá, sin duda alguna, repercusión en la transferencia de tecnología en nuestros propios países, fundamentalmente por la calidad de las experiencias asimiladas y de la vivencia lograda en este breve pero fructífero e intensivo período.

Agradecen además, la cooperación de la UNICEF, esperando que en el futuro se intensifiquen la integración y colaboración interinstitucional de las Agencias Internacionales de Desarrollo, para coadyuvar a las actividades del Proyecto Regional Mayor.

Firman esta nota con especial deferencia y gratitud,

Aracaju (SE), 25 de abril de 1985

1. Argentina	Osvaldo Emílio CAPPE	
2. Bolívia	Carlos Fernandez JAUREGUI	
3. Chile	Guido SOTO ALVAREZ	
4. Ecuador	Eduardo FIGUEROA GARCIA	
5. Ecuador	Rodrigo CALERO HIDALGO	
6. México	Mario VILLAREAL PULIDO	
7. Paraguay	John A. FITZPATRICK	
8. Paraguay	Juan Carlos BERNIE	
9. República Dominicana	José Daniel PEÑA G.	
10.Venezuela	Maria S.de PEREIRA	
11. Venezuela	Hernan CONTRERAS MANFREDI	

Comments of the African and Latin American participants in their original languages

"This event marked a turning point in the traditional mehod of aid to third world countries. It was during the process of this program that it became clear to each and everyone of the participants from Latin America and Africa that here was a new method much more fruitful than the standard operational procedure of sending experts, consultants and administrators. The members themselves fulfilled all of these roles spontaneously and with enthusiasm.

Technical know-how was exchanged horizontally, comparisons, judgements, questions and criticisms and conclusions reached in the field were passed about freely. Hands-on operation of technical equipment, sample taking and consultations marked the activities from dawn to dusk. Many new ideas were generated and will be put to the test. Being technically-minded people the communication was natural and harmonius.

Although this meeting had as a specific objective the study of research techniques and the field of application of water in arid and semi-arid zones in order to better the living conditions and increase crop production, the spin-off from this activity was the realization of the surprising success of such a method of horizontal technology transfer. This method provides a new strategy for development."

"Los asistentes al Encuentro de Transferencia de Tecnología han observado que CPATSA/EMBRAPA y EMATER-PE y EMATER-SE desarrollan una estrategia operacional que constituye un modelo de desarrollo rural integral y que debe ser divultada más ampliamente hacia los niveles específicos de decisión de cada país, para asimilar, adaptar o aprovechar las experiencias ya obtenidas en la realidad de cada uno de ellos.

Destacan la relevancia del sentido social integral de la actividad que realizan las instituciones antes señaladas y su significado tanto para las áreas rurales del Nordeste de Brasil, como asimismo la posibilidad que dichas instituciones brindan a otros programas de desarrollo de regiones áridas y semiáridas de América Latina y de Africa. Destacan, igualmente, el valor informativo y de capacitación técnica, como asimismo por el ejemplo que dicha actividad representa para estas regiones.

Consideran de gran transcendencia la experiencia adquirida y las vivencias obtenidas en el encuentro y se consideran impresionados por la estrategia utilizada, o sea: participación equitativa tanto de las comunidades rurales como de las instituciones, las que han considerado deferentemente al campesino, valorando su verdadero rol. Esta estrategia está

referida a la investigación (CPATSA/EMBRAPA) y a la transferencia de tecnologías obtenidas, adaptadas y/o desarrolladas, al ámbito rural (EMATER-PE y EMATER-SE).

Expresan su satisfacción por el apoyo brindado por UNICEF a esta actividad, por cuanto la incidencia de este apoyo está directamente relacionada con la calidad de vida, el abastecimiento de poblaciones, con el desarrollo agropecuario y con la atenuación de los problemas alimentarios existentes en el momento actual en las áreas rurales de América Latina y Africa."