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# STABILIZED RAINFED AGRICULTURE
# DEVELOPMENT STRATEGIES
# NORTHEAST BRAZIL

CONSULTANT'S REPORT

FOR

CPATSA/EMBRAPA

BY

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## INTRODUCTION

The one months stay in Northeast Brazil by the consultant was not long enough to fully determine the many problems confronting agricultural development in Northeast Brazil. Only three project areas in two states, Pernambuco and Alagoas were visited. Airline flights and bus trips were made across Bahia State to Macieo, Alagoas. Alagoas state was crossed from east to west and an evaporation control project and two small pond projects were examined in that state.

An examination of the rainfall record at Petrolina reveals a highly variable rainfall pattern with the rainy season extending from November through May in some years, other years only from January through March. Although some of the storms exceed one hundred mm per day, many are small and do relatively little good except to reduce the evapotranspiration on that particular day.

The water holding capacity of the upper soil pro-file at the sites visited was not high. Soils are relatively shallow 50 to 80 cm down crystalline materials which are hard to penetrate, even with a pick. The distinct change in soil types restricts water movement so that it would take a near saturation of the upper soil layer before water would move into the much more impermeable crystalline layers. This low soil-moisture-holding-capacity combined with highly variable rainfall makes it imperative that on farm surface-water storage-systems be developed in order that rainfed agriculture can be stabilized in Northeast Brazil.

Surface water storage is complicated by a high evaporation (2.2 meter pan evaporation average at Petrolina) combined with the relatively shallow

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soils which make it difficult to construct deeper reservoirs. As a result most reservoirs are less than 11/2 to 2 meters deep making it virtually impossible to store water on annual basis in a single compartmented reservoir. Some of the area of Northeast Brazil has a sufficient grade so that the ponds can be placed on the side of a slope and irrigations can be made by gravity. The slope generally required for a gravity irrigation using pond systems is 5 percent or more. Much of the better agriculture lands in the Northeast appear to have slopes less than 5 percent making gravity removal of water from small ponds impossible for all except very shallow ponds.

## RECOMMENDATIONS

It is recommended that research in the important area of water catchments and water storage be increased. This research should be concentrated in the following areas. Water catchments: Water catchment research should be directed to increasing water yield to crops and for livestock and human consumption.

1. Livestock and Domestic use : These uses in general justify more expense than catchments for agriculture. In this area it is recommended to investigate the use of gravel covered catchments that can be installed using hand labor. The gravel protects the plastic against damage by the wind and sun (CLUFF & FROBEL, 1977, Appendix A) . The gravel is available on-site in many of the soils of the northeast or can be screened from nearby waterways. Gravel up to 1/2 inch size should be used. Any larger size gravel is generally not needed and merely increases the necessary depth to cover the plastic. This increased depth reduces the amount of precipitation that can be collected. A properly installed gravel

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covered plastic catchment should collect 90-95 percent of all the rain greater than 3 mm that comes in a storm (a single rainfall event). The average efficiency should be 60 to 70 percent. It is important not to put too much gravel on since this will reduce the yield. It is equally important that all the plastic is kept covered to protect it from the sun and it will last for 30 to 40 years or more. Another catchment system that should be investigated for domestic use would be a reinforced mortar covered plastic. This consists of covering plastic with chicken wire (wire mesh with 1/2 or 3/2 inch openings) and then hand plastering with cement and sand mortar. A 4.5 sand to 1 cement ratio is generally sufficient. If the sand is coarse enough, and if the mortar is properly troweled the material generally will not crack too badly. This type of system if properly installed should last 30-40 years. Since the thickness of mortar is just sufficient to cover the wire one cubic meter of mortar should cover at least 20 $m^2$ of pond or catchment area. The mortar is used for protecting the plastic from mechanical damage. The plastic provides the water barrier.

Studies should continue on the compacted earth catchment passing through a sand filter either before or after storage. The two types of systems should be demonstrated side by side. The filtration after storage should be more efficient since many of the smaller storms will otherwise be lost through evaporation from the sand fitter if placed ahead of the storage.

This loss is important because at not only reduces available water volume but also reduces the frequency of the runoff.

It is recommended that CPATSA buy a small meter-wide vibratory compactor. If such a compactor is not available a substitute would be the use of a automobile on the catchment driving back and forth until covering

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the entire area. This has already been demonstrated to Mr. Everaldo on one of his small catchments. This method of compaction works as long as the catchment is twice as wide as the car. This will be the case in most domestic and/or livestock systems. It will generally not be the case for agriculture catchments with strip plantings.

A NACL sodium treated compacted system should be installed as soon as possible for a domestic and livestock system.

A treatment of 12,500 kg per HA is recommended. Keep track of the water quality and taste etc. over time.

2. Agriculture catchments: In heavy 100 mm/day storms creating a catchment area to contribute runoff to the planted area does not appear necessary. However, some years do not have a heavy rainfall and water is limited. A computer analysis using RAMOD and CROP 82 (CLUFF, 1977, Appendix B) models show that experiments in strip farming using compacted earth runoff areas should be tried. Set up a experiment using cowpeas as the crop with (1) a regular row spacing, (2) double the row spacing creating an equal catchment to cropped area and (3) Triple the spacing for a 2 to 1 catchment to crop area. Catch the runoff from each of these treatments and use it back on the crop during dry periods. Compare the yields over a minimum period of 3 years. If possible double the crop 1:1 and 2:1 catchment to cropped areas whenever there is sufficient water in storage in the reservoir. A compactor will have to be purchased prior to the start of this experiment. In addition it would be very helpful to have a Harley Rock rake of 2 meter width. These are available from Clarissa, Minnesota, USA. The strip farms should be placed on a contour on sloped land or "V" shaped for flat land less than 4 to 5 percent slope.

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The above experiment should be repeated with Jojoba and grapes. Jojoba should do well if given an ocassional irrigation to avoid dropping flowers after flowering has occured. Jojoba is very susceptible to water floo ding. Excess water should be stored or reapplied during dry periods. Do not try to increase water penetration by ponding around the plants.

It should be possible to grow two crops of grapes in rainfed areas if sufficient surface storage is provided where seepage of evaporation are controlled. These systems should be designed using RAMOD and CROP 82.

Seepage Control : The use of mortar covered plastic for seepage control of domestic/livestock tanks has been demonstrated by the consultant by modifying one Elocrado's small plastic lined tanks. The sides of the tank has a very steep slope 2:I (2 vertical : I Horizontal) The ends were almost vertical. Although there was a few diffi-culties with the vertical slope the system appears that it will work upto 2 meteres deep. For slopes less than 2:I there would be no depth constraints.

The use of earth-filled used automobile tries to hold soil onto plastic on steep slopes was explained to Elvorado. Tires have been located for a test on steep slopes. These earth filled tires can then be covered with rock for further erosion protection..In areas where there is a lot of surface rock the entire tank can be filled with rock to provide evaporation control or protection against vandalism. The rock reduces capacity by 40 to 60 percent but pro-vides a secure place to store water.

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It is only effective when clear water from a catchment such as a gravel covered plastic is fed upto the tank. Sediment-filled water would quickly fill up the pore space in the rock with no means of cleaning it.

Experience has shown that plastic should never be used without a earth or mortar cover. Even a small animal such a a frog can penetrate the plastic and cause a serious leak. If there is a earth cover even though there is a leak when holes are inadvertantly put in the plastic during installation the earth tends to minimize the effect of the holes.

Silty clay soil if devoid of rock is better for a earth cover than sand since the silty clay soil would seal any holes in the plastic better than sand. Sediment out of old ponds that need cleaning make excellent cover material for the plastic lining.

For larger agriculture tanks lining with plastic may be too expensive- local clay sources should be brought in if available. In addition the use of $Na_2CO_3$ or NaCL in the tank and/or Nacl on the catchment above the tank should be investigated. Often times the cheapest seepage control might be the establishment of a I to 2 hectare sale-treated catchment above the tank. Not only will runoff be enhanced but the catchment will provide sodium laden clay to the tank for continued seepage control. It is recommended that this type of demonstration be established both at the CPATSA Research Center and at the demonstration project in Alagoas state where it appears that seepage might be a serious problem. At the Alagoas site there is about I2 percent clay, which should be enough for a compacted salt treated system.

Evaporation Control : Many people consider evaporation like the weather. It is something that has to be tolerated, there is no way to control it. Fortunately there are somethings that can be done to control evaporation although much more research is needed in this area. The most economical is the compartmented reservoir.

The use of pumps in stabilized rainfed agriculture in flat lands is unfortunately unavoidable. They add to the cost and complexity of a system but make the system possible since gravity fed systems cannot be made in flat areas. Even with a floating pump the cost of irrigating a hectare of land using small tanks should still be for under the $ 10,000 (U.S.)/hectare average cost the World Bank indicates is the cost of developing a typical irrigation project.

Floating vapor barriers: The other method of evaporation control suggested for Northeast Brazil is floating rafts. The consultant innitiated studies in the use of Paraffin/Carnuba Wax dipped expanded polystyrene, this treatment using a 25% Carnuba/75% paraffin looked good. The Carnuba wax was unrefined and therefore amber in color. It will have to be watched to see if it melts in the hot sun. If it does perhaps the use of refined carnuba which is white will eliminate the problem. If not white latex painted sheets of expanded polystyrene will have to be used. "C" clamps made out of 1 1/2" PVC pipe were made up to show how they could be used for clipping the sheets of expanded polystyrene together. This will keep the rafts from being removed by wind.

Two o ther evaporation control possibilities that were innitiated by the consultant is the use of foam filled tile brick. A brick factory was visited in Juazeiro after a innitial test showed that the tile brick would float. The brick factory indicated they would make 1,000 light weight tile bricks for 20,000 Cr which is 8,000 Cr above their standard price. The increased price is because of development costs and excess breakage. It should be able to cut this cost to 10,000 Cr/1000 bricks with further development and competition. At this price for the 10 cm x 20 cm brick this method of evaporation control should be competitive with other ways of controlling evaporation.

Another demonstration that was started is the use of vermiculite imbeded in a 25% carnuba/75% paraffin mix. This technique is much less expensive than using wax by itself. Further more the floation appears to be about 50/50 50 percent in the water of 50 percent above the water, this is much better than straight wax.

The vermiculite is locally available, relatively inexpensive. Furthermore it is not affected by temperatures below 300°F. Therefore, the wax could melt on top of the vermiculite filled float without increasing the weathering of the vermiculite. This has been a big problem when expanded polystyrene is used as the base material.

It is recommended that all of these ideas be tested on a research area set up in the CPATSA field station. Standard class A pans should be used for the comparative tests. When the tests are completed the pans can be used at other locations.

It is further recommended that a 3 pond area be also established where the better materials can be first tested before being used in other places. These ponds should be a minimum of =6 x 25 meters and 2 meters deep. One of the ponds could be used as a control to establish a pan to pond coefficient which would be invaluable in hydrologic studies in northeast Brazil.

Solar Energy

The use of solar energy should be introduced into northeast Brazil by CPATSA. The use of the intermediate concentration on photovoltaic panels offers a low cost way of pro_during electric power during periods of of sunshine (Cluff).

Small 1/4 to 1/2 hp portable systems can be developed up to larger village sized projects. Where topographic relief is available storage of electricity in the hydraulic head difference between two reservoirs is possible. During daylight hours water would be pumped using solar generated electricity from the 2nd tank to a upper tank. Then during cloudy periods electricity could be generated by releasing water through a generator. This method would be practical for larger village sized systems. F or pumping storage of electricity is not needed. Water is stored in a upper reservoir whenever the sun is shining. From this pond it can be gravity fed to the field.

Two other potentials for use of solar energy should be mentioned. One of them is to destill water. For small uses, distillation using a simple solar still offers a simple way of supplying desease free water even when water of low disolved solids is available. It also offers the possibility of using low quality ground water for drinking. This groundwater is available in many part of northeast Brazil. The intermediate concentration provides thermal energy in addition to electric energy. The thermal energy could be used to inhance the operation of the simple solar still so that the standard water production of ten gallon/$ft^2$/day might be greatly increased.

The second potential use of solar energy is to use it for distilling alcohol. This could simplify the process of making alcohol so that the typical farmer could make up his own fuel to use in his pump, small tractor etc. - Such solar distillation units for alcohol have already been tested by United Energy Corp.

# CONCLUSION

Northease Brazil, due to its variable rainfall pattern appears to offer many challenges to researchers. There is much that has been done, but much that needs to be done to improve the people carrying capacity of this part of the world. The key to sucess is water and power. Alternative power sources such as alcohol or solar look promising. Stabilized rainfall agriculture through the use of compartmented reservoir systems should be tested . This could be combined with a floating evaporation barrier on the "last compartment which is the compartment that has water in it most of the time.

New simplified solar stills using alcohol or solar floating collectors need to be demonstrated in northeast Brazil so that flat areas can also benefit from additional surface water. Simplified reservoir construction techniques such as the mortar coated plastic covered banks reeds to be investigated.

The more favorable land with a higher rainfall and/or greater soil water holding capacity should be developed first, expanding the systems into less favorable conditions as economic and population pressures increase.