

14/11/88

*100L
11255
doacau*

THE BRAZILIAN SEMI-ARID TROPIC AND
AGRICULTURAL RESEARCH

BY
EDUARDO ASSIS MENEZES

JUNE - 1988



53204

EMBRAPA - EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA

THE BRAZILIAN SEMI-ARID TROPIC AND
AGRICULTURAL RESEARCH

BY

EDUARDO ASSIS MENEZES*

JUNE 1988

* RESEARCHER OF THE AGRICULTURAL AND LIVESTOCK
RESEARCH CENTER FOR THE SEMI-ARID TROPIC (CPATSA/EMBRAPA)
CAIXA POSTAL 23 - 56.300 - PETROLINA (PE) - BRAZIL

THE BRAZILIAN SEMI-ARID TROPIC AND AGRICULTURAL RESEARCH

The northeast region of Brazil is located between 1° and $18^{\circ} 30'$ South latitude and $34^{\circ} 30'$ and $48^{\circ} 20'$ Greenwich West longitude with an area of 1,640,000 Km^2 including nine States and a population of 35,000,000 in 1984. Climatic differences occur in this region, going from humid to very arid.

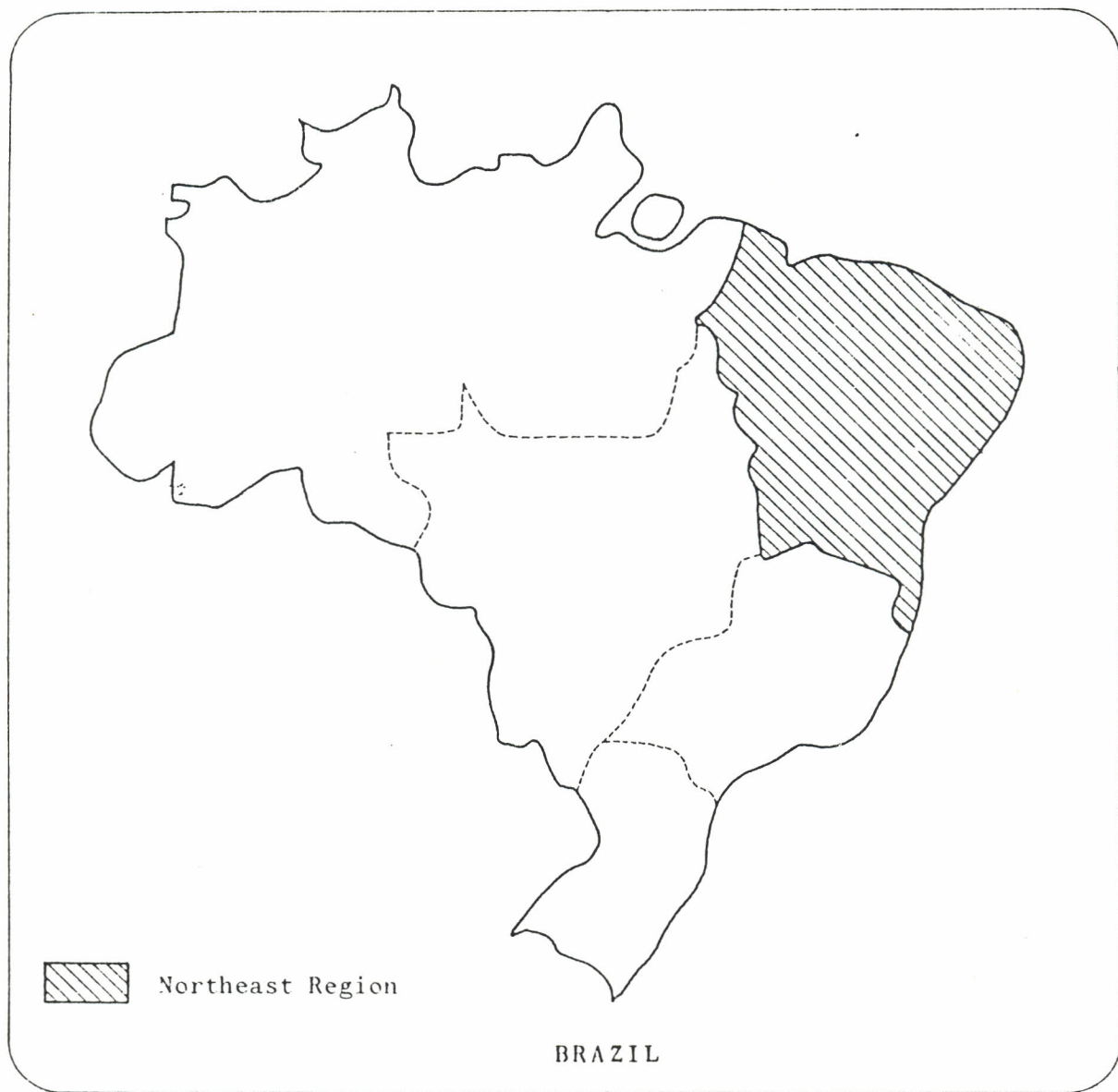
Studies by HARGREAVES (1974) allowed the classification of the region in four distinct classes, according to climate:

- . Very arid - 450,179 Km^2
- . Arid - 402,524 Km^2
- . Semi-Arid - 291,107 Km^2
- . Subhumid - 502,840 Km^2

Even though water resources are limited in northeast Brazil, it is estimated that 36 billions m^3 of water are annually lost by runoff. This water, together with water reservoirs in dams (20 billions m^3), underground water (17 billions m^3) and water from the São Francisco and Parnaíba rivers would be enough to irrigate more than 5 millions hectares, supposing part of this water were not used for electric purposes.

Taking into consideration soil and climatic characteristics, it is estimated that the northeast region could be classified for agricultural use as follows:

- . Areas for non-irrigated agriculture - 170,000 km^2
- . Areas for irrigated agriculture - 47,000 km^2

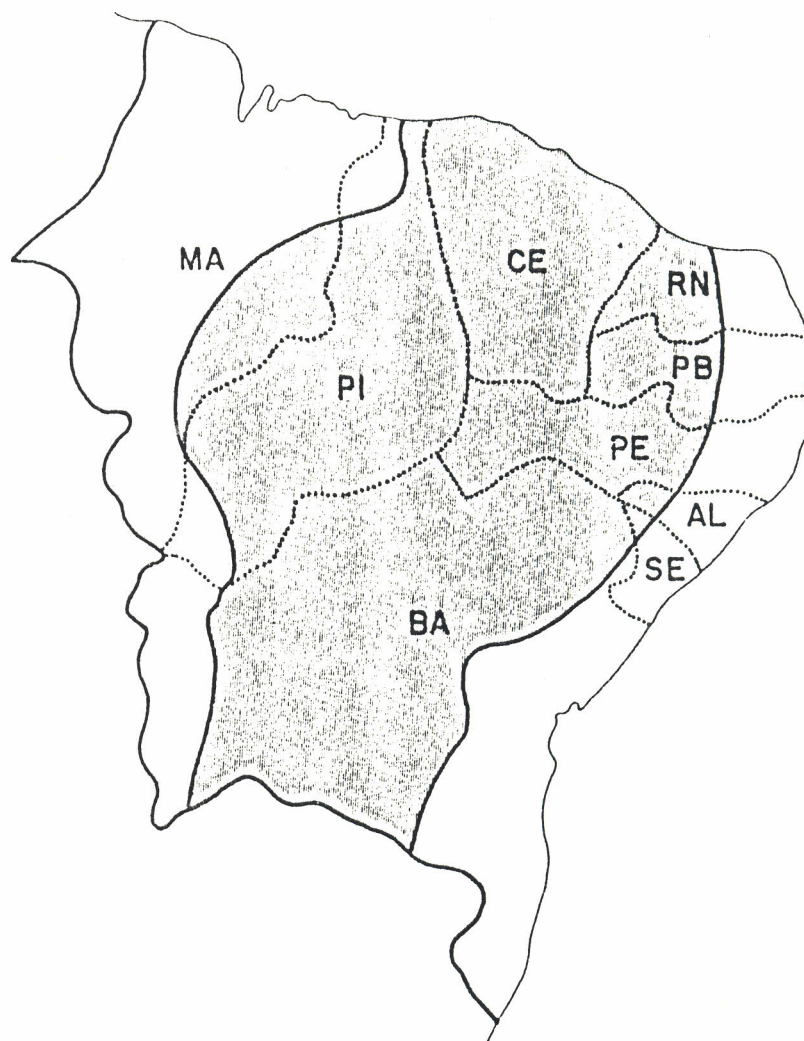


- . Areas for dry crops (including
livestock exploitation) - 140,000 Km²
- . Areas for forest exploitation - 1,288,650 Km²

The Brazilian semi-arid tropic represents 75% of the northeast region and shows heterogeneous physiographic zones, which stipulates distinct economic activities. In a synthetical analysis of the potentialities of the Brazilian semi-arid, within each sub-region, the following situations can be identified:

- . Areas of low rainfall but with soils and reservoirs of surface and underground water that make them possible to be exploited with irrigation;
- . Areas subjected to high climatic instability, but favourable to livestock activity;
- . Areas with less irregularities in rainfall distribution and with soil potential able to give reasonable harvests with short cycle crops (dryland agriculture).

Due to the climatic instability of the Brazilian semi-arid, more characterized by the irregular distribution of rainfall in time and space than by its lack, the cultivation of food crops is extremely vulnerable under dryland agriculture. Because of this and due to the occurrence of frequent droughts with subsequent food crisis the Federal Government has provided emergency measures with large sums of money spent on programs in various types of famine relief. These types of activities seldom result in improving the stability and long term productive potential of the environment. The last decade showed an increase of land concentration and disproportion of income distribution in the Brazilian semi-arid, followed by a decline of production and



Semi-Arid Region

NORTHEAST BRAZIL

productivity on the traditional crops with the uprising of a serious and generalized emergency situation.

According to Kampen and Krantz (1977), some of the most relevant characteristics of the semi-arid tropics are:

- . Intensive rainfall interspersed with unpredictable droughts.
- . Relatively short rainy seasons.
- . Highly variable rainfall during the wet season.
- . Low soil organic matter content.
- . Low infiltration capacity of soil.
- . Great water erosion potential.
- . Small farms with many small fields.
- . Limited capital resources.
- . Mainly animal or human labor power sources.
- . Severe seasonal unemployment.

These and other characteristics have been matter of attention by the Brazilian scientists at the semi-arid region. Even though with severe climatic irregularities to which this region is subjected, there are evidences that it is potentially able to reach satisfactory levels of economical development. The diversity of agro-ecological situations, associated with the socio-economical conditions of the rural population in the Brazilian semi-arid motivated the adoption of specific and complex farming systems involving several activities: intercropping of annual crops; small cattle and poultry; extract of native essences for human and animal feeding; home industrial arts of clay, tanning, milk derivatives, flour and small trade.

Agriculture in the Brazilian semi-arid can be classified as traditional. The technology adopted by the farmers is

rudimentary and the resistance to the introduction of new technologies is accentuated. Since agriculture is the main activity in the Brazilian semi-arid, the social welfare of the population depends on its development. Small farmers are the majority in this region and they are characterized by several qualifications, being the small size of the farm and the low income level the two most commonly used. The working up of methodologies and technologies which allow the optimization and/or maximization of the available resources is one of the main objectives of the agricultural research. Resource management research for rainfed areas must be production oriented. Unless the farmer can see the changes which improved management technology can make on the crop he grows in any particular year, he will be unable to risk implementing the technology and not commit himself. Visible change is critical to widespread and rapid implementation. It is evident the importance of a methodology of agronomic analysis which will identify the real problems of the Brazilian semi-arid agriculture, in such wise as to direct the development of research aiming at specific solutions. This should result in new agronomic techniques easier of access by farmers or in assistance to the national industry to produce agricultural goods necessary to the solution of the problems identified. Some of the prerequisites for a successeful modern agriculture among the small farmers are (Alves, 1987):

- . existence of cooperatives or enterprises which heve machinery and implements and deal with commercialization;
- . level of instruction;
- . association capacity;
- . existence of technologies and an efficient extension service;

- . economic policy which favours modernization, and
- . ability in rural administration.

Due to insufficient knowledge about the Brazilian semi-arid and inadequacy of available technologies for the solution of its problems, a scientific model has been adopted, which involves three phases in the research process:

1. Survey and identification of the problems which can be solved by research;
2. Development of technologies;
3. Analysis of the interactions between the results from research and their dissemination and adoption in the agricultural systems.

Agricultural research in the Brazilian semi-arid has been administered by EMBRAPA ("Empresa Brasileira de Pesquisa Agropecuária"), the agricultural and livestock research enterprise, which functions in the region with the following research Units and Enterprises:

1. Agricultural and Livestock Research Center for the Semi-Arid Tropic (CPATSA), Petrolina - PE;
2. National Research Center for Cassava and Fruit Crops (Cruz das Almas-BA);
3. National Research Center for Goats (Sobral-CE);
4. National Research Center for Cotton (Campina Grande-PB);
5. National Research Center for Irrigated Agriculture (Parnaíba-PI);
6. National Research Center for Coconut (Aracaju-SE);
7. National Research Center for Cashew (Fortaleza-CE);
8. State Research Unit (Teresina-PI);
9. State Research Enterprises for the States of Bahia, Alagoas, Pernambuco, Paraíba, Rio Grande do Norte, Ceará, Sergipe and Maranhão).

More than 800 research projects are currently being carried out by the above research agencies (24.4% of the national total) which count on 259 scientists directly employed by EMBRAPA and 480 scientists employed by the State enterprises.

Great effort has been devoted to a performance of the agricultural research in the Brazilian semi-arid in a process which involves several research institutions and starts with a methodic investigation of the rural environment, its problems and potentialities. With this point of view, research has been developed concerning several fields like ecology, botany, breeding, climatology, irrigation, drainage, animal health, plant pathology, entomology, sociology, economics, mechanization, seed production, farming systems, and technology transfer.

Agricultural research in the developing countries of the semi-arid tropics has until recently been aimed primarily at increasing production in irrigated and/or dependable rainfall areas. Faced with a situation of limited resources and serious food shortage, this appeared to be a logical decision. In recent years there has been an increasing concern about agriculture in unirrigated areas. The awareness of the widening gap between irrigated and rainfed regions has been growing. Moreover, an increasing number of people have realized that the potential of the semi-arid tropics to produce food for a hungry world far exceeds present production levels (Kampen and Krantz, 1977).

Present farming systems in the semi-arid tropics are characterized by low and undependable yields and by an inefficient use of the rains and the soil. Thus, substantial improvement in the productivity of the resource base is required. Cooperative operations research programs must be strengthened so that integration of new technology is emphasized, interdisciplinary research is facilitated,

farmers are involved in technology development, and group action questions are solved. Only sustained, integrated development programs, executed by well-trained professionals and supported by problem-oriented, applied research projects, will have the desired impact (Kampen, 1979).

In the Brazilian semi-arid, the agricultural research institutions have been working concurrently aimed at identifying alternatives to improve the farms in such a way to make them economically viable. To reach this goal, a series of activities is concomitantly executed and/or coordinated by those institutions, and among them are:

- . Research at laboratories and experimental fields;
- . Courses and Training for scientists, technicians, students, farmers, and developemnt workers;
- . On-farm research;
- . Educational programs on radios and televisions;
- . Publication of research results through periodicals, journals which can easily reach the concerned people.

After the recognition of the need of a new research methodology, and with the creation of EMBRAPA, there has been a set of technologies developed over the last years to which researchers from EMBRAPA and other institutions have provided an outstanding contribution to the Brazilian semi-arid. It will be impossible to report all of those technologies in this paper but some of them were selected to be shortly described. The contribution of EMBRAPA and related institutions to the semi-arid agriculture in Brazil includes soil and water management, pest management, agricultural mechanization, farming systems improvement, introduction of new varieties and/or new crops to diversify the existent systems, animal nutrition and health, reforestation. etc:

. LEGUME AND CEREAL CROPS:

- In areas with better rainfall distribution, navy beans (Phaseolus vulgaris) can show 50% yield increase in intercropping with maize when a combination of improved varieties, adequate fertilization and soil and crop management is used.
- Simultaneous planting of three or more cultivars of cowpea with different cycles can yield 56% more in dry years; organic fertilizers can increase cowpea yield in 344%; data have shown that cowpea weevil can reduce up to 50% of the commercial value of the grains, and that this can be reduced to 5% with the use of cheap storage materials such as semi-hermetically containers covered with sand; a breeding program with the introduction of 2,000 lines of cowpea is being carried out in the Brazilian semi-arid which will be used in future breeding crosses.
- New varieties and hybrids of maize have been introduced with yield increases of up to 150% compared to the yield showed by traditional varieties; the use of the right spatial arrangement and plant population can give up to 73% yield increase in maize when intercropped with beans.
- Research has proved the economical viability of growing sorghum in the Brazilian semi-arid; after the introduction of this crop in the region a breeding program has been carried out and new hybrids/varieties have been obtained showing yields of up to 10,000 Kg/ha in areas where maize would fail.
- Soyabean has been introduced in the Brazilian semi-arid and a local variety has been bred with yield superior to 2,000 Kg/ha under less than 400 mm rainfall.

. COTTON:

- New cotton varieties have been obtained with significant yield increases; farming systems including cotton for dry areas were studied showing 40% increase in yield; an integrated pest control program was developed which can give money saving to both farmers and the country; efficient control of boll weevil (Anthonomus grandis) has been obtained in the Brazilian semi-arid tropic; new varieties with longer and more resistant fiber have been bred and are in use by the farmers.

. CASSAVA:

- An intensive program is now in progress aimed at identifying varieties of cassava resistant to the main pathogens in the region and around 50 different varieties have already been obtained; identification of adequate levels of fertilization has been researched and recommendations for different locations are available; the use of animal power for cultivation of cassava fields has reduced 42% with weeding costs, compared to manual labor, and increased yields by 55%; the use of double rows can give increase in cassava yield of 58%.

. FRUIT CROPS:

- The introduction of viticulture in the Brazilian semi-arid under irrigation was one of the most successful programs, since up to three harvests can be obtained annually and the climatic conditions are excellent. A collection of national and international cultivars is in observation although adapted varieties have been already selected and recommended, which attracted large enterprises to the region, some of them having already planted thousands hectares. Studies are carried out on

grafting, water consumption, irrigation methods and post-harvest physiology.

- The introduction of short varieties of bananas, resistant to diseases, has made a big progress in irrigated areas; the biological control of insects and diseases reduced 66% the costs with toxic pesticides, is a cheap and non-pollutant practice; a lot of new introduced varieties of bananas are available, which produce 4 months earlier than the old local varieties and can produce 55,000 Kg/ha.
- Different kinds of intercropping small grains with pineapple have been studied with success, which has shown higher yields for pineapple (20%) and additional yield of grains, improving the farmers' income; vegetative propagation from stem sections of pineapple improves the health conditions of the plant reducing the incidence of Fusarium and the costs of production.
- Studies combining different canopies/rootstocks in citrus have identified materials free of diseases and incompatibility; cheap sources of phosphates have been recommended for citrus with big profits.

. HORTICULTURE

- Research results indicated the viability of growing asparagus in the Brazilian semi-arid region with irrigation, showing yields of 10,000 Kg/ha, 3-4 times higher than the yields obtained in the South of Brazil, the traditional growing area. This is one more option for the local agriculture with an open international market.
- New varieties of tomatoes were developed in the Brazilian semi-arid region, both for the industry and for "in natura" consumption, with costs of production 6 times lower than

traditional varieties, having resistance to diseases and higher productivity.

- Induction of onion flowering through artificial vernalization of the bulbs in cold chambers, which reduces 50% the vernalization time required by the crop for seed production; cultivars of onions developed in the semi-arid region with 12.7 ton/ha and good conservation of bulbs after harvest are available.
- New varieties of watermelon and melon have been developed which are resistant to mosaic virus and show high yields.

. AGRICULTURAL MECHANIZATION:

- Wheeled tool carrier is an equipment adapted in the Brazilian semi-arid, using animal power, which can work in up to 15 hectares and is a great help to small farmers. It can work with all the required implements for farming operations using animal power, planting depth can be adjusted, has a high efficiency for beds and furrows systems.
- The manual seeder for buffel grass is an adaptation of the "tico-tico" kind of cotton seeder which can speed up the work of the farmers.
- The manual seed harvester for buffel grass is another adaptation made by EMBRAPA researchers at the Brazilian semi-arid tropic, which can harvest up to ten times faster than the traditional methods used by small farmers.
- A machine has been developed in the Brazilian semi-arid to make barbed wire fixer, used making suspended fences, which reduces the required labour in fence construction and the maintenance costs.

. SOIL AND WATER MANAGEMENT:

- Saline water has been used from deep wells during the raining season to irrigate grasses when rain water is insufficient, which has been used before only for animal consumption.
- A set of technologies for use and conservation of water resources is being developed and/or adapted for the arid and semi-arid conditions of Northeast Brazil, which have shown extreme interest by farmers and developmental workers and great success. These technologies consist of: 1. Water Harvesting Systems for human consumption through rural cisterns, for animal use through small tanks, and for vegetal use through tanks for "life saving irrigation"; 2. Receding agricultural systems from dams, rivers, and lakes through broadbed-furrows in level; 3. Microcatchment Systems, and 4. Unconventional Irrigation Method, using clay pitchers and porous capsules. All of these technologies have already been introduced in small farms and have shown a good perspective of utilization by small and medium farmers, since they increase stability and/or food production in small agricultural areas.

. OPTIONAL CROPS:

- Trying to find new options to diversify the semi-arid, agricultural research is being carried out with several drought resistant crops and some of them are already in small-scale use, although showing a great potential: 1. sesame - around 75 cultivares were introduced and yields over 300 Kg/ha have been obtained; 2. safflower - more than 50 cultivares were introduced and yields over 2,000 Kg/ha have been obtained; 3. guar - about 330 cultivares from different countries were introduced in a collection and yields over 2,000 Kg/ha have been obtained;

4. jojoba - a germplasm collection has been under observation for over 5 years to study the adaptation of this crop to the local conditions.

. FORAGES:

- Cultivars of buffel and other grasses have been introduced in the Brazilian semi-arid with excellent adaptation. The native vegetation (called "caatinga") is the basic source of food for animals in the region. However, 13-15 hectares are necessary to maintain an animal-unit (AU) per year. Introduced grass, like buffel grass (cv. "Biloela") were shown to require only 1 hectare/AU/year. Seeds of this cultivar have been distributed among small farmers.
- The use of leguminous shrubs or trees in small areas seems to be a good option for animal feeding in the Brazilian semi-arid. That is to complement the feeding of animals during the dry season since even the introduced grass shows a very low level of crude protein (< 5%), during that dry period. Leucaena (Leucaena leucocephala) has been one of the most promising species for this objective, mainly due to its ability to produce new green leaves during the dry season.

. FOREST:

- Native and introduced species have been studied in the Brazilian semi-arid, some of them for reforestation programs, some for local wood production and some for lots of uses like Prosopis spp. Promising results have been obtained, seeds/seedlings can be obtained by farmers.

. ANIMAL PRODUCTION:

- Several studies have been carried out with goats and beef cattle, to diversify and improve their nutrition, based on products or resources that can be easily obtained by small farmers in the semi-arid. This can be done mainly through a more rational "caatinga" management, feeding of crop residues, grass standing hay or by-products, like urea; animal health programs are under way, mostly towards to the control of gastrointestinal parasites, one of the most limiting factors to animal performance

Some obstacles related to the Brazilian semi-arid agriculture are:

1. The climatic irregularity, which generates serious social and economical crisis;
2. The low productivity due to the local rudimental agricultural system;
3. Agrarian structure, characterized by the co-existence of large and too small farms, which generates both sub-utilization of the land and lots of farmers without land and underemployed;
4. Low income levels, resulting from inadequate land exploitation, high costs of agricultural production and the existent commercialization system;
5. Low standard of living, which can be a barrier to the improvement of production processes and to organization of communities.

Our final goal is to improve the Brazilian semi-arid agriculture in such a way to keep the rural man at his origin. It is necessary that the governmental organs change the agricultural

policy aimed at capitalizing the farmers and thus the amounts subsidized to keep them at their origin will be much less than those necessary to keep them in "slums" in the big cities.

BIBLIOGRAPHY

- ALVES, E.R. de A. Pobreza rural no Brasil; desafios da extensão e da pesquisa. Brasília, CODEVASF, 1987. 79p.
- AVILA, A.F.D.; OLIVEIRA, A.J. de & CONTIM, E. Pesquisa agropecuária e pequeno produtor: a experiência da EMBRAPA. Brasília, EMBRAPA-DDT, 1986. 39p. il. (EMBRAPA-DEP. Documentos, 26).
- BARBOSA, M.M.T.L.; CRUZ, E.R. da & AVILA, A.F.D. Benefícios sociais e econômicos da pesquisa da EMBRAPA: uma reavaliação. Brasília, DF, EMBRAPA, 1988. 18p. il.
- BRASIL. SUDENE. Programa especial de transformação e fortalecimento da economia da região semi-árida do Nordeste. (Projeto Sertanejo). Recife, PE, 1976. 48p. il.
- EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, Brasília, DF. EMBRAPA Ano 6. Brasília, 1978. 64p. il.
- EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, Brasília, DF. EMBRAPA Ano 7; síntese dos resultados de pesquisa 1979. Brasília, 1979. 52p. il.
- EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, Brasília, DF. EMBRAPA Ano 8; destaques de resultados de pesquisa de 1980. 65p. il.
- EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, Brasília, DF. EMBRAPA Ano 9; destaques dos resultados de pesquisa de 1981. Brasília, 1981. 100p. il.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, Brasília, DF. EMBRAPA
Ano 10; destaques dos resultados de pesquisa de 1982. Brasília,
1982. 113p. il.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, Brasília, DF. EMBRAPA
Ano 12; síntese das atividades realizadas no período 1979/84.
Brasília, 1984. 72p. il.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Centro de Pesquisa
Agropecuária do Trópico Semi-Árido, Petrolina-PE. A pesquisa
em produção animal no Nordeste Semi-Árido; I reunião de compa-
tibilização. Petrolina, 1976. 40p.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Centro de Pesquisa
Agropecuária do Trópico Semi-Árido, Petrolina, PE. O Trópico
Semi-Árido do Nordeste - características gerais e pesquisas em
desenvolvimento no CPATSA. Petrolina, 1978. 7p.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Centro de Pesquisa
Agropecuária do Trópico Semi-Árido, Petrolina, PE. Síntese da
atuação do CPATSA no Trópico Semi-Árido Brasileiro. Petrolina,
1982. 8p.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Centro de Pesquisa
Agropecuária do Trópico Semi-Árido, Petrolina, PE. Levantamen-
to das tecnologias e metodologias desenvolvidas pelo CPATSA. Pe-
trolina, 1987. 74p. il.

KAMPEN, J. & KRANTZ, B.A. Resource conservation, management and
use in the semi-arid tropics. Hyderabad, India, ICRISAT, 1977,
s.d. 22p. il.

KAMPEN, J. Watershed management and technology transfer in the semi-arid tropics. Hyderabad, India, ICRISAT, 1979. 18p.

KAMPEN, J. & KRANTZ, B.A. Soil and water management in the semi-arid tropics. Hyderabad, India, ICRISAT, s.d. 33p. il.

SILVA, A. de S. & PORTO, E.R. Utilização e conservação dos recursos hídricos em áreas rurais do Trópico Semi-Árido do Brasil; tecnologias de baixo custo. Petrolina, PE, EMBRAPA-CPATSA, 1982. 128p. il. (EMBRAPA-CPATSA. Documentos, 14).

SOUZA, R.A. de. Nordeste e a pesquisa agropecuária. Petrolina, EMBRAPA-CPATSA, 1984.