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WATER AND CONSERVATION PROGRAMS FOR CAPE VERDE

by

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INTRODUCTION

In accordance with Contract No. AID/afr-C-1203, effective February 3, 1977, a review was made of activities in Cape Verde related to irrigation development, water spreading and soil conservation. An inspection was made of existing conditions and projects on the island of Santiago. Available literature was reviewed.

Cape Verde has an area of 4032 km^2 and a population of about 300,000. Nearly half of the population lives on the island of Santiago which comprises approximately one-fourth of the total land area.

At the request of Engineer Horatio Silva Soares, Director, Nacional Agricultura, Florestas e Pecuaria, the study was confined largely to the island of Santiago. This decision was made because of the importance of Santiago with respect to its size, population and developable resources and to the existing and planned programs for the other islands.

Agricultural Development Programs are being planned for Fogo and Brava by the West Germans, for S. Nicolau by the French, for Santo Antao by the Dutch and for part of Boavista by an organization from Switzerland. The ultimate scope of these programs has yet to be defined.

There are many possible and desirable program activities relative to improved soil and water conservation. Some are recommended for early action. The intensity of cultivation and overgrazing on steep slopes is such that major changes in policy are needed in the immediate future. Progress at a reasonably adequate rate will require the substitution of new work activities for those traditional ones that are wasteful of both land and labor. Some of the required new procedures may be found locally in other types of agriculture, but considering the very limited agricultural resources, a real effort will be required to find new alternative labor intensive crops and enterprises.

The conditions relative to soils, climate, hydrology, land use and related conditions have been described in a brief and concise manner. Specific program suggestions have been made for new or increased activities in irrigation experiments and demonstration, training, meteorology, hydrology, bed load measurement, surface erosion measurements, watershed management, ground water development, reforestation and for an improved inventory of the land and water resources available for agriculture.

A summary is presented of current program activities related to soil, water, forestry and various associated agricultural programs.

CONCLUSIONS

As a result of this study, several basic conclusions have been reached that will strongly influence the planning of future programs. Some of the conclusions considered to be of special importance are:

1. The area under cultivation (40 to 50 thousand hectares) is generally steep, mountainous and broken. A large percentage of the soils are very rocky or shallow. The rainfall is unusually undependable over much of the area. The total gross area having 3 months of adequate dependable rainfall probably does not exceed about 33,000 hectares. Of this area the part having favorable soils and topography probably does not exceed about 10,000 hectares. Due to the extreme limitations of the basic agricultural resources, a detailed reliable inventory of the soil, slope, water and climatic resources available for development should be given first priority.

2. The cultivation of steep slopes (principally for corn cultivation) and the frequency of high intensity rainfall results in a rapid erosion of the topsoil in the mountainous areas with a resultant rapid reduction in the limited soil resources available for present use and future development. Immediate steps should be taken to reduce erosion to the minimum through extension work and publicity.

3. The area currently under irrigation (about 1,900 hectares) should be expanded as rapidly as feasible and irrigation efficiencies should be improved. The total new area that is economically developable for irrigation may not exceed 2,000 to 3,000 hectares.

4. The land slopes and rainfall distributions are largely unsuitable for intensive cultivation of corn. Other land uses such as forest and forage can produce greater economic returns and at the same time provide for greater conservation and efficient use of the limited soil and water resources.

5. Programs for the introduction of improved land uses should provide the following:

a. Labor intensive activities
b. Feed, forage or fodder for livestock
c. Provision for cooking fuel
d. An alternative source of corn to provide the basic staple in the Cape Verdian diet.

6. Soil and water conservation and development can only provide a small portion of the solution to the problems facing the Republic of Cape Verde. Soil and water projects should, therefore, be part of an overall integrated planning effort which might include coordination of the following:

a. Improvement of the fishing industry
b. Use of forest products in industry
c. Rural electrification
d. The promotion of tourism
e. The use of Cape Verdians in the development of other countries.

7. Success of this effort will depend on the willingness of the Cape Verdians to work hard and on the existence or development of basic technical skills as favorable factors in considering new development programs.

RECOMMENDATIONS

Although natural resources are limited in Cape Verde there are many possibilities for improving conditions. Change may not be rapid and must take place in a manner acceptable to the culture and traditions of the area. In order to promote both change and development the following recommendations are made for priority consideration.

1. It is recommended that a comprehensive inventory be made of the land use potential.

2. It is recommended that the culture, traditions and ownership and operational size of holdings be carefully evaluated since they will greatly influence the potential for introduction of new crops and practices.

3. It is recommended that projects for the construction of cross dykes and terraces for erosion control be continued as needed. In most cases the ultimate solution to the erosion problem will include taking large areas of land out of annual cultivation and planting them to some type of high income permanent vegetation.

4. It is recommended that studies be made to determine the highest economic land uses consistent with promoting soil conservation and providing labor intensive activities, cooking fuel and livestock feed.

5. It is recommended that expansion of the growing of corn be provided with strong negative incentives or strongly discouraged. Corn production, except for a very limited area, is a relatively uneconomical use of the limited resources. This change will require the importation of an adequate supply of corn and the provision for alternative labor intensive activities or enterprises.

6. Research recommended for consideration includes the following:

   a. Investigation designed to either develop or introduce a shorter growing season corn and to find varieties best suited to the two different zones, upland and lowland.
   b. Investigation to determine the most suitable millet or millets to be introduced.
   c. Research to compare the economic returns from pasture, forage and tree crops with those from corn and millet.
   d. Investigation to determine the most desirable types of contour soil conservation treatment to be used for erosion control.

e. Investigation leading to selection of types of trees. bushes and palatable plants to be introduced in arid coastal areas. A thornless cactus used in Brazil for livestock feed (Palma) is suggested for trial.

f. Investigation to determine the suitability of various types of irrigation.

g. Investigation of the adaptability of various methods of water harvesting and storage.

7. Data collection programs should be improved and new items added:

a. A program to improve collection of weather data.

b. A program of stream gaging and sediment and bed load measurement.

c. An investigation of possible dam and reservoir sites.

d. Additional soils mapping and analysis in areas to be irrigated or to be used as water management areas.

e. An improved inventory of other physical resources related to agricultural development and land use.

8. Short range development activities and/or programs are recommended as follows:

a. Water spreading.

b. Construction of small ponds and dams.

c. Drilling new wells for irrigation and for water supply.

d. Torrent control.

e. Terracing and contour cropping.

9. Long range development activities recommended for consideration include:

a. Training of professionals and extension workers

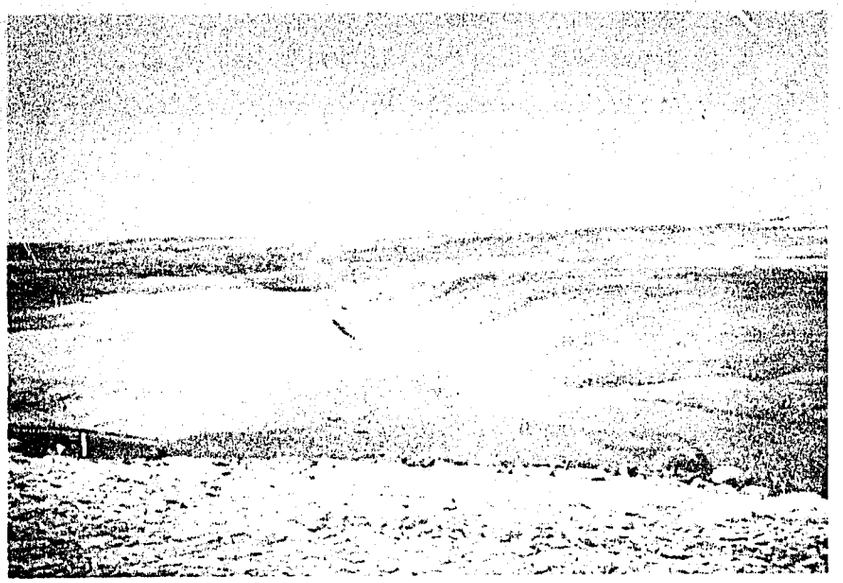
b. Establishing an agricultural school and demonstration farm. (Possibly facilities at S. Jorge and S. Domingos could be used.)

c. A pilot project in rural electrification

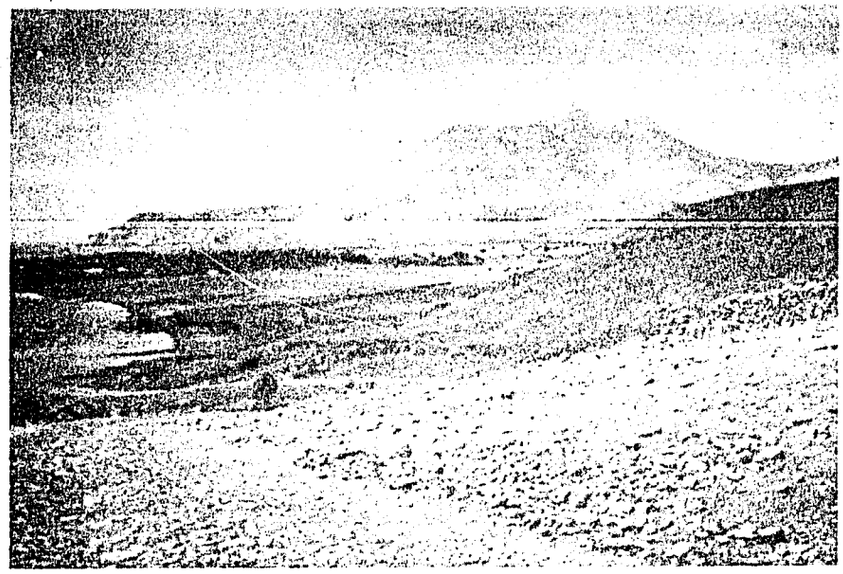
d. A major program of reforestation and other means of developing other permanent vegetative cover.

P I C T U R E S

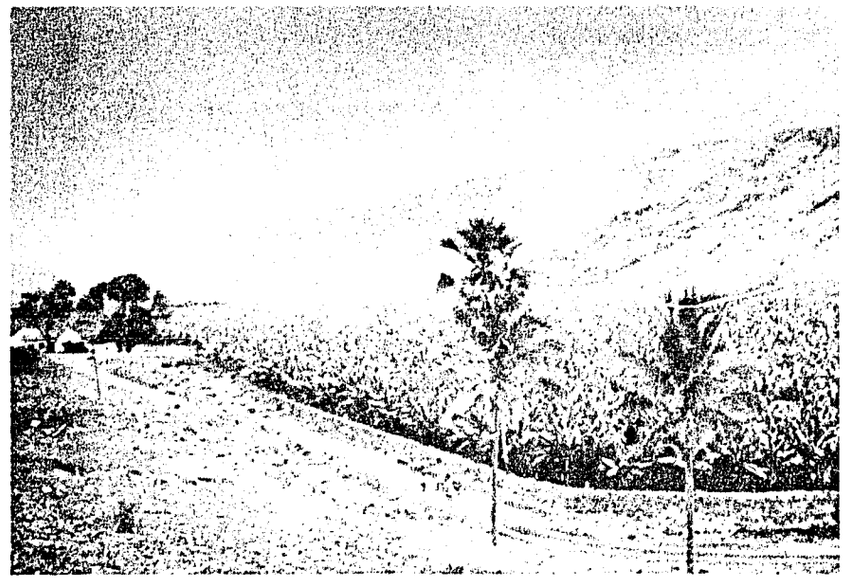
Picture 1. Lands that are being considered for possible future irrigation near Tarrafal, Santiago.



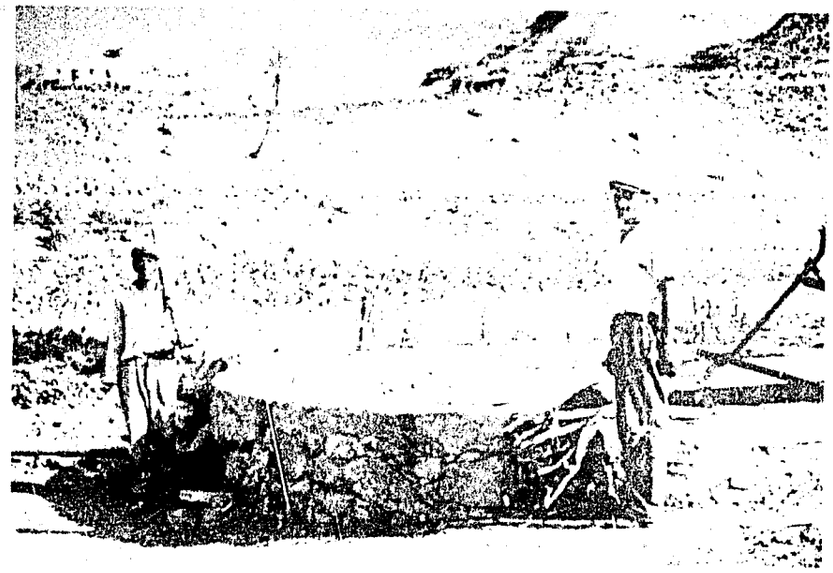
Picture 2. Lands that are being considered for possible future irrigation near Tarrafal, Santiago.



Picture 3. Small irrigated area near Tarrafal is visible in the distance.



Picture 4. Bananas produce well under irrigation where irrigation applications are adequate.

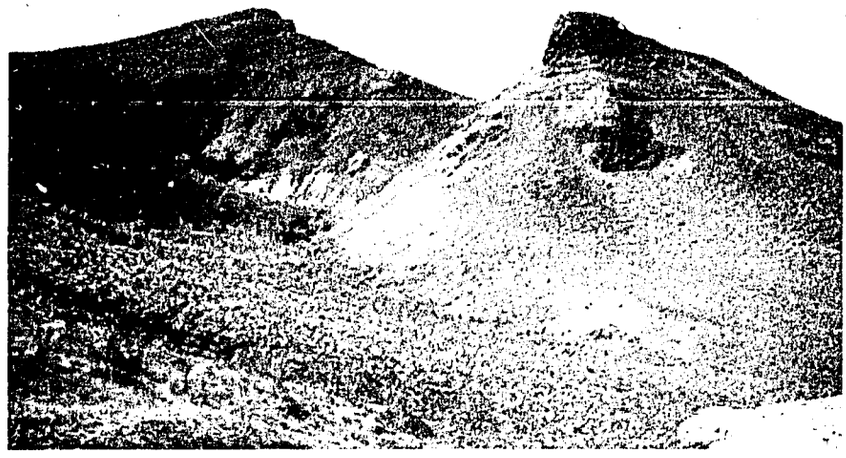


Picture 5. Hand dug well used for the irrigation of bananas.

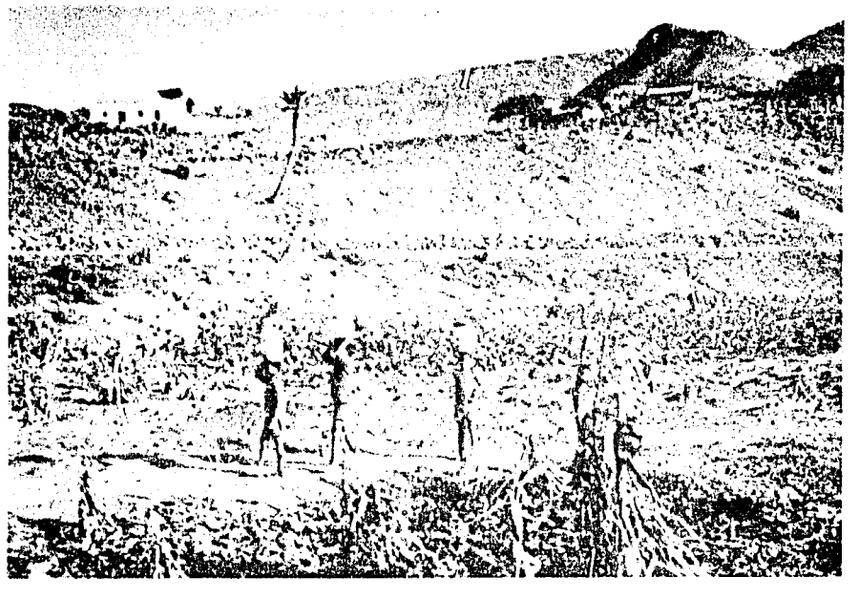
Picture 6. Terraced lands near San Jorge Orgaos, Santiago.

Picture 7. One of the areas of more favorable rainfall distribution. This area is one of the better locations for forest production.

Picture 8. Typical corn lands in the steeper upland regions. Some small terraces are visible above the houses in the center of the picture.

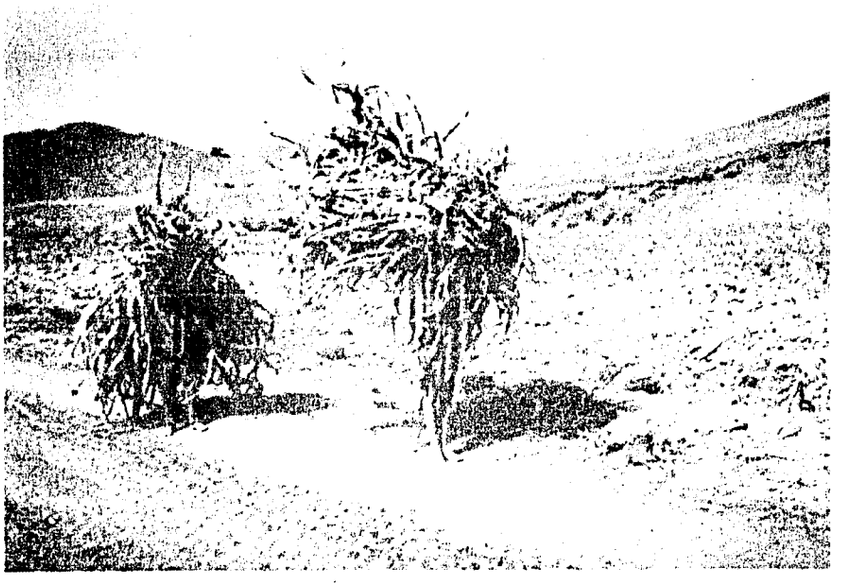


Picture 9. Corn fields near the Northeast Coast of Santiago. These lands are typical of a large portion of the corn producing area.



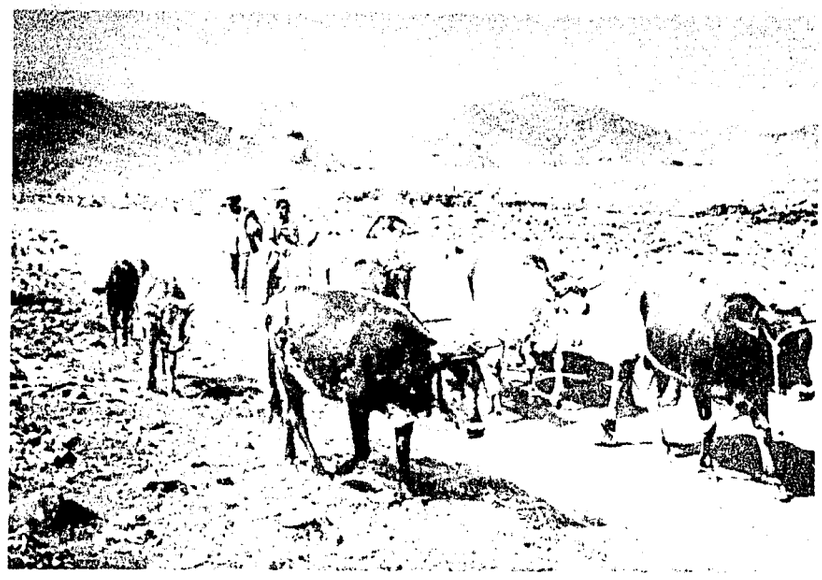
Picture 10. Water is carried long distances in cans.

Picture 11. Corn stalks are harvested and brought in from the fields in order to provide fuel for cooking and leaves for animal fodder.



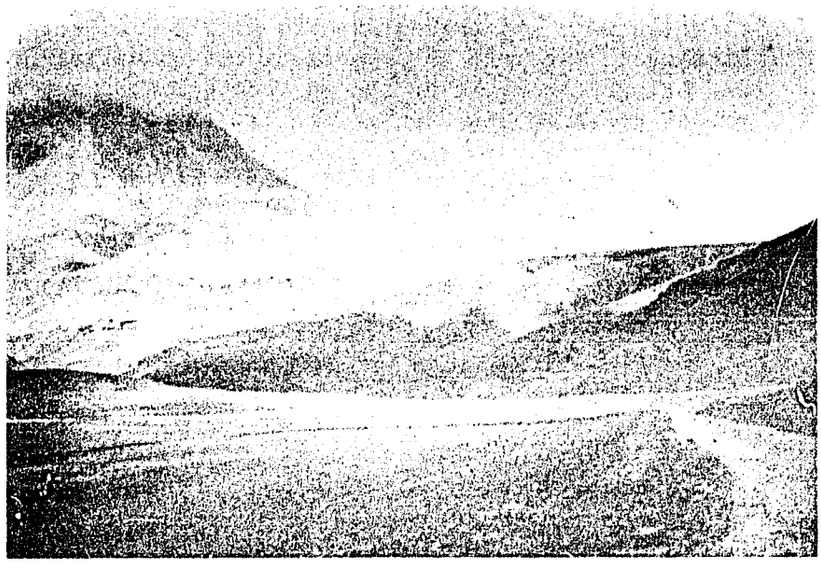
Picture 12. Boys bringing corn stalks in from the fields.

Picture 13. In the population centers people stand in line waiting their turn to obtain water to be carried to their homes.

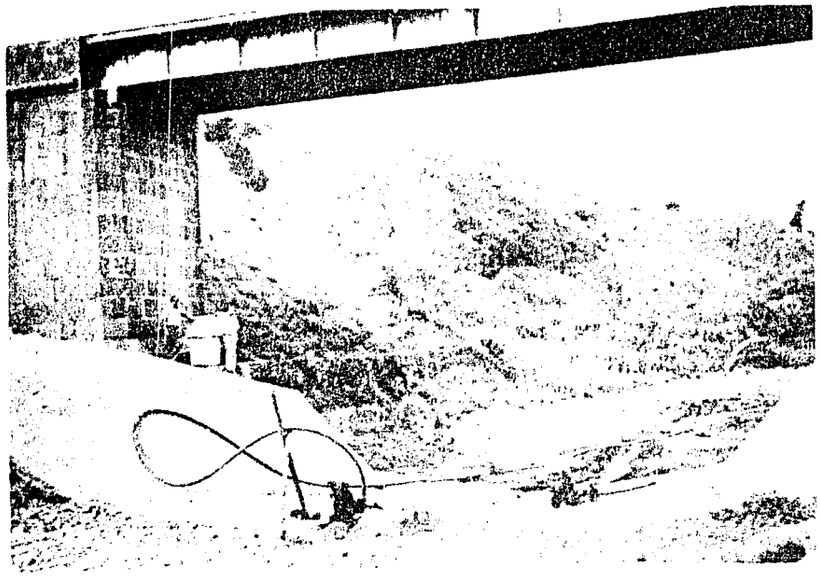


Picture 14. These cattle are produced and maintained principally with corn leaves. The principal livestock is goats resulting in severe overgrazing of the range areas.

Picture 15. The city of Praia in the distance.



Picture 16. Low carrying capacity range lands near Tarrafal.



PROJECT PROPOSALS

Various project activities were discussed with the Ministry of Rural Development and cleared for this presentation. The first priority proposals recommended for immediate financing are:

a.	Land Capability and Crop Introduction for Santiago	*$ 156,000
b.	Reforestation (1,650 ha)	665,000
c.	Irrigation Experiments and Demonstrations	55,000
d.	Observation training	90,000
e.	Surface Hydrology and Bed Load Measurement	122,000
f.	Meteorology and Climate	110.000
g.	Groundwater Development	$2,177,000
	TOTAL	$3,375,000

Second priority items recommended for consideration include:

a.	Management of the Santa Cruz Watershed	$ 506,500
b.	Cloud Seeding--Expert Opinion Only	5,000
	TOTAL	$ 511,500

Other project proposals under consideration by the Ministry of Rural Development were not as carefully evaluated as those above. Three additional activities were submitted for consideration. These are presented with the recommendation that consideration be given to whether the same amount of money could produce better results if invested in additional reforestation or in the planting of other permanent vegetation on the presently cultivated steeply sloping agricultural lands. The proposals are:

a. Project for soil conservation and torrent control in the watersheds of Ribeiras Sao Joao Batisca, Grande, San Martinho Grande and San Martinho Pequino. The project proposal includes technical assistance, training, equipment

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*Costs are in U.S. Dollars

and labor at a total estimated cost for the period 1977-1983 of 103,150,000 Escudas or $3,438,333.00.

b. Project of on-farm management practices including check dams, terraces, wide beds for silt deposits and related torrent control. The total cost for the period 1978-1982 is 27,740,000 Escudos or $924,666.00.

c. Project for sand due stabilization along 7 kilometers of the coast of Boavista at an estimated cost of 12,400,000 Escudos or $413,333.00.

SOILS

A considerable number of soils studies have been made of various portions of Cape Verde. These are available in the library of the Direction Nacional Agricultura, Floresta e Pecuaria. A 1970 study by Xavier de Faria[1] describes the methodology used and general conditions of the island of Santiago and gives the morphologic, physical and chemical characteristics of the soils of the island. The potential soil uses, classifications and capabilities are described. The map accompanying the report is at an approximate scale of 1:50,000. The comments contained herein are based primarily upon direct field observation of the soils and upon the information given by Xavier de Faria[1] as well as other technical studies.

The soils of most of the Cape Verde Islands (except for Maio, Buenavesta and Sal, which have little importance for agriculture), have been formed principally from the in-situ weathering of igneous rocks. Although there are minor areas of sedimentary materials and some area of tuff and lava, by far the predominant source material is basaltic or basic igneous rocks. The parent material or underlying rocks over large expanses are broken and fractured, permitting significant water penetration. Other soil areas overlay impervious rocks or slowly permeable tuff. The nature of the C horizon or underlying materials has a significant effect on soil erosion.

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[1] F. Xavier de Faria, "Os Solos de Ilha de Santiago," Junta de Investigacoes do Ultramar Estudos Ensaios e Documentos 124, Lisboa 1970, 157 p.

For example, on the island of Santiago one day rainfalls in excess of 100 mm are not uncommon. At Serra de Malagueta during the period 1961-1970 daily precipitation exceeding 100 mm occurred 12 times. For shallow surface soils on steep slopes and with continuing rain after the soil has become saturated, the potential for erosion is great.

Most soils are described by Xavier de Faria as being of medium texture without much profile development. However, several areas of heavier textured B horizons were observed. The soils are generally friable with an open permeable structure. Water generally penetrates rapidly. Fertility for soils developing from basic igneous materials appears to be good.

A list of the soils studies available is given as follows:

Soil studies and maps

1. Carta dos solos do Vale de S. Francisco (Ilha de Santiago) 1ª. e 2ª. partes Estudo Preliminar por F. Xavier de Faria e Danilo A. Bizarro, 1961.
2. Solos de Ilha de S. Nicolau - Mateus Nunes - 1962.
3. Carta de Solos da Ribeira Seca - Nuno Quintino Rogado - 1968.
4. Carta de Solos dos Vales de S. Domingos e Gaspar - F. Xavier de Faria - 1968.
5. Os Solos de Ilha da Boa Vista - Mateus Nunes - 1968.
6. Fertilidado dos Solos de Ilha de Santiago - Esboqo de uma carta de pintos. - A. da Silva Cardoso - 1969.
7. Solos de Ilha de Santiago - F. Xavier de Faria - 1970.
8. Alguna solos das zonas aridas do Arquipelago de Cabo Verde (Posibilidade duma mais conveniente utilizacao) - F. Xavier de Faria - 1970.
9. Os Solos de Ilha de Maio - Mateus Nunes - 1971.
10. Estudo sobre a fertilidade dos solos de Cabo Verde - Ilha de Santiago. 1. - Ensaios de adubacao em vasos - A. P. Silva Cardoso, M. Mayer Goncalves, Vielante Braga - 1972.
11. Estudos sobre a fertilidade dos solos de Cabo Verde - Ilha de Santiago - II. Ensaio preliminar de adubacao de um bananal em aluvio solo da Ribeira de S. Cruz - A. P. Silva Cardoso, M. Mayer Goncalves, C. Oliveira e Silva - 1973.

12. Os Solos de Ilha de Fogo - (Nao ha na Biblioteca) - F. Xavier de Faria - 1974.

CLIMATE AND WATER REQUIREMENTS

The climate of Cape Verde is extremely variable with respect to the amounts and distribution of rainfall. Babini[1] gives the following data for three locations:

Station	Elev	Average Precip.	Max. Daily Intensity	Date	ETP Penman
Praia	27 m	252 mm	232 mm	Aug 51	2354 mm
San Jorge	319 m	740 mm	534 mm	Oct 51	
Sta. Catarina	555 m	654 mm	330 mm	Oct 51	1793 mm

It is normal for nearly one third of the annual precipitation to occur in a single month, September or October. Roughly 80 percent of the yearly precipitation comes in three months (August-October).[1]

Mean monthly temperatures vary somewhat with latitude and location. For sea level and lower elevations in the monthly means vary from a low of about 22 degrees to approximately 27 degrees Celsius (72 to 81 degrees Fahrenheit).

Radiation data are given by Loff, Duffie and Smith[2] for a period of about five years for Mindelo and Praia. The average of the two locations is 541 Langleys per day (Mindelo having 544 and Praia 538). It appears that radiation is fairly uniform throughout the Cape Verde Islands. The variation is from a low of 384 Langleys per day for December to a high of 675 Langleys per day in April. For the season (August-October) the average is about 513 Langleys per day.

Potential evapotranspiration, ETP, and crop water requirements are remarkably uniform throughout the islands. Generally water

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[1] Babini, O. S., "Report Duty Travel to Cabo Verde Islands," FAO Mission Report, 13-31, July, 1975.

[2] Loff, George O. G., John A. Duffie and Clayton O. Smith, "World Distribution of Solar Radiation," Solar Energy Research Laboratory, College of Engineering, The University of Wisconsin Engineering Experiment Station Report No. 21, 1966, 59 p., plus maps.

requirements decrease somewhat with temperature. Temperature decreases about 5.5 degrees Celsius per 1000 meters in elevation. Potential evapotranspiration is estimated to vary from 100 to 115 mm during December depending on location and from 180 to 200 mm during May. Peak water use by most crops for periods of full crop cover can be expected to average about 1.10 to 1.25 times potential evapotranspiration depending upon the crop and the prevailing local conditions.

Wernstedt[1] gives mean precipitation data for periods varying from 15 to 30 years for 32 locations. Mean temperatures are also given for most locations. In determining moisture available from precipitation for agricultural use several factors should be considered. These include some that are quite difficult to quantify such as the amount of water that enters and is stored in the soil. A 75 percent probability of precipitation occurrence (that equaled or exceeded during 3/4 of the years of record) provides an index of dependability. Distribution within months is of importance. For determining actual precipitation distribution within the rainy months, fairly long records of daily rainfall are necessary.

For most areas of similar or fairly uniform climate a good relationship usually exists between mean monthly precipitation, PM, and the 75 percent probability, PD. For Cape Verde the relationship expressed in mm per month is approximately:

$$PD = -30 + 0.65 \times PM \qquad (1)$$

Estimates were made by computer of average potential evapotranspiration, ETP, for each month at each location. A moisture availability index, MAI, was determined for each month (MAI is equal to PD/ETP). Months having MAI of 0.33 or less as calculated using PD from Equation 1 were considered as having precipitation undependable for rainfed agriculture. Those with MAI of 0.34 or above were considered to be dependable for cultivation of most crops. This procedure may be somewhat on the optimistic side of reality because the rainfall in Cape Verde is not favorably distributed within the

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[1]Wernstedt, "World Climatic Data," Climatic Data Press, Lemont, Pennsylvania, 1972, 522 p.

monthly periods. Also with shallow soils and limited rooting depths the soil moisture storage is often limiting on crop production. This can be verified by obtaining the long term daily rainfall and completing probability studies.

It is of interest to note that intense rainfall occurs with considerable frequency. Based on 19 years of records at Serra da Malagueta, Santa Catarina and Curralinho the mean maximum daily precipitation varies from 14 to 18 percent of the mean annual precipitation. Mean annual rainfall for the period varied from 695 mm at Santa Catarina to 1031 at Serra de Malagueta. Mean maximum daily rainfall varied from 112 mm at Santa Catarina to 145 mm at Serra de Malagueta.

For Trinidade and Praia mean annual precipitation is much lower but the percentage falling in one day is significantly higher. The data are given as follows:

Station	No. of Years	Mean Annual Precipitation	Mean Maximum Daily	Mean Daily as Percent of Annual
Trinidade	16	342	87	25
Praia	24	252	68	27

Appendix 1, entitled Climate and Moisture Availability, presents a computer analysis showing temperatures, mean rainfall, dependable precipitation, potential evapotranspiration deficits and a moisture availability index for each month. Those locations having three months of favorable rainfall for agriculture were plotted on the map of Cape Verde. Out of the thirty-two stations, five on Santiago and three on Fogo, have at least three months of dependable precipitation. An approximate zone was drawn around these locations and then measured. The area on Santiago was 22,000 ha and on Fogo 11,000 ha.

LAND USE

The total land area of the Republic of Cape Verde is 4032 square kilometers. The areas under cultivation on the various islands, crops grown and yields per hectare are given in Tables 2 and 3. The area actually cultivated varies significantly with availability of rainfall and availability of irrigation water.

As is evident from Tables 1 and 2 the principal crop grown is corn currently comprising about 10 percent of the total land area. Corn is usually interplanted with beans where conditions are favorable, resulting in a duplication of area in Table 2. This interplanting usually occurs on the better areas of good soils and higher available moisture. These areas comprise perhaps about one-fifth of the total area planted to corn.

The total area under irrigation, although variable with fluctuating water supply, is generally described as being about 1,900 hectares. The principal irrigated crops are sugar cane and bananas. Peanuts, potatoes, manioc and various vegetable crops are also grown under irrigation.

There is some disagreement concerning the character of the original native vegetation. One description states that when discovered, the islands had an abundant brush and tree cover. Early export crops are given as oranges, tobacco, wines and coffee. Presently, trees are found on a total area probably not exceeding 3,500 hectares. The major portion of the land area can be described as range land of very low animal carrying capacity or as rocky barren wasteland.

Yields of some of the crops shown in Table 2 appear to be too low for economical production and below the potential expected for this climate. A review of the climate, soils and cultural practices is recommended to determine the potential for either improving production or for substituting crops with higher economic returns.

It seems evident that there has been accelerated deterioration of the crop and range lands during recent years. Human and livestock populations have for some time exceeded the carrying capacity of the land. Future development needs to be based upon public acceptance

Table 1. Areas Cultivated in 1969, in hectares.[1]

Island	Peanuts	Sweet Potato	Corn and Beans	Manioc or Yuca	Banana	Sugar Cane	Coffee
Brava		94	1,763	12	10	12	17
Fogo	69	486	10,608	160	2		250
Santiago	202	229	15,608	391	100	287	28
Maio		12	409	2			
Boavista		6	682				
S. Nicolau		85	1,637	148	19	70	12
Santo Antao		239	6,117	160	202	355	127
Total Cape Verde	271	1,151	37,205	873	333	704	434

[1]Rapport de la Mission d'Etude Sectorielle Agricole 7 juin-27 juillet 1975. "Situation Actuelle de l'Agriculture de la Republique du Cap Vert" No. 13. Organisation des Nations Unies pour l'Alimentation et l'Agriculture, Rome., 1975, 136 p.

Table 2. Area Cultivated and Yields, 1966-1967 and 1975-1976.[2]

Crop	1966-1967 Area	1966-1967 Ton/Ha	1975-1976 Area/Ha	1975-1976 Ton/Ha
Corn	30,000	0.8	40,000	0.2
Beans	7,000	1.2	7,000	0.6
Manioc	870	4.0	900	3.0
Sweet Potato	1,150	4.0	1,200	2.0
Peanuts	270	0.4	150	0.4
Banana	330	16.0	500	18.0
Coffee	430	0.3	300	0.15
Sugar Cane	700	15.0	250	15.0
Other	1,250		1,250	
Total	42,000		51,550	

[2]Lloyd Baron "Compte-Rendu de la Mission du Dialogue en Matiere d'Elevage. Cabo Verde, Janvier, 1977 - p. 89.

of the high probability of drought and the limited resource base. However, assuming that the pressure for intensive use can be in some manner controlled, there is considerable potential for increasing producitivity of these overused lands.

METEOROLOGY

The most important weather measurements related to agricultural development are precipitation, temperature, radiation, relative humidity and sunshine hours in approximately that order of importance. Other climatic measurements are required for navigation and other purposes. Wind measurements are desirable for sprinkler irrigation design and for assessment of potential crop damage.

The rainfall station network should be improved. Some additional gages are needed at important locations. Additional temperature measurements would be desirable. Radiation, sunshine hours and relative humidity are presently measured at Praia, Mindelo and Sal. It would be desirable that temperature, radiation, sunshine and relative humidity be measured at enough additional locations so that more accurate estimates of irrigation requirements and water requirements for dry land agriculture can be made wherever these estimates are of significant importance for agricultural planning.

A large portion of the precipitation data is published in the Annuario Hidrologico de Cabo Verde in four volumes. These data plus additional available data need to be published in one volume in a more useful format. Other available data on temperature, humidity, radiation and sunshine hours should also be published.

SURFACE HYDROLOGY

Surface runoff is generally torrential and intermittent. Since about 80 percent of the annual rain falls within a three-month period, it is obvious that most runoff follows this same pattern with some lag time.

Various individuals and organizations including the Ministry of

Rural Development and BURGEAP[1] have located sites that may be suitable for dams and storage reservoirs. Important considerations in the evaluation of these sites will include the amount of flow available and the quantities of bed load and suspended solids transported by the torrential runoff.

For the island of Santiago, topographic maps are available at a scale of 1:25,000. These should be carefully searched for possible additional water storage sites requiring additional investigation. Special emphasis should be placed on attempting to locate off-stream reservoir sites where water can be stored without the risk of rapidly losing reservoir capacity due to the rapid accumulation of sediment from bed load and suspended solids.

There are three stream gaging stations on Ribeira Seca equipped with automatic recording instruments. Staff gages were observed at the road crossings on Ribeira Seca and Ribeira dos Picos. Whether or not reservoir storage is found to be feasible, additional surface water measurements are required for basic planning activities including possible water spreading for aquifer recharge.

There has been some water development on Santiago. A hydrologic study[2] lists several water collection galleries as follows:

Ribeira	Length of Gallery
S. Martinho Pequeno	548 m
S. Francisco	107 m
S. Domingos (Choupana)	43 m
S. Domingos (Gaspar)	94 m
S. Domingos (Pinha)	17 m
Trindade	14 m
Boa Entrada (No. 1)	106 m
Boa Entrada (No. 2)	20 m
Aguada	170 m
Lem de Agua	73 m

[1] BURGEAP, Etude et Mise en Valeur des Eaux Souterraines dans l'Archipel du Cap Vert, Juillet 1974.

[2] Companhia Nacional de Prospeccao e Perfuracoes, Ltda. Por honrosa incumbencia de Sua Excelencia o Subsecretarie do Estado do Fomento Ultramarino, "Estudo Hidrologico do Arquipelago de Cabo Verde Vol. III" 1960, 116 p.

Dams and/or aqueducts have been constructed in the valleys of Santa Cruz, S. Francisco, Picos, Boa Entrada, Engenhos and Aguada. The annual discharge or total amount of water available from these development is not given. Flow rates of several streams are given for 1958 (1). The largest flow is 6000 m^3/day (about 70 1/sec) for October 10 for Ribeira Santa Cruz.

In order to more accurately define the surface water resources, a review should be made of possible gaging station sites. Probably about eleven additional gaging stations and about ten sites for measuring the solid materials transported would be fairly adequate. Additional measurements could be added later if necessary.

SMALL DAMS

Over large areas there is a high probability that 100 mm or more of rain will fall in one day during the year. This results in large quantities of runoff. The storage of this water suggests a potential for improvement of agriculture and the quality of life in the rural areas. An assumed runoff of 50 mm would allow storage of 500 m^3 of water per km^2 of watershed area.

In other arid and semi-arid areas of the world considerable success has been attained with the use of small earth dams for water storage. These other areas include Northeast Brazil, Northern Mexico, and the western United States.

Although runoff conditions are favorable in Cape Verde for the use of small dams and reservoirs, not all conditions are as favorable as could be desired. The solids transported by the runoff are considerable in amount and some small reservoirs would be quickly filled by deposition of sediment. There is a shortage of clay or of impervious fill material for dam construction in many areas. Some portions of the islands are too steep and broken to provide good reservoir sites. Evaporation and seepage losses might be substantial.

Wherever feasible, water storage projects should be combined with water spreading and watershed erosion control. Possible uses of the stored water would include domestic and livestock consumption and

irrigation of small areas to produce vegetables adjacent to these small water storage areas.

Considering the almost universal availability of rocks, and the need to create labor-intensive projects, these small dams could be constructed of masonry or rock-fill backed with earth fill, excavated from the storage areas where feasible. Plastic membranes might be required in some cases to make the fill in the dams impermeable. The probability of reservoirs filling with water-transported solids could be reduced in some cases by the use of off-stream water sites and multiple constructions on the same water-course.

In order to gain experience with small dams it is proposed that some areas be selected for pilot testing and demonstration programs. Such areas might include the uplands of Santa Catarina. Experience should be also gained in an arid coastal area. Several possible sites were observed near Praia. If the initial effort indicated a satisfactory level of benefit then the program could be expanded greatly to include other areas.

IRRIGATION

Valley lands suitable for a high level of production under irrigation are limited. Available water is presently even more limiting to irrigation development. The presently irrigated area is reported to be about 1,900 hectares. The study by BURGEAP indicates that ground water may be available to irrigate nearly that much additional land. Even assuming that some of the possible dam and reservoir sites are found feasible for construction, the ultimate irrigated area would not be large. Estimates of the total area that might be planted under irrigation vary from about 4,000 hectares to as much as nearly 10,000 hectares. Until more data on irrigable lands and potential water supply become available, it seems desirable to assume that the lower estimate is more realistic.

Irrigation should be made as efficient and productive as possible. The presently irrigated lands take water readily, a high degree of uniformity of application and high irrigation efficiencies are

difficult to achieve with the existing surface irrigation systems. Sprinkler irrigation may present some problems because of wind. Drip irrigation should be considered but is rather sophisticated and requires an expensive filter system.

A surface irrigation system that has proven to be very efficient if carefully operated is the use of level furrows or furrows with no slope. A carefully measured amount of water is run into each furrow quite rapidly. In this manner water penetration is uniform and of a correct amount. The system is labor intensive but is adapted to most crops.

A high degree of irrigation efficiency requires experience in operating whatever system used. A good knowledge of crop water requirements, some method of irrigation scheduling, good water measurement, and a strong desire to minimize waste of water are necessary. In view of the limited agricultural resources and the need to maximize productivity in Cape Verde, it is desirable that a start be made as soon as possible and that experience be gained with several methods of improved irrigation. The methods selected could include surface application by basins or level furrows, drip irrigation, low pressure under tree sprinklers, high pressure sprinklers and intermediate types. Expert assistance should be sought in determining the most desirable types and systems to be tried.

WATER SPREADING

Procedures or activities that retard runoff allow more time for the water to enter the ground and find its way to groundwater aquifers. Various possible activities for increasing groundwater recharge could include improved vegetative cover of the watersheds, cross dikes or drops to slow the torrents, temporary impounding areas (usually of fairly shallow depth and extensive area) and over-irrigation on the agricultural lands.

A significant problem in Cape Verde is that little is known about the quantity and occurrence of water available for spreading or how much suspended sediment material should be removed prior to spreading. Also of significance is the change in runoff patterns

caused by the considerable lengths of longitudinal masonry dikes constructed to keep flood waters off from agricultural lands. One real problem is that of removing the larger portion of the bed load material and at the same time controlling flooding within manageable limits.

In some of the irrigated valleys low stone masonry dry wall dams have been constructed across the valley to retain bed load and debris to improve the water supply and to recover some of the eroded soil. In some cases drainage galleries have also been constructed to recover the improved water.

Various areas of unused dry lands were observed in the valleys. Some of these can be dyked off as water spreading areas. Where feasible such water spreading should be combined with flood irrigation or over-irrigation during flood periods. This may cause some temporary drainage problems due to reduction of soil permeability. Experience in other areas indicates that permeability can usually be restored to a satisfactory level by a drying cycle. Water spreading in these valley areas will increase the total available for use from existing wells and those to be developed.

Water spreading or the retarding of runoff can play an important role in the hilly and mountainous areas. Small flat areas can be dyked off and water diverted to infiltrate in these areas. In Puerto Rico considerable use has been made of a system called diamond ditches, cross slope ditches or low terraces are constructed in both directions, intersecting each other. In this manner water can move across the slope or back and forth across the slope, but cannot flow directly down the slope.

SOIL CONSERVATION

Soil erosion is a very serious problem that is rapidly depleting the important topsoil resource base of Cape Verde. The situation may have some similarity to that of Greece. The mountains of Greece that were once covered by the forest used to build ships for war and commerce are now in many instances only bare limestone.

In Cape Verde the cultivation of corn is widespread even in areas of inadequate rainfall. Much of the cultivation is below an economic limit for production and is also on slopes up to 100 percent. Soils are generally permeable and take water readily, but erosion is still a problem. Mean maximum daily rainfall for the year usually exceeds 100 mm in the corn growing areas. Intensive rain on bare soil causes runoff and erosion problems.

Many soils overlay broken fractured basaltic rocks, however a considerable area overlays relatively impervious material. With the intense rainfall, shallow soils are soon saturated resulting in excessive erosion and large quantities of bed load, soil and sediment, in the torrents.

Taking these areas out of corn production and their use for crops less erosive in nature is suggested. In view of the urgency of the situation any action that produces results in the right direction, however meager, should be considered.

The Acacia albida is a plant that grows well under most conditions encountered in Cape Verde, if protected for three to four years. This tree popularly called algeroba, offers considerable potential for forage production and for soil conservation.

Various programs of reforestation and terracing, produce desirable soil conservation benefits. Large soil conservation improvements are possible providing substantial reduction can be made in the cultivation of steep slopes and reduction of overgrazing by goats.

TRAINING

A proper balance in technical and professional training programs is difficult to achieve. Although training is required at the professional level, of equal importance is the development of skills at intermediate levels.

In order to improve program planning and work execution at the technical and professional level both academic and field training of people with good potential can be considered. For observation and field training no one geographical area is ideally suited, however,

several have considerable to offer. Northern Mexico, for example, has an arid climate and some conditions similar to those of Cape Verde. Here use of irrigation, small and large reservoirs and commercial and subsistance farming can be observed. The Mexican small irrigation program is worth observing. Puerto Rico should be visited to see the successful irrigation and soil conservation practices used there. Brazil has had mixed experience with irrigation. One of Brazil's important programs is fish production in the reservoirs. In Spain, considerable use has been made of rock-filled wire mesh gabions for torrent control work. Also there is a long history of irrigation in Spain and Portugal.

For formal academic training, several possibilities exist. The University of Arizona had a team at Fortaleza Brazil for a period of years. Some of their professors speak Portuguese. Utah State University has considerable proficiency in Spanish and has taught courses in irrigation and water resource development to non-English speaking engineers. Courses can again be given in Spanish if there is sufficient demand or under special contract.

POSSIBLE SUBSTITUTE USES FOR CORN LANDS

Corn grown in Cape Verde is described as having a 4 month growing season. The rainy season is generally about 3 months or less of fairly dependable rain. However, droughts within this 3 month rainy period are also fairly frequent.

Corn has a skeletal root system and in the pollination period corn is very drought susceptible. Yield for the season is determined to an important degree by total moisture availability and more importantly, by moisture availability during the pollination period. Moisture stress during this critical pollination period can reduce grain yields to practically zero even though moisture adequacy is maintained throughout other crop growth stages.

Corn is listed by Sarraf and Kowal[1] as having a growing season of 80 to 180 days with an optimum of 100 to 150 days. A possible

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[1]Sarraf, S. and J. Kowal, "Provisional Groupings of Main Crops in Respect to their Eco-Physical Responses and Characteristics with Draft, Soil and Land Sanitability," Unpublished Table, FAO, S.

substitute grain crop, Japanese barnyard millet, is shown as having a growing season of 45 to 55 days. Panicum millet is listed as having a range in growing season of from 60 to 100 days. Millets vary in their rooting characteristics. Some varieties have root systems that spread throughout the soil and are quite resistant to drought and erosion. For good production, millet requires adequate moisture during the early vegetation period in order to establish the plants. If drought occurs during other stages in the vegetation cycle, millet can wait for the rain to come and then tiller and produce a satisfactory crop. This characteristic makes millet well adapted to culture under intermittent rainfall conditions.

Production of corn on steep shallow rocky soils is a primary cause of the rapid erosion of the soil. Contour planting of bands of any crop or plant more resistant to erosion would be the logical first step. If millet is substituted for corn, it should not be grown on the steeper slopes.

The erosion and food production situation is critical. The possibility of finding an ideal solution is remote. For this current season, any programs or changes that will be accepted within the culture and traditions of the area and has the potential for reducing erosion even slightly should be promoted. Corn should be replaced as soon as possible by perennial vegetation on the steeper slopes. Possibly as much as two thirds to three fourths of the area currently used to produce corn should be changed to other crops.

RURAL ELECTRIFICATION

One of the approaches to the solution to the problem of soil erosion can be giving the farmers alternatives to growing corn or other clean cultivated crops on the steep, shallow, permeable, rocky mountain slopes. Corn is an ideal crop from several points of view. It can be stored easily or left in the field for months during the long dry season, thus extending the harvest season and better utilizing the rural labor. The leaves provide animal fodder and the stalks provide cooking fuel.

Rural electriciation would provide a very strong motivation for change. Electric power will increase productivity. With refrigeration other crops could be more easily stored and/or processed. With electricity for cooking, the requirement for growing fuel would be greatly reduced. However, with the increasing costs of other energy sources, solar cooking should receive consideration for its introductior

In the valleys, rural electrification would be a strong factor promoting change and making it easier to introduce better irrigation practices. The availability of electrical energy makes operation and maintenance of irrigation from wells, sprinkler irrigation and drip irrigation much easier and in most cases more dependable and economical.

Experience with rural electrification in Latin America has demonstrated that a change in agricultural production plans occurs with a substantial increase in farm income. Returns to the national economy have been much greater than the investment, demonstrating favorable internal rates of return and favorable benefit cost ratios.

Availability of electricity pays an especially important role in areas with warm climates such as Cape Verde. Refrigeration of fish, meats and dairy produce and various food processing activities make significantly more food available for consumption. The end result is as effective as a significant increase in food production.

Perhaps of equal or greater significance is that rural electrification creates favorable conditions for change in methods of agricultural production making the introduction of new crops, new equipment, and new techniques easier. It is a prime mover in development or a catalyst to the desire to develop.

The introduction of rural electrification should be a long range program and should have modest beginnings. The rural electrification of Puerto Rico started with a program designed to furnish one light bulb , er house or shack. It was expanded when ability and willingness to pay for metered service developed. However, this expansion was much more rapid than had been anticipated.

On the island of Santiago several areas have significant importance. The valleys of Ribeira Seca, Ribeira dos Picos and

Ribeira Santa Cruz are of major importance for present and potential agricultural development.

The central upland area or semi-plateau of Santa Catarina has relatively favorable conditions for rainfed agriculture. The period of dependable rainfall is longer and more adequate than in most other areas. The soils appear to be deeper and more favorable than is the case for many other sectors of the country. The area, is, as would be expected, rather densely populated.

The city of Tarrafal is fairly important. A small irrigation development is located nearby. Additional irrigation facilities are being planned and are to be constructed if investigations indicate their feasibility.

The valleys along the northeast coast, the area near Santa Catarina and Tarrafal could all be provided with electrical energy by construction of 80 to 100 km of main line. Based upon the above considerations it is recommended that the necessary steps be undertaken to develop a pilot project in rural electrification that will demonstrate feasibility and usefulness for future expansion of this proposed program.

EXISTING PROJECTS

Several project activities related to soil conservation and water use are being planned or undertaken by various international organizations. The following descriptions indicate the more important activities.

Santiago

a. Torrent control and soil conservation financed by USAID Loan 655-2-001. The project provides for dikes, terraces, and small reservoirs in the drainage basins of Ribeira Seca, Ribeira dos picos, R. Engenhos and R. S. Domingos. About $ 4,000,000 have been released and additional releases are to be negotiated.

b. USAID grant of $ 1,900,000 for investigations designed to develop water for the irrigation of 400-600 hectares. Possible works include 50 experimental wells, 10 water collection galleries,

2 dams of about 100 feet height, tunnels, canals, dikes, and terraces. Technical assistance and 13 man/years of training are to be provided in hydrology, geology, agronomy and agricultural economy.

c. UNDP Pilot project in hydrology and irrigation in the valley of Ribeira Santa Cruz. The project provides $ 148,300 to be used for technical and consulting assistance, equipment for soils analyses and support financing.

d. A pilot project in vegetable production is being financed by the Swiss Technical Corporation.

e. Development of vegetable production on 16 hectares is being financed by the Ecunimical Church Council.

f. UNDP has a Reforestation Project for Santiago, Fogo and Santa Antao. The project furnishes an FAO Forester, Mr. Herman Gomez, and provides for the planting of 150 hectares of trees each year, for a total of 300 hectares. Considerable knowledge of species suitable for both high and low elevation plantings has been developed.

g. UNDP has a Project in vegetal protection. This project furnishes vehicles, technical assistance and equipment. Some USAID assistance in crop protection is also being provided.

S. Nicolas

a. The Ministry of Cooperation of France is financing a project for soil and water conservation, ground water investigations and pasture and forage development.

Fogo and Bravia

a. The Federal Republic of Germany through the organization Agro-action is financing a project in soil and water conservation irrigation development and pasture improvement. It includes construction of small infrastructure works and water supply systems for populated areas.

Boavista

a. An organization of the Protestant Church of Switzerland (HEKS) is financing a project for soil and water conservation in the basin of Ribeira do Rabil.

Santo Antao

a. The government of Holland is financing a project for soil and water conservation, irrigation development, infrastructure and agricultural research or experiments.

PROPOSED PROGRAM ACTIVITIES

It is proposed that several expanded current activities and new initiatives be grouped together into one integrated investigation and development program. Details of some of these activities are now being developed and others are to be defined in the future. Some of the more obvious desirable activities are listed below:

Irrigation Experiments and Demonstrations

The available water is so limiting to agricultural production that every effort needs to be made to maximize water use efficiencies. It is proposed that various types of sprinkler irrigation systems be tried on about 2 hectares at each of the following locations: S. Domingos, Santa Cruz, Tarrafal, Achada Baleia and Engenhos.

It is also proposed that experimentation and demonstration be made on about one hectare with drip irrigation systems at each of these locations or on a total of about 5 hectares. Experimental work should be carried out on methods of improving the efficiency of surface irrigation. Various methods can then be compared. The total estimated cost for equipment and installations for the different types of irrigation is $55,000.

Observation Training

Observation training is proposed for four professionals or technicians each year for three years. Half are to be trained in soil conservation and half in irrigation. The proposed locations for training are Mexico, Puerto Rico and the South Western States of the U.S.

Meteorology or Climate

There is a need to make better use of the existing climatic data. All available rainfall, temperature, relative humidity, solar

radiation and records of hours of sunshine should be collected, reviewed and published in one volume. Monthly values should be published at most locations. A few of the more important locations should be selected and the daily rainfall records published for the period of record.

The Direction Nacional, Agricultura, Florestas e Pecuaria has prepared a proposal for improving the meteorologic network by installing additional precipitation stations and increasing the number of weather measurements at several locations considered to be of importance for agriculture development or conservation planning. It is estimated that a three-year program of improving data collection would cost about $90,000.

The estimated cost of compiling and publishing the existing climatic data is roughly $20,000. More refined estimates are being prepared by the National Direction of Agriculture, Forests and Livestock.

Surface Hydrology and Bed Load

There are three existing stream gaging stations on Ribeira Seca. It is proposed that 11 additional stations be established as follows:

Ribeira Grande, Santiago	2
Ribeira S. Miguel, Santiago	2
Ribeira Santa Cruz, Santiago	2
Ribeira dos Picos, Santiago	1
Ribeira S. Domingos, Santiago	2
Ribeira de Figueira de Horta, Maio	1
Ribeira des Patas, Santo Antao	1
Total	11

The equivalent costs in U.S. dollars of one installation includes about $8,400 for construction of an overflow weir and about $1,600 for equipment purchase. Installation costs are $10,000 per gaging station.

It is proposed that one transit, 4 levels and 10 engineer's surveying rods be purchased for bed load evaluation. Ten sites are to be selected and construction completed to measure surface erosion.

The total equivalent costs in U.S. dollars is estimated as follows:

Item	1977/78	1978/79	1979/80	Total
Construction of gaging weirs		50,000	42,400	92,400
Purchase of stream recording equipment	17,600			17,600
Surveying instruments	5,200			5,200
Evaluating surface erosion		6,800		6,800
TOTAL	22,800	56,800	42,400	122,000

Management of the Santa Cruz Watershed

A proposal has been developed for the construction of check dams, terraces, drop structures and flat areas for collecting sediment deposits and for water spreading, surface water storage and additional irrigation. The total estimated cost for these watershed control and development works within the drainage basin of Ribeira Santa Cruz is 15,195,000 Escudos ($506,500). The proposed construction period is 20 months.

Groundwater Development

The Ministry of Rural Development has an ongoing program of drilling wells for domestic water supply and for irrigation. A goal for the next three years is 150 wells programmed roughly as follows: Santiago 28, Maio 45, Boavista 45 and 32 on S. Nicolao. Drilling screening and casing costs for 50 wells of average depth of 60 meters and diameters varying from 165 to 250 mm are estimated at 13,500,000 Escudos ($450,000).

The costs of pumps motors and windmills to equip these wells are estimated as follows:

41 pumps BP 105-8 with Lister Motor LR2	5,800	$238,000
15 Pumps BP 105-15 with Lister Motor SR2	14,200	213,000
94 Windmills at 4,000		376,000
Total equipment costs		$827,000

The total cost of the proposed three-year program is estimated at 40,500,000 Escudos and $827,000.

Cloud Seeding

Significant benefits are possible if cloud seeding can result in additional rains during critical periods of the growth cycle of the rainfed crops or to refill reservoirs. It is therefore, recommended that expert technical advice be obtained in order to further determine the possible feasibility of increasing agricultural production through cloud seeding. An approximate estimate of the cost of this preliminary expert assistance is $5,000.

Reforestation

The current reforestation project financed by FAO provides for a two-year program of planting 150 hectares per year to tree crops. The islands selected are Santo Antao, Fogo and Santiago. It is planned that 50 hectares will be planted each year on each island.

In theory, reforestation provides an ideal means of erosion control. Perhaps as much as 40,000 hectares or ten percent of the land area should be considered as having a good potential for producing trees and brush. This could well be the most economic use of these lands.

In the higher areas (800 to 1400 meter elevation) the Mediterranean type plants do well. In the lower areas arid and semi-arid vegetation should be considered.

Considering the importance of reforestation, it is proposed that the planting of tree crops be speeded up. It is proposed that the area planted each year be increased by 550 hectares (50 ha, on Santiago, 200 on Santo Antao, 200 on Fogo, 50 on S. Nicolao, 20 on Boavista and 30 on Maio). The estimated cost is 12,000 Escudos/Ha for labor and about $3/ha for seeds.

A special study needs to be undertaken to determine economical and desirable rates of forest harvesting. Some areas now require thinning to promote regrowth. Such a study should include a comparison of potential economic returns as compared with the present land uses.

Land Capability and Crop Introduction for Santiago

There has been much written in general terms about the resources to be developed in Cape Verde. Improved development planning will result from a better definition of these resources. The islands of Santiago, Fogo and Santo Antao have the major portion of the agricultural lands and of the potential for agricultural development. Santiago has roughly 40 to 45 percent of the agricultural cropped area of Cabo Verde.

Topographic maps are available for Santiago at a scale of 1:25,000. A generalized soils map has been prepared at an approximate scale of 1:50,000. Considerable climatic data are available in publications and as unpublished material in the archives.

The quality of development planning can usually be significantly improved by use of a clear and easily understood definition or evaluation of the available resources. From these considerations a proposal has been developed to provide a level of potential land use zoning for the island of Santiago. The proposed elements are as follows:

a. Assembling in one place the available daily and monthly precipitation, temperature and radiation data and the monthly values for relative humidity.

b. A complete precipitation probability analysis using both daily and monthly data. Five, ten and fifteen day probabilities would be calculated by computer along with monthly values.

c. The estimation of water requirements for various crops and plants and the calculation of the hydrologic balance wherever data are adequate.

d. The mapping of zones of similar moisture deficits.

e. The preparation of soils and ecological maps.

f. The grouping of soils, slopes and potential land use.

g. The selection of pilot zones for the introduction of new land uses and practices.

h. The application of various practices to an experimental watershed (the Santa Cruz Watershed).

The estimated cost of items "a" is $3,000; of "b," "c," and

"d" is $20,000, of "e" and "f" is $13,000; and of "g" and "h" $120,000, for a total cost of $156,000.

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APPENDIX 1 - CLIMATE AND MOISTURE AVAILABILITY

Table 1, Potential ET (ETP) and Moisture Availability indices for the Cape Verde Islands, presents the following data and calculated values.

Heading	DESCRIPTION
MEAN TEMP	The mean monthly temperature in degrees Celsius either measured or estimated from elevation
MEAN PREC	The mean monthly precipitation in mm from the years of record shown as YRS in the station heading
DEP PREC	The dependable precipitation in mm or the 75 percent probability of precipitation occurrence (that equaled of exceeded during three fourths of the years) estimated from an overall average relationship
POT ET	Potential evapotranspiration (ETP) in mm estimated from temperature and incident solar radiation. ETP = 0.0075 X RSM X TMF, in which RSM is radiation in equivalent mm of water evaporation and TMF is mean monthly temperature in degrees Fahrenheit.
ET DEF	The evapotranspiration deficit or the POT ET minus DEP PREC
MAI	A moisture availability index MAI = DEP PREC/POT ET

The following monthly moisture availability index classification has been used in varous agricultural productivity and zoning studies.

Moisture Availability Index (MAI)	Classification
0.00 to 0.33	Very deficient
0.34 to 0.67	Moderately deficient
0.68 to 1.00	Somewhat deficient
1.01 to 1.33	Adequate
1.34 and above	Excessive

The moisture availability index correlates well with potential crop production and crop yields. A classification developed by Hargreaves[1] and modified by Johnson[2] is given as follows:

Criteria	Classification	Agricultural Stability
All months with MAI of 0.33 or below	Very Arid	Not suited for rainfed agriculture
1 or 2 non-consecutive months with MAI of 0.34 or above	Subarid	Not suited for rainfed agriculture
2 consecutive months with MAI of 0.34 or above	Arid	Limited suitability for rainfed agriculture
3 or 4 consecutive months with MAI of 0.34 or above	Semiarid	Production possible of crops requiring a 3 to 4 month growing season
5 or more consecutive months with MAI of 0.34 or above	Wet-dry	Production possible of crops requiring a good level of moisture adequacy during 5 or more months

Johnson concluded that maize (corn) production should be limited to the semiarid and wet-dry zones. Grain sorghum is the recommended crop for the arid areas. Very arid and subarid zones are not recommended for rainfed agricultural crops.

The classifications of the various rainfall stations by islands is presented as follows:

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[1]Hargreaves, George H., "Precipitation Dependability and Potentials for Agriculture Production in Northeast Brazil," EMBRAPA and Utah State University, 1974 (CUSUSWASH 74-D155), 123 p.

[2]Johnson, Dennis, "Agroclimatological Zonation for Maize and Grain Sorghum in Northeast Brazil," Paper presented to the Geographical Review, 1977, 14 p.

Santiago	
Curralinho	semiarid
Picos	semiarid
Praia	very arid
San Jorge Orgaos	semiarid
Santa Catarina	semiarid
S. Domingos	subarid
Serra de Malagueta	semiarid
Trindade	very arid

Fogo	
Achada	arid
Achada Furna	subarid
Atalaia	semiarid
Cova Figueira	very arid
Feijoal/Mosteiros	arid to semiarid
Galinheiro	arid
Monte Grande	subarid
Monte Palha	arid to semiarid
Monte-Velfa	wet-dry
Patim	very arid
S. Domingos/Tonzon	subarid
Sao Felipe	very arid

Santo Antao	
Passagem	arid
Ponta do Sol	very arid
Tarrafal	very arid

Boavista	
Fundo de Figueiras	very arid
Povacao Velha	very arid
Sal-Rei	very arid

Brava	
Furna	very arid
Vela Ribeira	very arid

S. Vicente	
Mindelo	very arid

S. Nicolas	
Preguica	very arid

Sal	
Santa Maria	very arid

Additional details showing the conditions for each month are given in Table 1.

TABLE 1 POTENTIAL ET (ETP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

ACHADA — YRS 16 ELEV 1099 LAT 14 56 LON 24 23

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	16.2	16.2	16.2	16.8	17.3	18.4	19.0	20.1	20.7	20.7	19.5	17.9	18.3
MEAN PREC	2.	2.	1.	0.	0.	0.	17.	137.	146.	81.	19.	24.	429.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	59.	65.	23.	0.	0.	232.
POT ET	109.	114.	152.	161.	166.	160.	147.	133.	141.	133.	113.	98.	1637.
ET DEF	105.	114.	152.	161.	166.	160.	147.	73.	76.	115.	113.	98.	1405.
MAI	.00	.00	.00	.00	.00	.00	.00	.43	.46	.16	.00	.00	.14

ACHADA FURNA — YRS 16 ELEV 949 LAT 14 52 LON 24 22

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	17.6	17.6	17.6	18.1	18.7	19.8	20.4	21.5	22.0	22.0	20.9	19.2	19.6
MEAN PREC	4.	3.	0.	0.	0.	0.	13.	115.	123.	78.	21.	19.	376.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	45.	50.	21.	0.	0.	192.
POT ET	113.	118.	158.	168.	173.	166.	153.	143.	146.	143.	118.	102.	1701.
ET DEF	113.	118.	158.	168.	173.	166.	153.	88.	96.	122.	118.	102.	1509.
MAI	.00	.00	.00	.00	.00	.00	.00	.31	.34	.14	.00	.00	.11

ATALAIA — YRS 16 ELEV 469 LAT 15 2 LON 24 24

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	19.7	19.7	19.7	20.2	20.8	21.9	22.4	23.5	24.1	24.1	23.0	21.3	21.7
MEAN PREC	18.	3.	0.	1.	0.	2.	62.	236.	254.	222.	72.	45.	915.
DEP PREC	0.	0.	0.	0.	0.	0.	10.	123.	135.	114.	17.	0.	596.
POT ET	120.	125.	160.	173.	183.	176.	162.	152.	154.	151.	134.	109.	1800.
ET DEF	120.	125.	159.	173.	183.	176.	151.	29.	19.	36.	109.	109.	1203.
MAI	.00	.00	.00	.00	.00	.00	.06	.81	.89	.76	.13	.00	.33

TABLE 1 POTENTIAL ET (ETP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

COVA FICUEIRA YRS 20 ELEV 458 LAT 14 53 LON 24 18

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	19.7	19.7	19.7	20.3	20.3	21.9	22.5	23.6	24.2	24.2	23.1	21.4	21.8
MEAN PREC	14.	3.	0.	0.	0.	1.	24.	103.	100.	34.	44.	57.	440.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	37.	35.	31.	0.	7.	240.
POT ET	120.	126.	163.	179.	184.	176.	162.	152.	154.	151.	125.	103.	1802.
ET DEF	120.	129.	163.	179.	184.	176.	162.	119.	119.	120.	125.	101.	1562.
MAI	.00	.00	.00	.00	.00	.00	.00	.24	.23	.21	.00	.06	.13

CURRALINHO YRS 20 ELEV 949 LAT 15 2 LON 23 38

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	17.0	17.0	17.0	17.6	18.1	19.3	19.8	20.9	21.5	21.5	20.4	18.7	19.1
MEAN PREC	19.	9.	7.	0.	0.	14.	43.	220.	315.	150.	72.	29.	874.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	113.	175.	68.	17.	0.	565.
POT ET	111.	116.	156.	165.	171.	164.	151.	141.	144.	141.	116.	100.	1675.
ET DEF	111.	116.	156.	165.	171.	164.	151.	28.	-31.	73.	99.	100.	1110.
MAI	.00	.00	.00	.00	.00	.00	.00	.80	1.21	.48	.14	.00	.34

FETJOAL/MOSTEIROS YRS 20 ELEV 249 LAT 15 2 LON 24 20

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	20.9	20.9	20.9	21.4	22.0	23.1	23.6	24.7	25.3	25.3	24.2	22.5	22.9
MEAN PREC	11.	2.	1.	0.	0.	1.	36.	125.	148.	101.	122.	46.	593.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	51.	66.	36.	49.	0.	355.
POT ET	124.	130.	173.	183.	189.	181.	167.	150.	159.	155.	128.	111.	1956.
ET DEF	124.	130.	173.	183.	189.	181.	167.	105.	92.	119.	79.	111.	1501.
MAI	.00	.00	.00	.00	.00	.00	.00	.33	.42	.23	.38	.00	.19

TABLE 1 POTENTIAL ET (CTP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

FUNDO DE FIGUEIRAS — YRS 15 ELEV 200 LAT 16 8 LON 22 44

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	21.1	21.1	21.1	21.7	22.2	23.4	23.9	25.0	25.5	25.6	24.5	22.8	23.2
MEAN PREC	0.	2.	0.	0.	0.	0.	4.	13.	22.	30.	15.	8.	99.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
POT ET	125.	130.	175.	185.	191.	192.	188.	157.	160.	156.	129.	112.	1869.
ET DEF	125.	130.	175.	185.	191.	192.	188.	157.	160.	156.	129.	112.	1869.
MAI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

EUPNA — YRS 20 ELEV 14 LAT 14 53 LON 24 41

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	22.1	22.1	22.1	22.7	23.3	24.4	24.9	26.0	26.6	26.6	25.5	23.9	24.2
MEAN PREC	5.	2.	0.	0.	0.	0.	4.	63.	62.	55.	22.	13.	231.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	14.	10.	6.	0.	0.	84.
POT ET	128.	134.	179.	190.	196.	197.	172.	161.	164.	160.	132.	115.	1918.
ET DEF	128.	134.	179.	190.	196.	197.	172.	147.	153.	154.	132.	115.	1934.
MAI	.00	.00	.00	.00	.00	.00	.00	.09	.06	.04	.00	.00	.04

GALINHEIRO — YRS 16 ELEV 409 LAT 15 0 LON 24 27

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	20.0	20.0	20.0	20.5	21.1	22.2	22.9	23.9	24.4	24.4	23.3	21.7	22.0
MEAN PREC	9.	3.	0.	0.	0.	2.	55.	210.	222.	119.	38.	19.	677.
DEP PREC	0.	0.	0.	0.	0.	0.	6.	107.	114.	47.	0.	0.	418.
POT ET	121.	127.	169.	179.	185.	177.	163.	153.	155.	152.	125.	109.	1815.
ET DEF	121.	127.	169.	179.	185.	177.	157.	46.	41.	104.	125.	109.	1397.
MAI	.00	.00	.00	.00	.00	.00	.04	.70	.74	.31	.00	.00	.23

TABLE 1 POTENTIAL ET (ETP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

MINDELO YRS 30 ELEV 20 LAT 16 53 LON 25 0

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	21.4	21.4	21.6	22.1	22.7	23.6	24.3	25.3	26.4	26.0	24.3	23.0	23.6
MEAN PREC	3.	5.	1.	0.	0.	0.	3.	20.	39.	30.	19.	9.	128.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
POT ET	120.	129.	176.	180.	189.	188.	178.	165.	167.	154.	128.	111.	1902.
ET DEF	120.	129.	176.	180.	189.	188.	178.	165.	167.	154.	128.	111.	1896.
MAI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

MONTE GRANDE YRS 10 ELEV 516 LAT 15 2 LON 24 21

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	19.4	19.4	19.4	20.0	20.5	21.6	22.2	23.3	23.8	23.9	22.7	21.1	21.4
MEAN PREC	0.	3.	0.	0.	0.	2.	8.	138.	106.	74.	21.	22.	374.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	60.	39.	18.	0.	0.	190.
POT ET	119.	124.	166.	177.	182.	174.	161.	150.	153.	150.	124.	107.	1787.
ET DEF	119.	124.	166.	177.	182.	174.	161.	91.	114.	132.	124.	107.	1597.
MAI	.00	.00	.00	.00	.00	.00	.00	.40	.25	.12	.00	.00	.11

MONTE PALHA YRS 16 ELEV 1415 LAT 14 57 LON 24 26

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	14.5	14.5	14.5	15.0	15.6	16.7	17.3	18.4	18.9	18.3	17.8	16.2	16.5
MEAN PREC	20.	3.	0.	0.	0.	3.	50.	217.	298.	108.	29.	34.	762.
DEP PREC	0.	0.	0.	0.	0.	0.	3.	111.	164.	40.	0.	0.	481.
POT ET	103.	109.	144.	153.	158.	152.	140.	132.	134.	131.	108.	93.	1558.
ET DEF	103.	103.	144.	153.	158.	152.	139.	21.	-29.	91.	108.	87.	1075.
MAI	.00	.00	.00	.00	.00	.00	.02	.84	1.22	.31	.00	.00	.31

TABLE 1 POTENTIAL ET (ETP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

MONTE VELHA — YRS 18 ELEV 1299 LAT 15 0 LON 24 22

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	16.3	16.6	18.4	20.4	22.5	22.8	19.5	19.1	19.4	19.4	17.9	15.6	18.9
MEAN PREC	70.	20.	4.	2.	0.	3.	54.	215.	191.	654.	244.	149.	1612.
DEP PREC	15.	0.	0.	0.	0.	0.	5.	110.	84.	395.	129.	67.	1113.
POT ET	109.	115.	162.	178.	192.	180.	145.	135.	136.	133.	108.	91.	1585.
ET DEF	93.	115.	162.	178.	192.	180.	140.	25.	42.	-262.	-20.	24.	565.
MAI	.14	.00	.00	.00	.00	.00	.04	.81	.69	2.97	1.13	.73	.66

PASSAGEM — YRS 20 ELEV 340 LAT 17 8 LON 25 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	20.4	20.4	20.4	20.9	21.5	22.6	23.1	24.3	24.8	24.8	23.7	22.0	22.4
MEAN PREC	29.	10.	12.	1.	0.	0.	24.	148.	174.	105.	71.	71.	645.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	66.	33.	38.	16.	16.	394.
POT ET	122.	128.	171.	181.	187.	179.	164.	154.	157.	153.	127.	110.	1933.
ET DEF	122.	128.	171.	181.	187.	179.	164.	88.	74.	115.	110.	34.	1439.
MAI	.00	.00	.00	.00	.00	.00	.00	.43	.53	.25	.13	.15	.21

PATIM — YRS 16 ELEV 551 LAT 14 52 LON 24 26

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	19.2	19.2	19.2	19.8	20.3	21.4	22.0	23.1	23.7	23.7	22.5	20.9	21.2
MEAN PREC	0.	2.	0.	0.	0.	0.	10.	84.	77.	54.	13.	9.	248.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	25.	20.	5.	0.	0.	96.
POT ET	113.	124.	166.	175.	181.	173.	160.	150.	153.	143.	123.	106.	1778.
ET DEF	118.	124.	166.	175.	181.	173.	160.	125.	132.	144.	123.	106.	1582.
MAI	.00	.00	.00	.00	.00	.00	.00	.16	.13	.03	.00	.00	.05

TABLE 1 POTENTIAL ET (ETP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

PICOS — YRS 16 ELEV 406 LAT 15 5 LON 23 39

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	20.0	20.0	20.0	20.6	21.1	22.2	22.8	23.9	24.4	24.4	23.3	21.7	22.0
MEAN PREC	12.	0.	0.	0.	0.	2.	25.	146.	186.	151.	50.	8.	580.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	65.	91.	69.	3.	0.	345.
POT ET	121.	127.	169.	179.	185.	177.	163.	153.	155.	152.	125.	109.	1816.
ET DEF	121.	127.	169.	179.	185.	177.	163.	88.	65.	34.	123.	109.	1471.
MAI	.00	.00	.00	.00	.00	.00	.00	.42	.59	.45	.02	.00	.19

PONTA DO SOL — YRS 21 ELEV 15 LAT 17 12 LON 25 6

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	21.4	21.2	21.6	22.0	22.9	23.6	24.4	25.5	26.0	25.9	24.5	22.6	23.5
MEAN PREC	2.	7.	8.	1.	0.	0.	1.	33.	60.	49.	39.	20.	226.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	0.	9.	2.	0.	0.	90.
POT ET	125.	131.	177.	187.	194.	184.	170.	159.	161.	157.	129.	111.	1985.
ET DEF	125.	131.	177.	187.	194.	194.	170.	159.	152.	155.	129.	111.	1905.
MAI	.00	.00	.00	.00	.00	.00	.00	.00	.06	.01	.00	.00	.04

POVOACAO VELHA — YRS 15 ELEV 84 LAT 16 2 LON 22 55

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	21.9	21.9	21.8	22.3	22.9	24.0	24.5	25.7	26.2	26.2	25.1	23.4	23.8
MEAN PREC	0.	1.	0.	0.	0.	0.	4.	42.	39.	40.	5.	13.	144.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	18.
POT ET	127.	133.	178.	188.	194.	185.	170.	160.	162.	158.	131.	114.	1900.
ET DEF	127.	133.	178.	188.	194.	185.	170.	160.	162.	158.	131.	114.	1982.
MAI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01

TABLE 1 POTENTIAL ET (ETP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

PRAIA — YRS 20 ELEV 34 LAT 14 54 LON 23 31

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	22.4	22.2	22.9	23.4	24.0	24.9	25.4	26.2	26.8	26.4	25.4	23.4	24.4
MEAN PREC	2.	2.	0.	0.	0.	0.	0.	45.	105.	58.	30.	10.	260.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	0.	38.	8.	0.	0.	105.
POT ET	134.	138.	184.	192.	193.	184.	186.	157.	143.	163.	134.	115.	1920.
ET DEF	134.	138.	184.	192.	193.	184.	186.	157.	121.	155.	134.	115.	1815.
MAI	.00	.00	.00	.00	.00	.00	.00	.00	.24	.05	.00	.00	.05

PRAIA — YRS 20 ELEV 24 LAT 16 34 LON 24 17

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	22.0	21.8	22.2	22.6	23.2	23.8	24.9	25.9	26.6	26.4	25.0	23.0	23.9
MEAN PREC	4.	4.	0.	2.	0.	0.	2.	29.	41.	18.	9.	9.	118.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
POT ET	128.	133.	180.	189.	195.	184.	171.	160.	164.	159.	131.	112.	1307.
ET DEF	128.	133.	180.	189.	195.	184.	171.	160.	164.	159.	131.	112.	1907.
MAI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

SAL-REI — YRS 30 ELEV 9 LAT 16 11 LON 22 55

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	22.0	21.9	22.3	22.9	23.4	24.3	25.4	26.4	27.2	26.6	25.0	23.1	24.2
MEAN PREC	1.	2.	0.	0.	0.	6.	3.	71.	61.	57.	38.	56.	289.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	18.	10.	7.	0.	3.	127.
POT ET	128.	133.	180.	191.	196.	187.	174.	162.	166.	160.	131.	113.	1920.
ET DEF	123.	133.	180.	191.	196.	187.	174.	146.	157.	153.	131.	110.	1793.
MAI	.00	.00	.00	.00	.00	.00	.00	.10	.05	.04	.00	.02	.07

TABLE 1 POTENTIAL ET (ETP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

SAN JORGE OPGAOS YRS 20 ELEV 318 LAT 15 3 LON 23 37

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	20.2	20.2	20.6	21.0	21.3	23.0	23.2	24.0	24.0	23.6	21.6	20.8	22.0
MEAN PREC	10.	4.	1.	0.	0.	2.	36.	149.	233.	131.	86.	27.	739.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	67.	121.	94.	26.	0.	464.
POT ET	122.	127.	172.	182.	189.	181.	165.	153.	154.	149.	120.	106.	1819.
ET DEF	122.	127.	172.	182.	189.	191.	165.	86.	32.	55.	94.	106.	1354.
MAI	.00	.00	.00	.00	.00	.00	.00	.44	.79	.63	.22	.00	.26

SANTA CATARINA YRS 20 ELEV 554 LAT 15 5 LON 23 41

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	17.5	17.4	18.3	19.0	19.8	20.6	21.3	22.0	22.2	21.8	20.6	18.5	19.9
MEAN PREC	10.	3.	0.	0.	0.	0.	29.	154.	236.	183.	53.	15.	693.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	70.	123.	89.	11.	0.	429.
POT ET	113.	118.	161.	172.	178.	170.	157.	146.	147.	142.	117.	100.	1720.
ET DEF	113.	118.	161.	172.	178.	170.	157.	76.	24.	53.	106.	100.	1290.
MAI	.00	.00	.00	.00	.00	.00	.00	.48	.84	.63	.09	.00	.25

SANTA MARIA YRS 20 ELEV 6 LAT 16 36 LON 22 54

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	22.2	22.2	22.2	22.7	23.3	24.4	25.0	26.1	26.6	26.5	25.5	23.9	24.2
MEAN PREC	0.	0.	0.	0.	0.	0.	1.	15.	26.	12.	11.	2.	67.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
POT ET	128.	134.	180.	190.	196.	187.	172.	161.	164.	160.	133.	115.	1920.
ET DEF	128.	134.	180.	190.	196.	187.	172.	161.	164.	160.	133.	115.	1920.
MAI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

TABLE 1 POTENTIAL ET (ETP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

S DOMINGOS — YRS 18 ELEV 314 LAT 15 2 LON 23 34

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	20.5	20.5	20.5	21.1	21.6	22.7	23.3	24.4	25.0	25.0	23.8	22.2	22.5
MEAN PREC	7.	0.	1.	0.	0.	1.	17.	115.	165.	88.	38.	12.	444.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	45.	77.	27.	0.	0.	243.
POT ET	123.	128.	172.	182.	187.	180.	165.	155.	157.	154.	127.	110.	1939.
ET DEF	123.	128.	172.	182.	187.	180.	165.	110.	80.	126.	127.	110.	1596.
MAI	.00	.00	.00	.00	.00	.00	.00	.29	.49	.18	.00	.00	.13

S DOMINGOS/TONGON — YRS 16 ELEV 407 LAT 14 55 LON 24 29

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	20.0	20.0	20.0	20.6	21.1	22.2	22.8	23.9	24.4	24.4	23.3	21.7	22.0
MEAN PREC	1.	2.	0.	0.	0.	0.	9.	118.	125.	47.	16.	17.	335.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	47.	51.	0.	0.	0.	161.
POT ET	121.	127.	169.	179.	185.	177.	163.	153.	155.	152.	125.	109.	1916.
ET DEF	121.	127.	169.	179.	185.	177.	163.	106.	104.	152.	125.	109.	1655.
MAI	.00	.00	.00	.00	.00	.00	.00	.31	.33	.00	.00	.00	.09

SAO FELIPE — YRS 30 ELEV 59 LAT 14 53 LON 24 31

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	23.0	22.8	23.2	23.6	24.2	24.9	25.6	26.4	26.8	27.0	25.9	24.1	24.8
MEAN PREC	2.	1.	0.	0.	0.	0.	4.	58.	76.	34.	19.	8.	202.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	8.	19.	0.	0.	0.	61.
POT ET	131.	136.	184.	194.	201.	189.	175.	162.	164.	161.	134.	116.	1948.
ET DEF	131.	136.	184.	194.	201.	189.	175.	155.	145.	161.	134.	116.	1886.
MAI	.00	.00	.00	.00	.00	.00	.00	.05	.12	.00	.00	.00	.03

TABLE 1 POTENTIAL ET (ETP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

SERRA DA MALAGUETA YRS 20 ELEV 849 LAT 15 11 LON 23 53

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	17.8	18.0	19.2	19.9	20.7	20.3	20.1	20.5	21.3	20.7	19.8	18.6	19.7
MEAN PREC	17.	5.	0.	0.	1.	2.	64.	251.	357.	261.	75.	26.	1053.
DEP PREC	0.	0.	0.	0.	0.	0.	12.	133.	202.	140.	19.	0.	704.
POT ET	114.	120.	156.	176.	183.	168.	152.	140.	143.	138.	114.	100.	1714.
ET DEF	114.	120.	160.	176.	183.	168.	140.	7.	-59.	-2.	35.	100.	1010.
MAI	.00	.00	.00	.00	.00	.00	.08	.35	1.41	1.01	.16	.00	.41

TARRAFAL YRS 20 ELEV 9 LAT 16 57 LON 25 19

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	25.8	24.4	24.8	25.2	26.2	27.3	27.7	28.5	28.5	29.9	28.8	27.1	27.0
MEAN PREC	6.	5.	3.	1.	0.	1.	1.	17.	29.	8.	6.	5.	82.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
POT ET	140.	142.	132.	202.	210.	201.	184.	170.	171.	172.	143.	124.	2051.
ET DEF	140.	142.	132.	202.	210.	201.	184.	170.	171.	172.	143.	124.	2051.
MAI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

TRINDADE YRS 20 ELEV 279 LAT 14 57 LON 23 34

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	21.9	22.6	22.9	23.4	23.8	24.4	24.2	24.3	24.6	24.7	23.6	22.3	23.5
MEAN PREC	4.	1.	0.	0.	0.	1.	9.	65.	119.	89.	34.	10.	332.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	12.	47.	28.	0.	0.	159.
POT ET	127.	136.	133.	133.	138.	137.	139.	154.	156.	153.	126.	110.	1893.
ET DEF	127.	136.	133.	133.	138.	137.	139.	142.	109.	125.	126.	110.	1734.
MAI	.00	.00	.00	.00	.00	.00	.00	.03	.30	.19	.00	.00	.08

TABLE 1 POTENTIAL ET (ETP) AND MOISTURE AVAILABILITY INDICES FOR THE CAPE VERDE ISLANDS

VILA NOVA SINTRA — YRS 20 ELEV 489 LAT 14 52 LON 24 42

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	18.3	18.0	18.6	19.2	19.9	20.4	21.2	22.1	22.6	22.2	21.2	19.4	20.3
MEAN PREC	9.	5.	0.	0.	0.	3.	25.	137.	136.	89.	66.	20.	490.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	59.	58.	28.	13.	0.	277.
POT ET	115.	120.	163.	173.	179.	169.	157.	145.	148.	144.	119.	102.	1734.
ET DEF	115.	120.	163.	173.	179.	169.	157.	87.	90.	116.	106.	102.	1457.
MAI	.00	.00	.00	.00	.00	.00	.00	.40	.39	.19	.11	.00	.16

VILA RIBEIRA BRAVA — YRS 16 ELEV 124 LAT 16 37 LON 24 18

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN TEMP	21.5	21.5	21.5	22.1	22.7	23.8	24.3	25.4	26.0	26.0	24.9	23.2	23.6
MEAN PREC	2.	6.	0.	0.	1.	0.	11.	73.	112.	61.	51.	23.	340.
DEP PREC	0.	0.	0.	0.	0.	0.	0.	17.	43.	10.	3.	0.	165.
POT ET	126.	132.	176.	187.	193.	184.	170.	159.	161.	159.	130.	113.	1989.
ET DEF	126.	132.	176.	187.	193.	184.	170.	141.	119.	148.	127.	113.	1724.
MAI	.00	.00	.00	.00	.00	.00	.00	.11	.27	.06	.02	.00	.09