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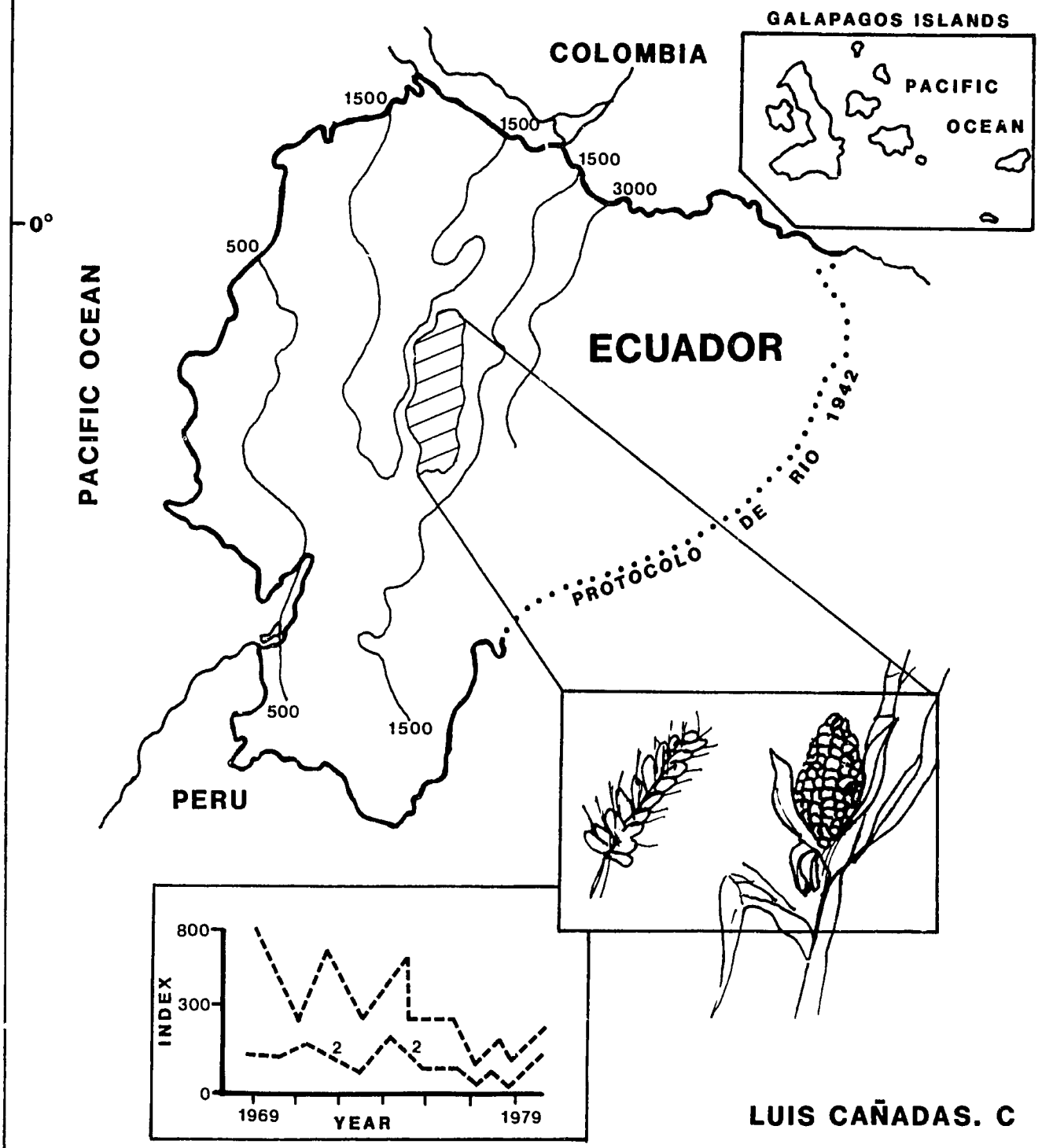
AGROMETEOROLOGICAL ASSESSMENT MODELS FOR RURAL DEVELOPMENT IN CENTRAL SIERRA OF ECUADOR



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FINAL REPORT

APRIL 1982

AGROMETEOROLOGICAL ASSESSMENT MODELS FOR RURAL DEVELOPMENT IN THE CENTRAL SIERRA OF ECUADOR:

Final Report

to

National Program for Agrarian Regionalization (PRONAREG)
Ministry of Agriculture
Quito, Ecuador

National Institute of Meteorology and Hydrology (INAMHI)
Ministry of Natural Resources and Energy
Quito, Ecuador

by

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for

Agency For International Development
Quito, Ecuador

Agency For International Development[2]
Office of U.S. Foreign Disaster Assistance
Washington, D.C.

U.S. National Oceanic and Atmospheric Administration
National Environmental Satellite, Data and Information Service
Center for Environmental Assessment Services
Washington, D.C. and Columbia, Missouri

APRIL, 1982

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[2] This project was sponsored by AID/OFDA under NOAA/AID PASA CC/OFDA-001-6-80 and conducted at NOAA/CEAS - Models Branch, Columbia, Missouri.

FORWARD

This report by Ing. Luis Canadas C., PRONAREG, Ministry of Agriculture and Ing. Hector Salvador C., INAMHI, Ministry of National Resources and Energy, Quito, Ecuador is the result of an intensive six week Orientation Program on Agroclimatic Models and Climatic Impact Assessment Technology. This program was conducted in Columbia, Missouri by the Models Branch of the Center for Environmental Assessment Services (CEAS). As an organization within the U.S National Oceanic and Atmospheric Administration/ Environmental Satellite-Data and Information Service, CEAS is responsible for using current and historical environmental data to provide timely decision assistance to managers of critical national resources by assessing the impacts of climatic variations on food, transportation, health, energy and the economy.

The agroclimatic assessment models developed by Senor Canadas and Senor Salvador for the Central Sierra region in Ecuador can be used as the scientific foundation for planning, organizing and implementing a regional climatic impact assessment program. The data and technical resources for such a program already exist in Ecuador. However, support is needed to establish the regional project so the economic benefits and value can be demonstrated to decision makers. A successful regional project can lead to a national program.

This project was sponsored by the Agency for International Development, Office of U.S. Foreign Disaster Assistance, (AID/OFDA), Washington, D.C. It was conducted by CEAS under a NOAA/AID project agreement. The basic goal is to transfer agroclimatic modeling and assessment technology to developing countries and to encourage the development of an in-country program. This technology can improve food security by increasing disaster preparedness and early warning, contributing to land use planning for agricultural and rural development, and mitigating socioeconomic vulnerability to climatic extremes including drought, flooding and frost. The current project focused on Peru and Ecuador. NOAA/AID Projects are also underway for technology transfer to other countries in Latin America and in Southern Asia.

CEAS received assistance through NOAA subcontracts to the Atmospheric Science Department, University of Missouri - Columbia and the Aspen Institute/Food and Climate Forum, Boulder, Colorado. Their contributions are appreciated.

It was a pleasure for us to work with Senor Canadas and Senor Salvador during their visit to CEAS. Their professional dedication and long hours of hard work were responsible for the results in this project report.

Louis T. Steyaert
Project Leader
NOAA/NESDIS/CEAS

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This five week technical orientation program was sponsored by the Agency for International Development, Office of U.S. Foreign Disaster Assistance (AID/OFDA), and conducted by the U.S National Oceanic and Atmospheric Administration, National Environmental Satellite, Data and Information Service, Center for Environmental Assessment Services, (NOAA/NESDIS/CEAS)-Models Branch, Columbia, Missouri, at the request of the Government of Ecuador. The authors wish to thank these agencies for funding and support.

Dr. Louis T. Steyaert, Research Meteorologist and Project Coordinator AID/NOAA Projects, CEAS/CIAD Models Branch, was the leader of this training program and the Agroclimatic Modeling and Climatic Impact Assessment technology transfer project. Dr. Clarence Sakamoto, Chief, CEAS/CIAD Models Branch provided expertise in agricultural meteorology, helpful suggestions and administrative support. Dr. Andres Ravelo, Research Associate, Atmospheric Science Department University of Missouri-Columbia (UMC), assisted in the program and interpretation of results. Their dedication, support and enthusiasm enabled the authors to successfully accomplish the training program.

The authors wish to thank the following individuals for their valuable help in making this report possible: Jerry Wright, UMC, drafted the figures and designed the cover. Rita Terry, NOAA, and Carlos Turc, UMC, edited the English version of this report. Joan Darkow and Lydia Lu, UMC, assisted in data base preparation. Susan Conrad, UMC and Carol Denton, NOAA, typed the report.

Dr. David Cusack, Aspen Institute/Food and Climate Forum and more recently Sierra Blanca Associates, Boulder, Colorado, assisted CEAS in data acquisition, travel and liaison.

EXECUTIVE SUMMARY

AGROMETEOROLOGICAL ASSESSMENT MODELS FOR RURAL DEVELOPMENT IN THE CENTRAL SIERRA OF ECUADOR

Luis Canadas C. and Hector E. Salvador C.

The agriculturally oriented economy of the Central Sierra of Ecuador is highly vulnerable to annual variations in climate. Severe drought, such as in the late 1970's, and occasional frost or flooding can lead to crop failures and economic losses. This vulnerability to climatic extremes is frequently compounded by other complex factors, including population pressure, deforestation and soil erosion. The expansion of rainfed agriculture into marginal lands, which usually require irrigation of crops, also contributes to climate vulnerability.

Increasing the level of agricultural production and reducing losses due to anomalous climatic conditions can be both economically and socially beneficial. Current programs to improve the socioeconomic conditions of the rural population can benefit from agroclimatic studies. Also, significant year-to-year variations in seasonal rainfall can be expected to continue and to be a dominant factor in determining the level of food production. Thus, climatic conditions represent important indicators of food supply and general socioeconomic conditions.

The Agroclimatic Analysis Program of Ecuador is supported by the Instituto Nacional de Meteorologia e Hidrologia (INAMHI), the Programa Nacional de Regionalizacion Agraria (PRONAREG) and Consejo Nacional de Desarrollo (CONADE). One component of this program involves training in agroclimatic modeling and climatic impact assessment procedures towards development of a regional and then a national Climatic Impact Assessment Program. This report for the Central Sierra should be viewed as a status report, as some analysis still needs to be

completed. However, it does describe the development of models and assessment procedures to support the Agroclimatic Analysis Program. It is designed to serve as a working document for assessment procedures in Ecuador and implementation of the Program in Ecuador.

The main objectives accomplished during this training include:

1) Development and quality control of meteorological and agronomic data bases to systematically study the climate and support agroclimatic modeling applications in the Central Sierra.

2) Development of practical agroclimatic models and techniques appropriate for the Central Sierra and including crop calendars, water supply-demand relationships, climate/crop condition indices, relative crop production indices and crop water requirements for assessing potential subsistence food shortages due to drought, contributing to land use studies, and providing irrigation advisories to farmers.

3) Development of expertise in climatic data, modeling and assessment applications to support the technical development of the program in Ecuador and to advise decision makers on the capabilities and limitations of these results.

The authors suggest that the results of this study have important implications to decision makers and planners involved with agricultural and rural development programs in the Central Sierra and other regions of Ecuador. These results support implementation of the Agroclimatic Analysis Program by using historic climatic data to develop models which contribute to the agricultural crop forecast problem, land use studies and crop/weather advisories for farmers.

This report is divided into eight chapters. Chapters I and II provide the Introduction and Agroclimatic Background Information for Ecuador and particularly the Central Sierra. The physical environment, climate, agricultural practices and social-agroclimatic conditions are described. Chapter III provides the methodology, data and various agroclimatic tools. These include methods for estimating potential evapotranspiration (a critically important tool for land use studies), soil moisture, the Palmer Drought Index (a potentially useful index of general drought impact on agriculture in Ecuador), crop coefficients (used to develop agroclimatic/crop condition indices and also to compute the crop water requirements, necessary input to land use studies) and crop water requirement for crops in the Central Sierra. Several types of agroclimatic/crop condition indices to provide decision makers (policy makers, planners and economists) with early warning assessment of impending drought impact are discussed in Chapter IV. Background information on statistical crop yield modeling is provided in Chapter V. The modeling results are discussed in Chapter VI. These include potential evapotranspiration analysis, agroclimatic/crop condition indices, relative crop production indices, assessment tools and crop water requirement curves. Conclusions and recommendations are provided in Chapters VII and VIII, respectively. The Appendices are very important as they contain the complete data and results of modeling for each station in the Central Sierra.

AGROMETEOROLOGICAL ASSESSMENT MODELS FOR

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CHAPTER I

INTRODUCTION

The agriculturally oriented economy of the Central Sierra of Ecuador is highly vulnerable to annual variations in climate. Severe drought and occasional frost or flooding can lead to crop failures and economic losses. This vulnerability to climatic extremes is frequently compounded by other complex factors, including population pressure, deforestation and soil erosion. The expansion of rainfed agriculture into marginal lands which usually require irrigation of crops, also contributes to climate vulnerability.

Increasing the level of agricultural production and reducing losses due to anomalous climatic conditions can be both economically and socially beneficial. Current programs to improve the socioeconomic conditions of the rural population can benefit from agroclimatic studies. Also, significant year-to-year variations in seasonal rainfall can be expected to continue and to be a dominant factor in determining the level of food production. Thus, climatic conditions represent important indicators of food supply and general socioeconomic conditions.

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CHAPTER II

AGROCLIMATIC BACKGROUND

A. Ecuador

Physical Environment and Geography

Ecuador, an Andean country in South America, is bordered on the North by Colombia, on the South and East by Peru, and on the West by the Pacific Ocean. The total land area is 280,277 square kilometers and can be geographically divided into four natural regions: Sierra, Costa, Oriente and the Galapagos Islands (Figure 2.1). Administrative divisions are shown in Figure 2.2.

The giant Andes form the backbone of Ecuador extending North and South through the center of the country in approximately two parallel mountain ranges. The inter-mountain basins lie between the ranges. The altitude of these basins or valleys ranges between 2,000 and 3,000m. Immediately to the West of the high Sierra lies the coastal plain or the Costa, which consists of mangroves, lowlands and gentle rolling hills. The Oriente region lies to the east of the Sierra. The Oriente is quite remote and consists of tropical rain forest in the upper Amazon River Basin.

Climate

Since the topographical features are quite complex in Ecuador, climatic conditions are very diverse. The climate is also determined by the wind exposure in the Andes, the location of Ecuador on the equator, the Humboldt and the Nino ocean currents in the Pacific, and other local factors.

In general, there are only two annual seasons in the country: the "verano" or dry season, characterized by low rainfall and the "invierno" or rainy season.

PHYSICAL ENVIRONMENT IN ECUADOR

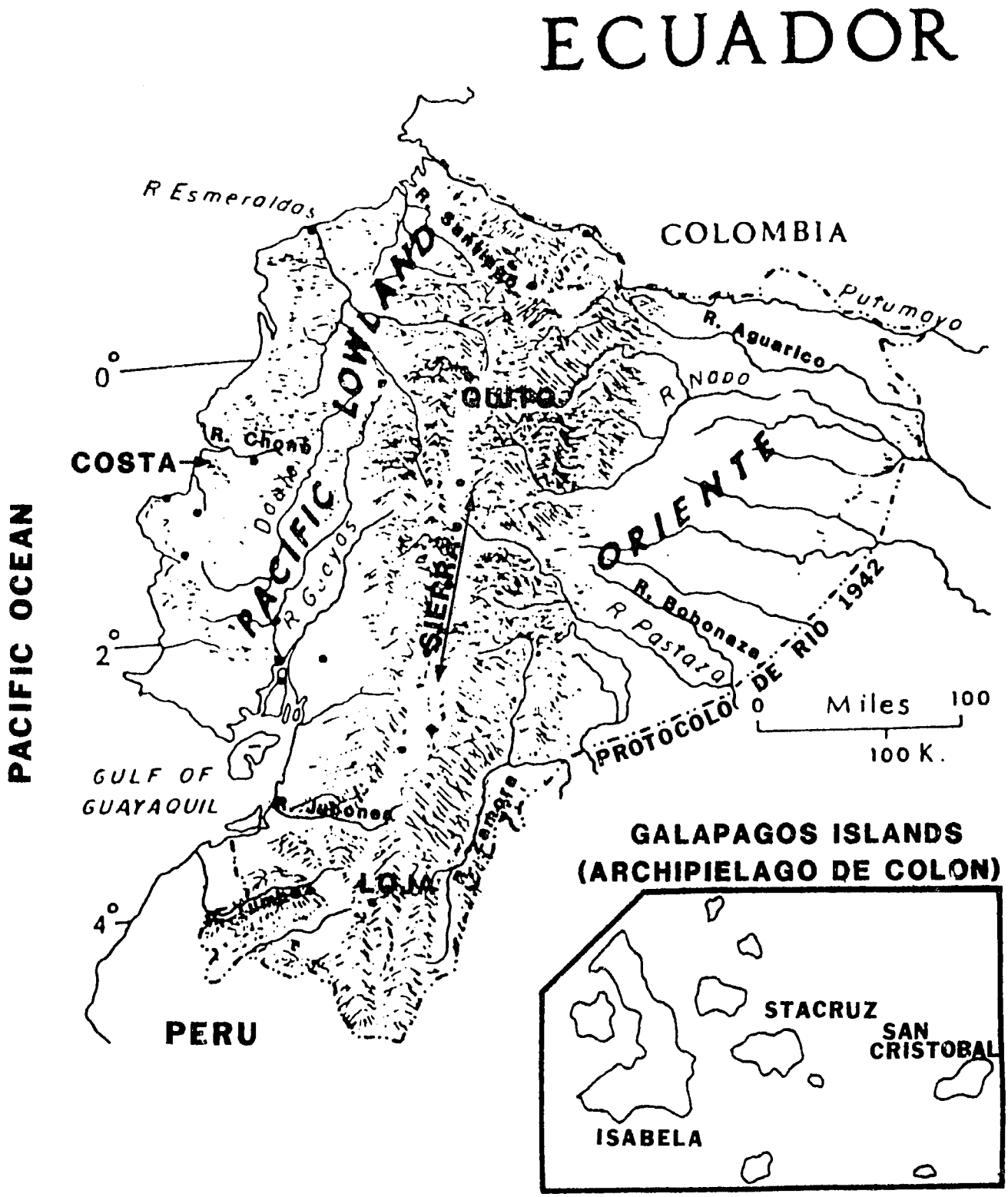

Figure 2. 1 Physical map of Ecuador

Figure 2. 2 Map. of Administrative Division in Ecuador

The seasonal distribution of rainfall during the year differs in the Costa, Sierra and Oriente regions. In the Costa, where "normal" temperature is between 24 and 26°C, the rainy season begins in December (Solstice) and ends in May, with maximum rainfall in April (Equinox). This is followed by the dry season that begins in June and lasts until mid-December. However, climatic conditions in the coastal plain range from wet/tropical rain forest conditions in the northwest to desert in the south. The annual rainfall ranges from 4,000 to only 80mm, respectively.

This contrasts with the Sierra, where the normal temperature ranges between 10 and 18°C, and the "Paramo", with temperatures below 10°C. In the Northern Hemisphere, the rainy season in the Sierra begins in October and continues through May with two peaks, the higher one after the Equinox of September and the lower one in the Equinox of March, followed by the dry season during the months of June, July, and August. In the Southern Hemisphere, the pattern is the same, although the peaks are the opposite, i.e., the highest maximum rainfall is in March and the lowest in September. The annual rainfall ranges between 300 and 3,000mm.

The average temperature in the Oriente Region ranges between 23 and 26°C. The rainfall is typically equatorial throughout the year, with a few months of less precipitation. It fluctuates between 3,000 and 6,250mm (Figure 2.3).

Agricultural Regions and Crops

The ecological conditions (climate and soils) of the three natural regions determine the distribution of crops. The main crops in the Costa are bananas, cacao, rice, coffee, cotton, sugarcane, soybeans, and oil palm. A wide variety of crops are grown in the Sierra: corn, potatoes, wheat, barley, tuber and roots (oca, melloco), lima beans, and some fruits. With the exception of tea,

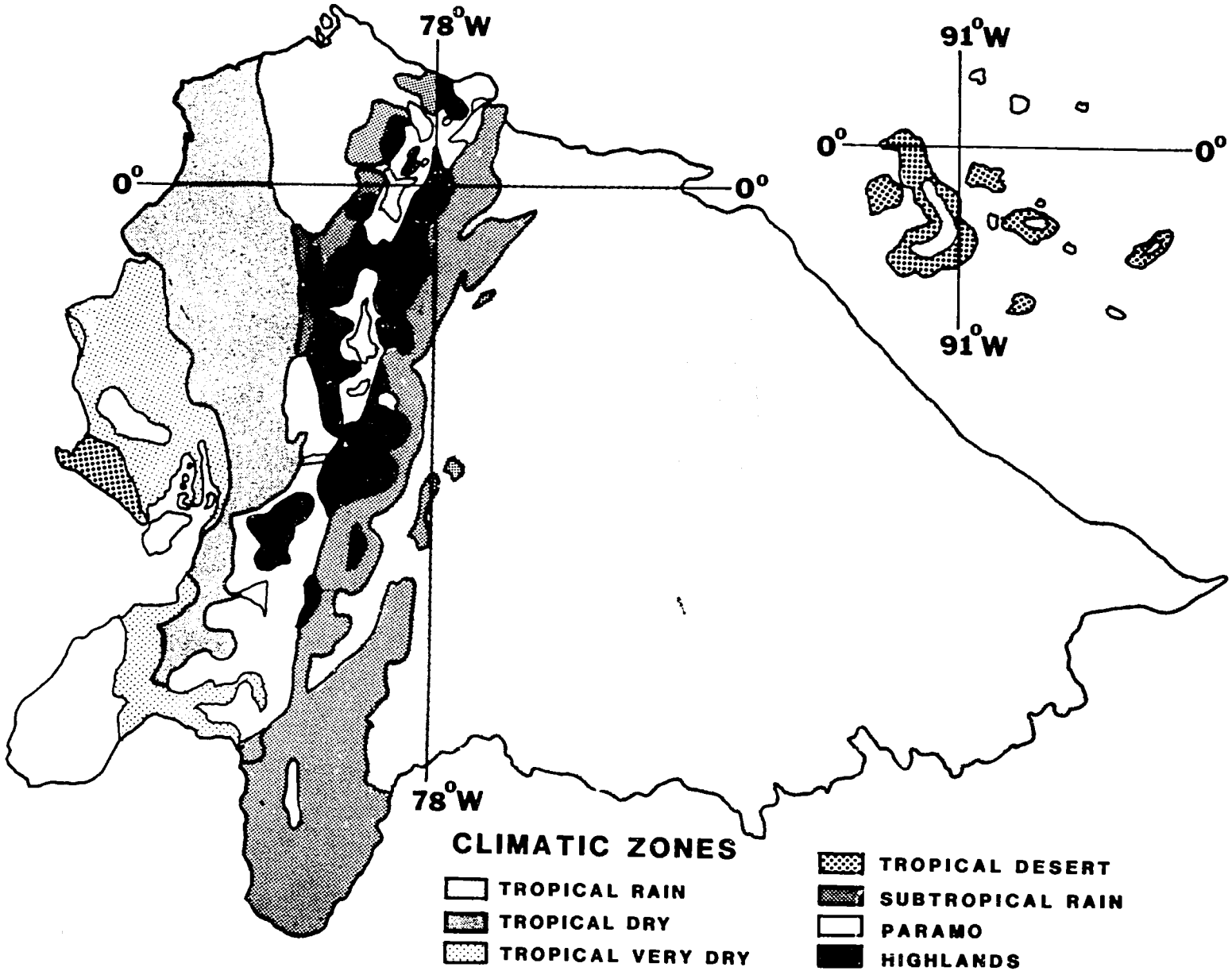

Figure 2. 3 Map of climatic zones in Ecuador

cincona and oil palm crops, the Oriente of Ecuador is agriculturally insignificant (Figure 2.4). Agricultural production can be generally classified as either "commercial" or "subsistance." Irrigation and improved technological practices are mainly available at the commercial level.

Climatic Impact on Agriculture

Each major geographic region has serious limitations to agricultural crop production under either rainfed or irrigated conditions. Because of the occasional or semi-permanent drought conditions in the coastal region, crops must be grown near irrigation sources, for example, along rivers. Expanded irrigation networks are required to increase cropland.

In recent years the coast has become more and more important as an agricultural region, but there are several physical factors which impede farming. In the huge Guayas Basin, heavy rains and runoff during the "invierno" create a flood plain in the entire basin, and inadequate facilities become a severe constraint to agricultural development.

Seasonal rainfall patterns are more favorable in the Sierra, but low temperatures as well as occasional droughts are also limiting factors. Thus, the success or failure of the crop growing season depends upon the beginning of the rainy season and the occurrence of sporadic drought and frost. In some areas, irrigation permits planting of some crops prior to the "normal" beginning of the rainy season.

In contrast, temperature and marginal rainfall are not limiting factors in the Oriente. Excess rainfall and the quality and depth of soils appear to be the factors which make this region less than ideal for agriculture. However, the Oriente presents a great potential for agricultural development if agricultural practices are consistent with environmental and soil conditions.

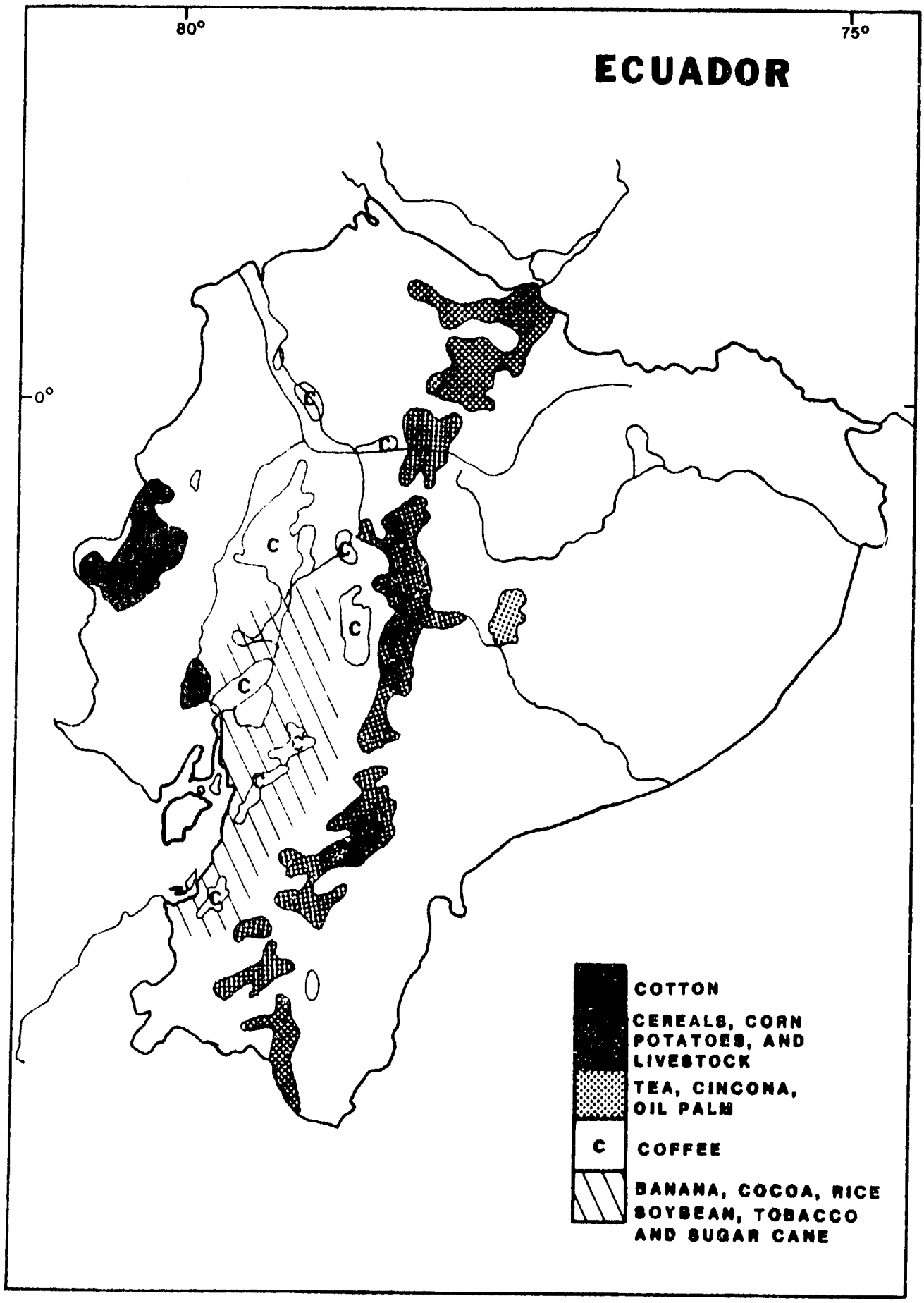

Figure 2. 4 Distribution of major commercial and subsistence crops in Ecuador

Figure 2.5 shows a rather simplified distribution of natural vegetation which reflects the diverse climatic conditions.

Importance of Agriculture to Ecuador

Agriculture contributes about 42 percent of the Gross Domestic Product in Ecuador and provides employment for approximately 56 percent of the national labor force. Ecuador has traditionally been an agricultural country. It is the world's major producer and exporter of bananas which, together with coffee and cacao, are the important cash crops for export. These crops are primarily grown on the coastal plain along with rice, sugarcane and soybeans. The traditional crops in the Sierra include: corn, potatoes, wheat, barley, and alfalfa. Most of these crops are either consumed by the farmers or sold to local markets. Table 2.1 shows the harvest area, the production and the production value of agriculture in Ecuador.

B. Central Sierra Area

1. Physical Environment

Geography/Topography

The Central Sierra area is located in the central part of the Andes in Ecuador, between 0°36' S and 2°00' S latitude and 78°31' W and 78°56' W longitude (Figure 2.6). The elevation varies from 2,000m on the valley floors to 6,675m (Chimborazo) in the highlands (Figure 2.6). The area planted to the main crops is about 234,277 hectares, equivalent to 11.6 percent of the country's total crop land.

Because of the Andes, there are different geographic configurations within the area, such as plateaus, valleys, and peaks, (Figure 2.7) causing microclimatic variations.

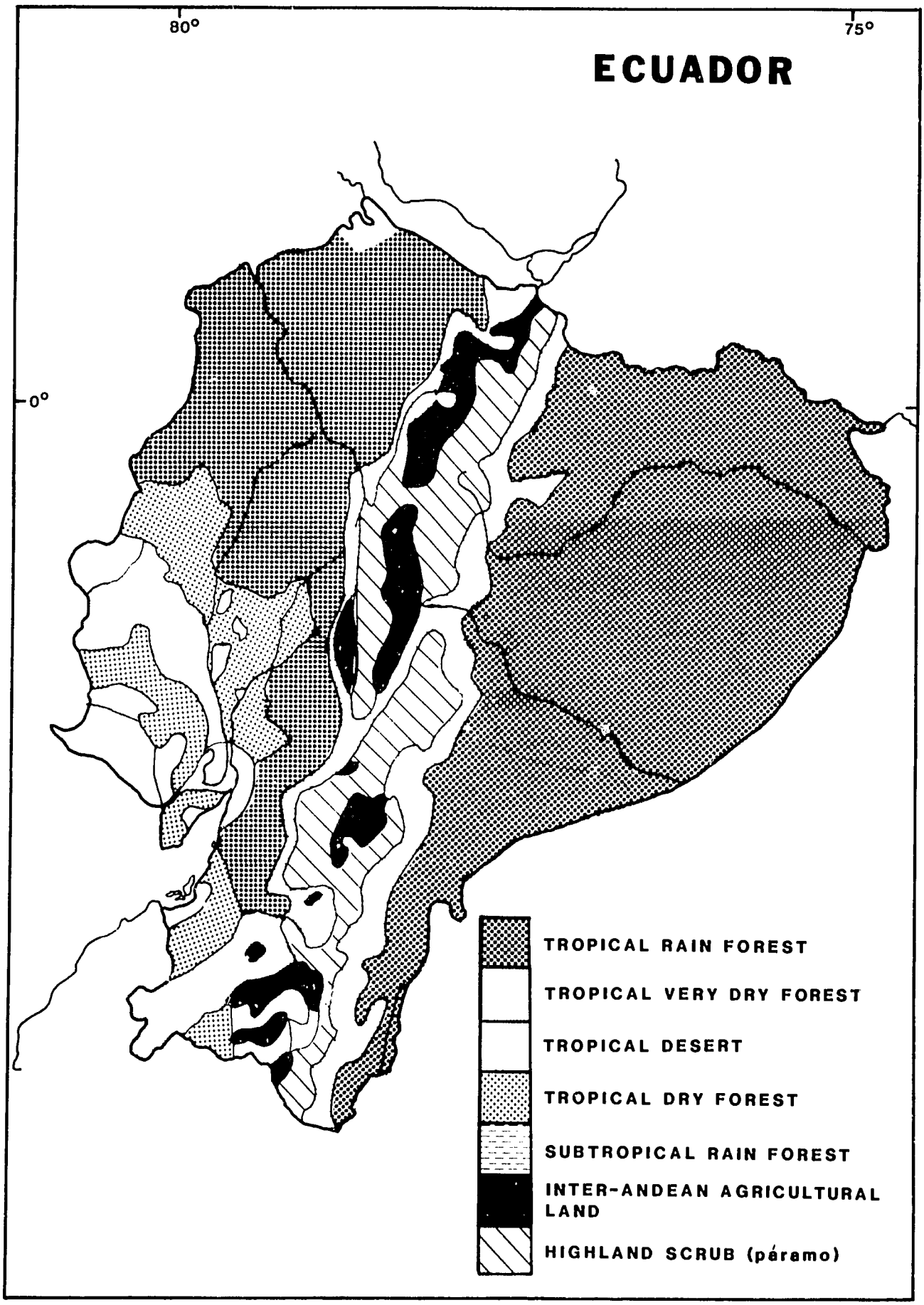

Figure 2. 5 Map of natural vegetation zones in Ecuador

TABLE 2.1

Harvest area, production and production value by natural region in Ecuador. (1975).

REGION	HARVEST AREA (has)	PRODUCTION (quintals)	PRODUCTION VALUE* (sucres)
Sierra	853,361.7	101,471,911	6,927,810,082
Costa	1,122,748.4	84,898,245	7,512,221,740
Oriente	47,023.9	6,409,650	297,649,906
Nacional	2,023,134.0	192,773,806	14,737,681,728

Source: Encuesta Agrosocioeconomica del Medio Rural Ecuatoriano, PRONAREG, MAG, QUITO, ECUADOR. 1975.
*one dollar = 40 sucres

Figure 2. 6 Geographic location of Central Sierra Area

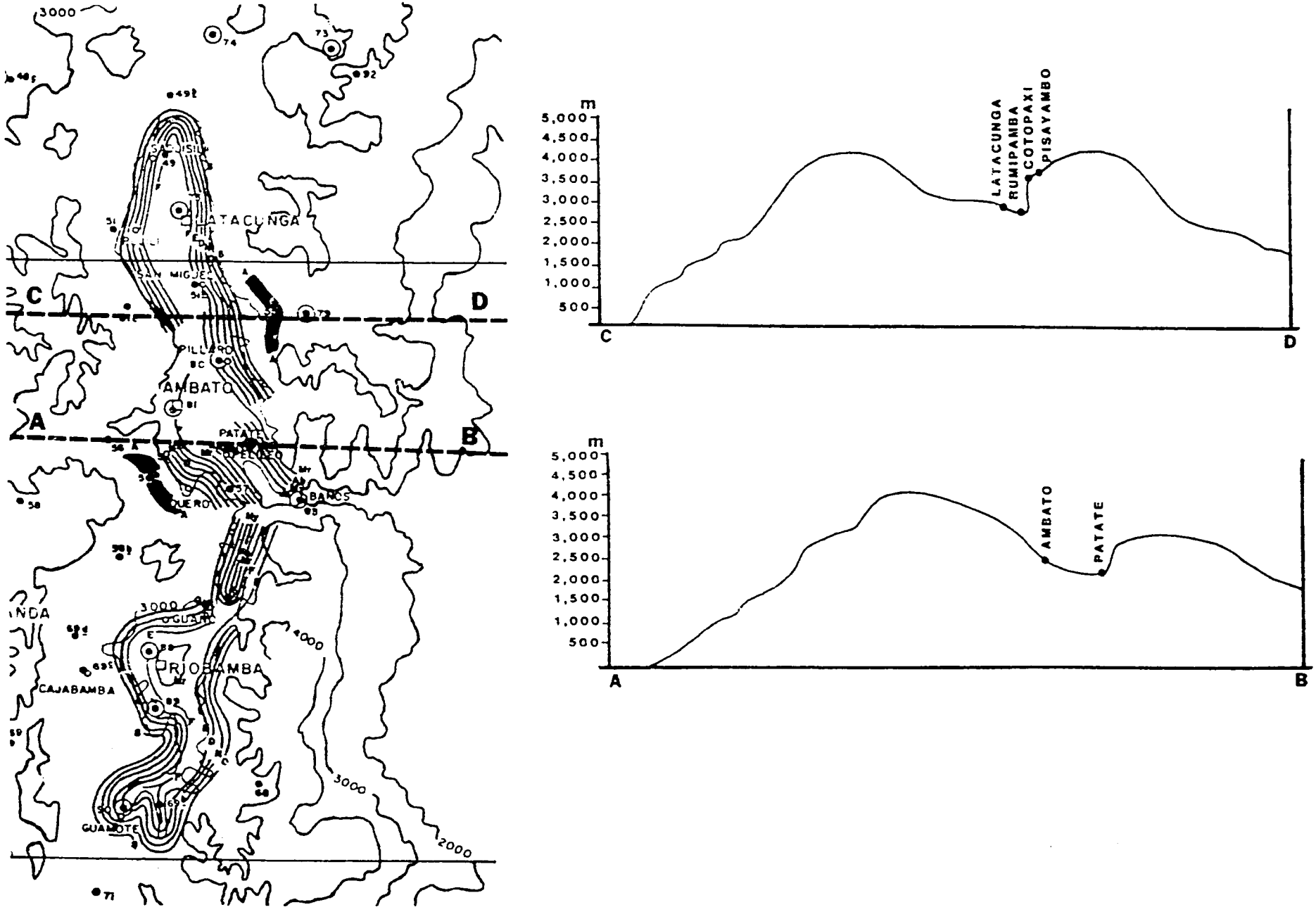

Figure 2. 7 Transect through Central Sierra Area

Climate

Figure 2.8 shows the stations which were used to build the data base for this study. The normal values of the temperature in the Central Sierra area range between 6.0°C (Pisayambo) and 15.9° C (Patate); the normal values of rainfall range between 399mm in Riobamba and 1,275mm in Pisayambo (see Figure 2.8a and 2.8b).

Soils

Most soils in the study area are derived from volcanic ash. The parent material between 2,500 - 3,500m is a thick deposit of hard volcanic ash called cangahua. At altitudes less than 2,500m, where it is drier, the slopes have been subjected to extreme water and wind erosion. The cangahua has been broken out and disintegrated. The soil is sandy, and the organic matter content is less than 1 percent (Psament-Orthens).

At higher altitudes, where moister conditions prevail, the cangahua is more intensively weathered and thoroughly disintegrated, forming a somewhat clay-silt (Durustoll) soil. A clay black soil, with an argilic horizon rich in organic matter (Duriodoll, Argiudoll), is found where rainfall increases with height. In some areas with gentle slopes (20 percent), the old cangahua has been covered by fresh volcanic ash. The soil is black, the organic matter is high (4-6 percent) and the soil is called Aplustoll or Hapludoll.

Finally, at 3,500m, under udic and perudic soil moisture content, one finds soils derived from volcanic ash with halofana material (Distrandeps-Hydrandeps).

Natural Vegetation

Since the pre-Colombian era, the indigenous population concentration has been largely in the study area. As a consequence, natural vegetation has been

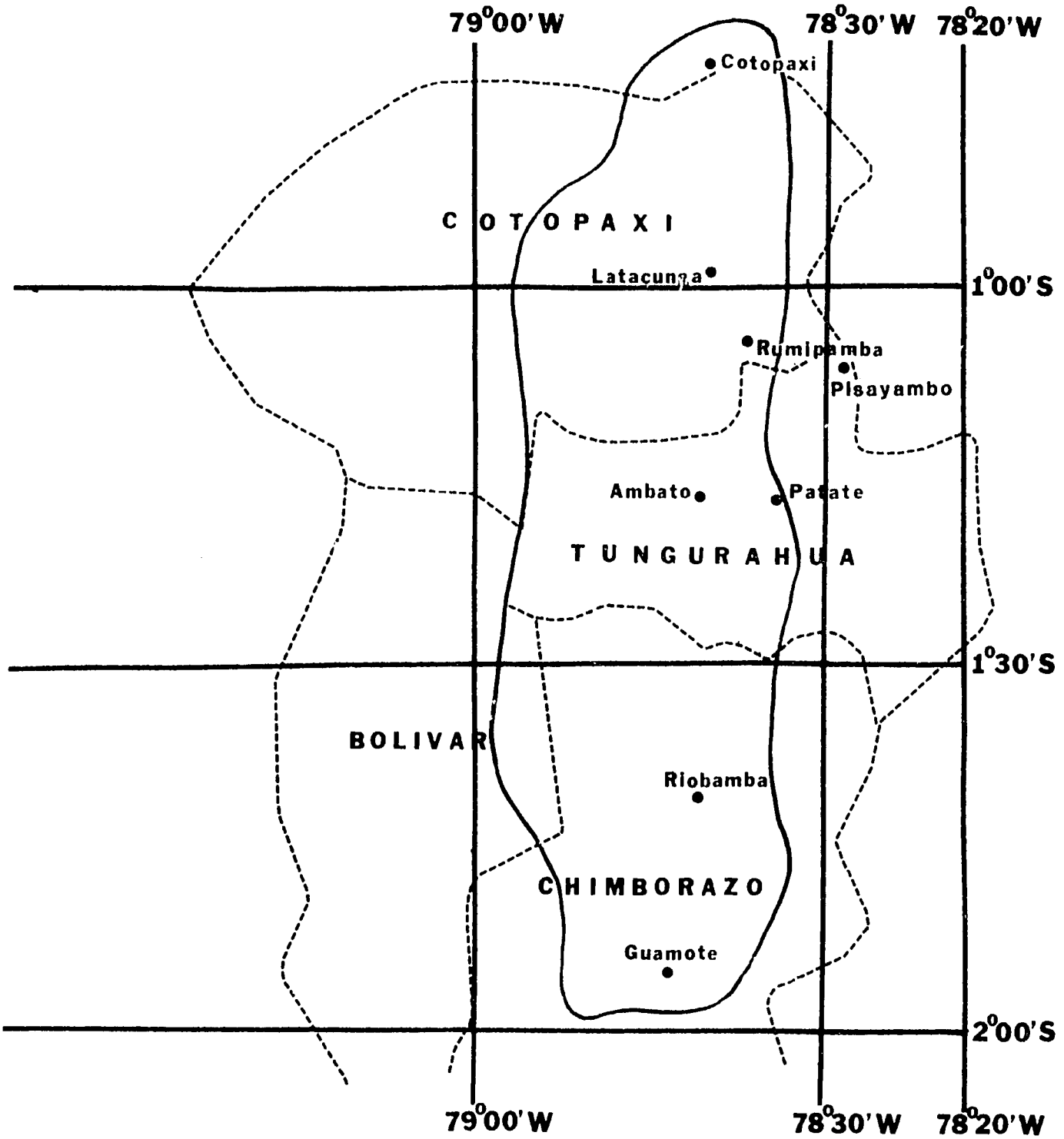

Figure 2. 8 Study Area and weather stations

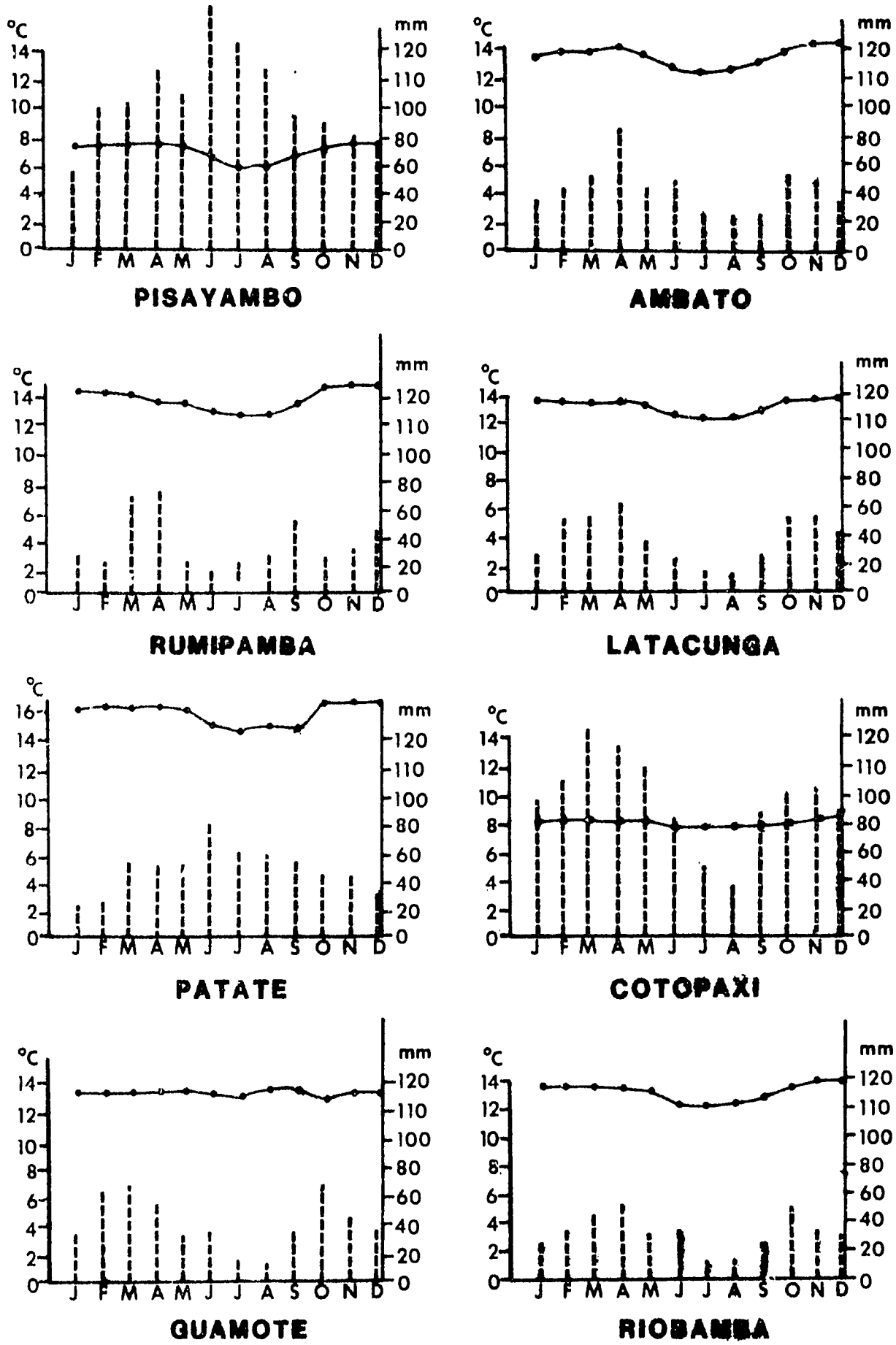

Figure 2.8a Monthly variation of air temperature and rainfall at eight stations in Central Sierra

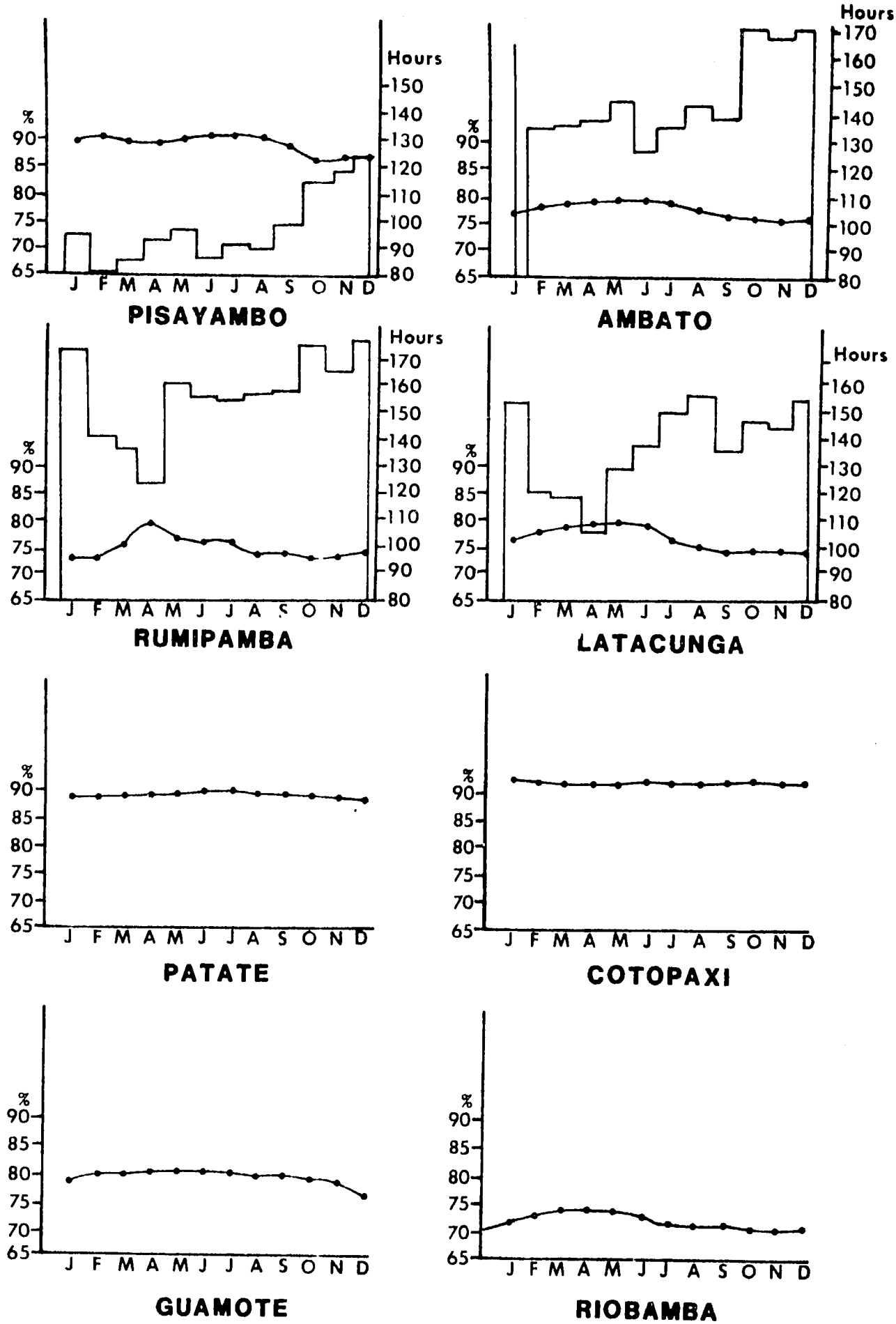

Figure 2.8b Monthly variation of relative humidity and sunshine for selected weather stations in Central Sierra

removed or given way to extensive settlement and farming. There are only small gaps of virgin vegetation. In dry lands, one finds Molle (Schinus molle), Capuli (Prunus sp.), Faigue, (Acacia macrachanta), Guarango (Tara spinosa), Mosquero (Croton sp.) and Chocho (Lupinus sp.). In wet lands, adjacent to Paramo, the main species are Chilca (Baccharis sp.), Puma maqui (Oreopanax sp.), Aliso (Alnus sp.) and Lechero (Sapium sp.). The highland scrub (Paramo) is mostly covered with Paramo grass, (Stipa ichu) (Figure 2.5).

2. Agriculture

Social-Agroeconomics

Agriculture represents one of the primary areas of economic activity in the Central Sierra. The primary land use is small farms where subsistence agriculture is practiced. Mechanization is limited to the big farms or in many cases nonexistent because of topography.

The total cropland for main crops is about 124,123 hectares with about 10 percent under irrigation, especially in Tungurahua Province.

Farm size and farm unit statistics taken by the Agro-Social Economic Survey of the Rural Sector (PRONAREG, 1975), helps in describing the status of agriculture.

Table 2.2 indicates that there are 108,476 individual farm units. The most striking feature is the inequality of land distribution. These farm units which are less than 5 hectares ("minifundios"), comprise 84 percent of the total number yet they account for only 16 percent of the total farm land. In contrast, the medium and large multi-family farms (50 hectares and above), occupy 61 percent of the land area, but only 2 percent of the total farm units.

Table 2.2

Farm size and number of farm units in the Central Sierra Area (Ecuador)

Size Farm (has)	Farm Units		Area	
	Number N°	Percentage	in 1000 Has	Percentage
Less than 1.0	40948	37.74	18593	2.17
1.0 - 4.9	50000	46.09	117380	13.74
5.0 - 49.0	15551	14.34	194394	22.75
50.0 -90,9.9	1873	1.73	221312	25.90
1000.0 an more	104	0.10	302832	35.44
TOTAL	108,476	100.00	854.511	100.00

Source: Encuesta Agrosocio economica del Medio Rural Ecuatoriano PRONAREG, Ministeria de Agricultura, Quito Ecuador. 1975

This wide disparity has existed in Ecuador since colonial times and will likely continue unless more stringent agrarian reform measures are taken.

The main types of crops, area, production and yield are shown in Table 2.3. Barley, corn, potatoes and wheat are the most common crops. Most of these are either consumed by the farmers or sold to local markets for local consumption.

Agricultural Practices

With the exception of the relatively small proportion of farms which are irrigated, the types of crops as well as the agricultural practices are primarily determined by both the precipitation and temperature regimes.

Major land preparation is accomplished just before the end of the dry season, from September to October. In the Andean areas, both subsistence and commercial farming are practiced. Most subsistence farming is under the "bio-energetic" system. Briefly this system is based on an affordable and simple lifestyle which uses human and animal power. Land is cleared by burning. Activities are timed to maximize the climatic resources. On the large farms, some of the crops such as potatoes and barley are grown under mechanization from seeding to harvest, but crops are harvested manually on small farms.

Crop Calendars

More than 90 percent of cropland is rainfed and therefore very much dependent on the climatic and weather conditions prevailing in the highlands of the country.

The agricultural practices begin in October. Farmers in the Central Sierra begin planting as soon as the soil contains enough moisture and the soil temperature is high enough to permit germination. If the rainy season is

TABLE 2.3

Area, Production and Yield of main crops in the Central Sierra Area (Ecuador)

CROP	AREA (Has)	PRODUCTION (Mt)	YIELD (Kg/Ha)
Wheat	3500.8	9375.77	2678.17
Onion	834.8	24,991.15	29936.69
Potatoes	34513.7	263282.59	7338.10
Barley	22666.4	37802.23	1663.75
Soft Corn	34676.9	22895.69	2210.74

Source. Encuesta Agrosocio-economica del Medio Rural Ecuatoriano PRONAREG. Ministeria de Agricultura, Quito, Ecuador. 1975

delayed, the farmer must also delay the planting. The annual variability in crop yields in the study area is closely linked to the annual fluctuations in weather. Weather factors may cause crop stress, leading to partial or total failure of the crop.

At altitudes of 2,000 to 3,000m, the sowing of the crops begins at the top of the highlands (3,000m), and occurs during November, December, January, February and March. The sowing period decreases with altitude so that crops can only be planted during February, at 2,000m.

Although the period for sowing may be 8 to 10 months at 3,000m, a limiting factor is frost, which can occur anytime during the growing season, particularly during September and October. Table 2.4 and Figure 2.9 show the crop calendar of the main crops (cereals, potatoes, tubers, and roots) by altitude zone and growth stage for the crops in Figure 2.9a.

Technological Changes

There has been a general trend toward modernization of agricultural practices when the circumstances permit a departure from traditional farming and irrigation methods which have been passed down from generation to generation.

According to Anderson (1977), the use of chemical fertilizer, sprays, tractors, and other automated machinery is slowly replacing oxen and the exclusive use of natural fertilizer. Contact with external influences such as government agricultural extension services has been minimal, therefore knowledge of many up-to-date farming procedures which could increase production is limited. Also, there is a lack of readily available credit (almost nonexistent among the rural

TABLE 2.4

Planting and harvest months of rainfed crops in Central Sierra Area.

NAME	CROPS	PLANTING MONTH	HARVEST MONTH
Patate	Barley-Maize	Jun-Jul	Dec
Ambato	Barley-Maize	Feb	Jul-Aug
Rumipamba	Barley-Maize	Feb	Jun-Aug
Riobamba	Barley-Maize	Feb	Jun-Aug
Latacunga	Barley-Maize-Wheat	Feb	Jun-Aug
Guamote	Barley-Maize-Wheat	Oct-Feb	Jun-Jul
Cotopaxi	Wheat-Barley-Potatoes Oca-Melloco	Oct-Feb	Jun-Jul
Pisayambo	Wheat-Barley-Potatoes Oca, Melloco	Oct-Feb	Jun-Jul

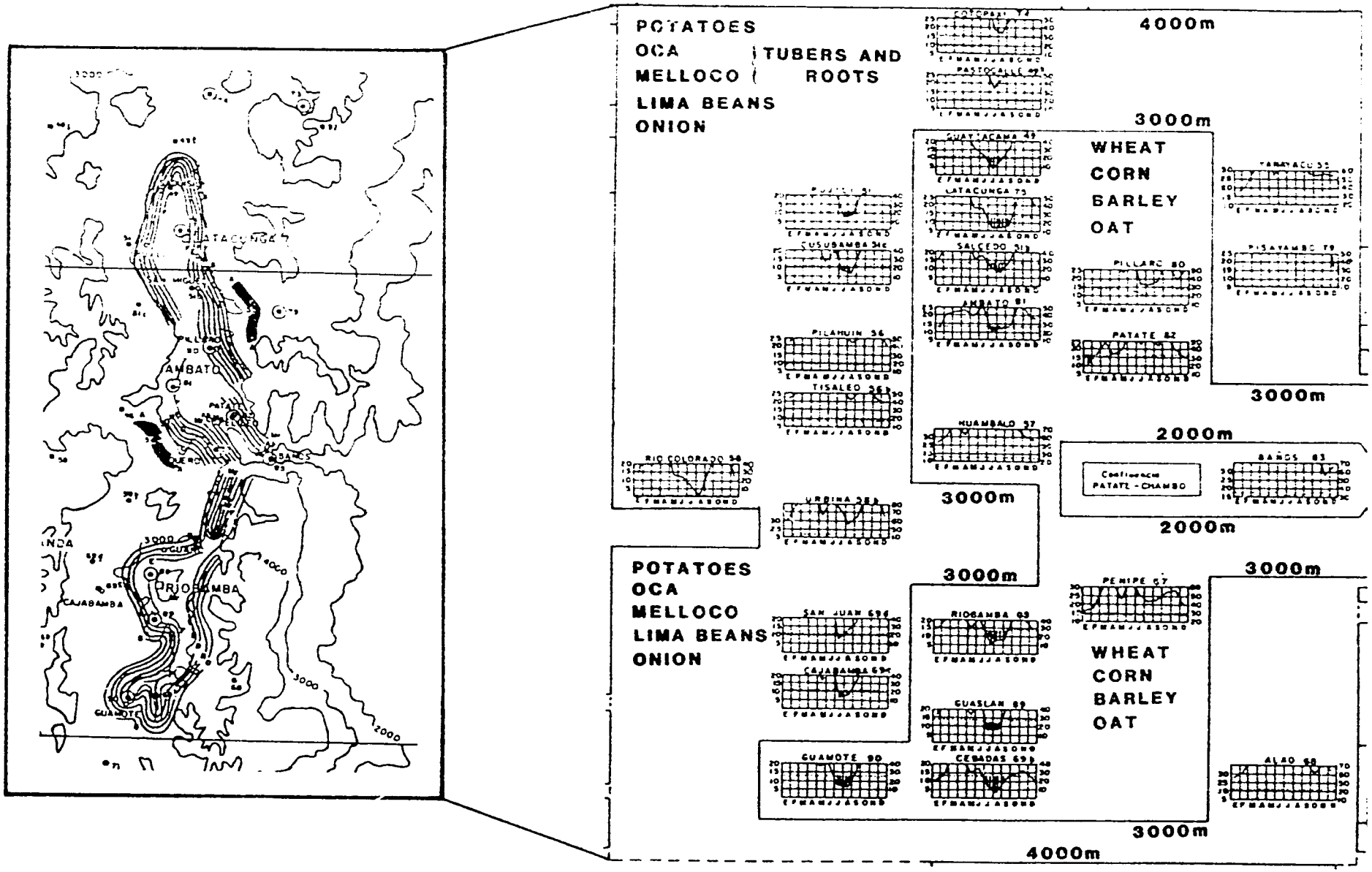

Figure 2. 9 Crop calendar of the main crops by altitude belt

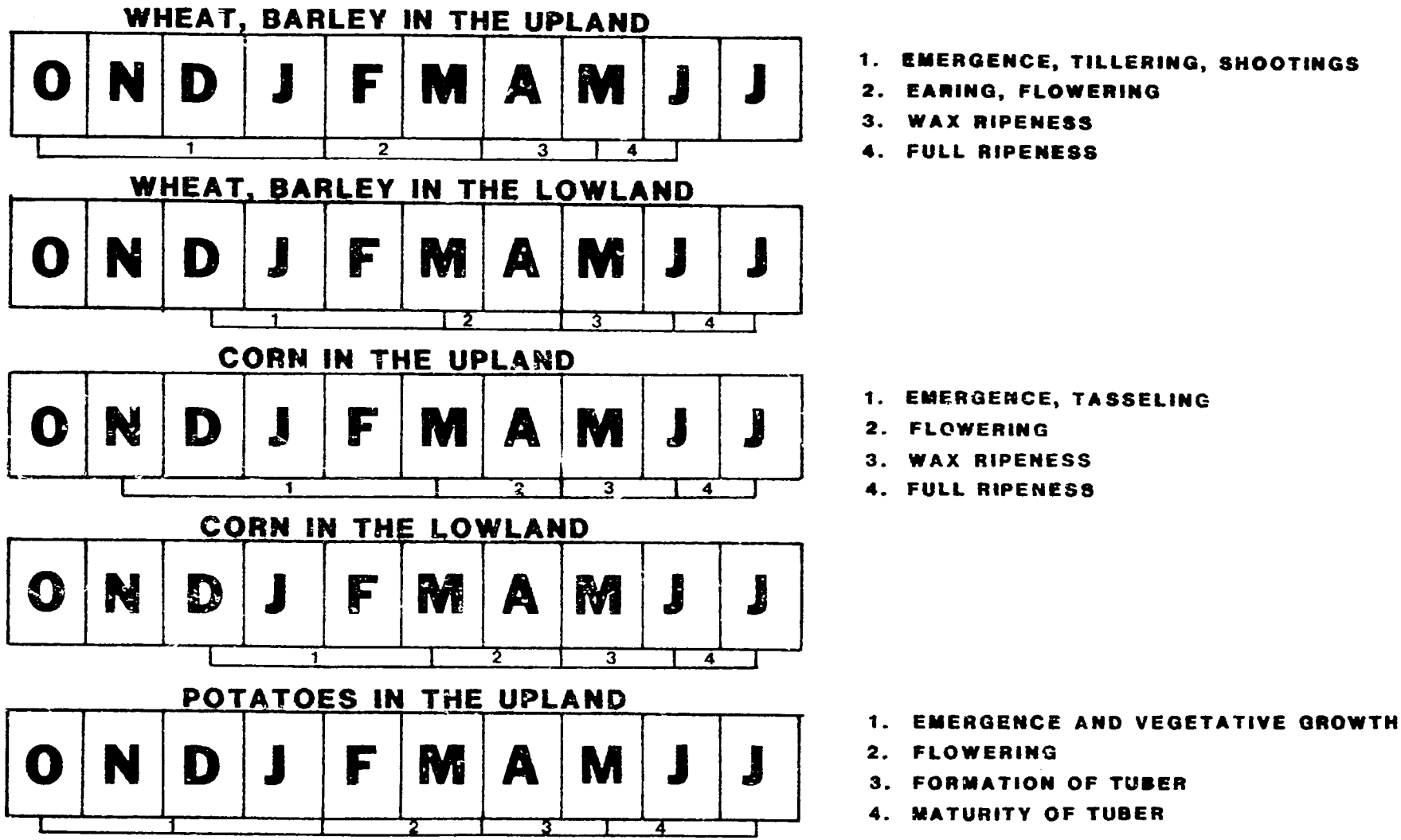

Figure 2.9a Grown stage of the crops in lowlands and hight lands

poor). Farmers cannot afford to risk what little they now have on some new practice which they are not certain will succeed. However, one cannot disregard resistance to change and the influence of custom and tradition.

Natural Hazards

The precipitation and temperature anomalies which sometimes occur during early vegetative stages of the crop cause serious damage and consequently reduce yields. Weather also effects yields indirectly by creating favorable environmental conditions for disease outbreaks.

CHAPTER III

DATA AND METHODOLOGY

A. Data

1. Meteorological

The meteorological data include available records of monthly rainfall, air temperature and relative humidity for eight stations for periods of 9 to 21 years; Rumipamba has 4 years of data since it is a new station. There are also 15 years of sunshine data for the stations Latacunga, Ambato and Riobamba with some values for Rumipamba and Pisayambo. Pan evaporation data are available for only a short period at three stations: Ambato, Pisayambo and Latacunga. Tables 3.1 and 3.2 show the climatological stations and the period of record.

Climatic Normals and Their Use

The climatic "normals" for monthly air temperature and rainfall for all stations were used to help develop the present study investigating weather effects on crop yield in the provinces of Cotopaxi, Tungurahua and Chimborazo. For example, climatic normals were used to estimate derived meteorological elements, such as potential evapotranspiration, by various methods. They were also used to help establish the water balance and to determine a drought index. Table 3.3 shows the normal values of rainfall and air temperature for the eight locations in the Central Sierra.

Selection of Data: Capabilities and Limitations

In this study, the data bases were quality controlled; the meteorological elements were carefully selected. Some elements have short periods of record, e.g., pan evaporation at Rumipamba with 4 incomplete years, Pisayambo with

TABLE 3.1

Geographic location of eight climatological stations of Central Sierra (Ecuador) and years of climatological records.

Stations	Longitude	Latitude	Altitude (m)	Records Year
Cotopaxi	78°-34'W	00°-37'S	3 560	1959-1979
Latacunga	78°-37'W	00°-55'S	2 809	1959-1978
Rumipamba	78°-35'W	01°-01'S	2 628	1976-1979
Pisayambo	78°-25'W	01°-04'S	3 615	1969-1979
Ambato	78°-38'W	01°-17'S	2 540	1950-1980
Patate	78°-38'W	01°-18'S	2 360	1963-1979
Riobamba	78°-40'W	01°-38'S	2 796	1971-1979
Guamote	78°-43'W	01°-56'S	3 020	1964-1978

TABLE 3.2

Meteorological data available Central Sierra - Periods

Stations	Temperature	Rainfall	Relative Humidity	Wind	Sunshine	Pan Evaporation
Cotopaxi	1959-1978	1979-1978	1965-1979	1965-1979	-	-
Latacunga	1959-1978	1959-1978	1965-1979	1965-1979	1965-1979	1971-1972*
Rumipamba	1976-1979	1976-1979	1976-1979	1976-1979	1976-1979	-
Pisayambo	1969-1979	1969-1979	1969-1979	1969-1976	1970-1975	1969-1979*
Ambato	1950-1980	1950-1980	1965-1979	1965-1979	1965-1979	1970-1976*
Patate	1963-1979	1963-1979	1965-1979	1965-1979	-	-
Riobamba	1971-1979	1971-1979	1965-1979	1965-1979	1965-1979	-
Guamote	1976-1979	1964-1979	1965-1979	1965-1979	-	-

* Some months missing

TABLE 3.3

Climatic Normals of Central Sierra Area (Ecuador)

Rainfall (mm)

Stations	J	F	M	A	M	J	J	A	S	O	N	D	YEAR
Cotopaxi	95.8	111.8	145.4	135.6	122.4	84.9	49.4	38.8	83.2	105.4	107.4	91.2	1.171.0
Latacunga	28.3	52.4	54.6	61.6	39.2	33.7	18.4	15.2	26.6	54.1	55.2	42.0	481.3
Rumipamba	30.0	24.1	67.8	73.5	20.0	16.4	20.8	27.6	51.8	22.3	29.9	42.6	426.8
Pisayambo	56.2	100.5	103.3	127.7	109.2	170.0	147.1	126.6	95.5	89.3	80.1	69.5	1,275.0
Ambato	35.4	41.2	51.5	82.7	42.3	42.5	27.1	25.6	27.8	51.7	45.3	34.4	737.9
Patate	21.9	35.8	54.1	52.4	53.3	80.9	61.4	60.4	54.5	45.1	42.2	29.1	591.1
Riobamba	27.2	38.6	47.7	53.4	32.1	34.3	11.6	13.9	23.2	48.9	38.4	30.1	399.4
Guamote	32.3	62.4	66.4	58.3	31.5	33.0	16.0	12.3	36.0	63.6	43.1	36.0	490.9

MONTHLY MEAN TEMPERATURE (^{o}C)

Stations	J	F	M	A	M	J	J	A	S	O	N	D	YEAR
Cotopaxi	8.2	8.1	8.2	8.1	8.2	7.8	7.8	7.8	7.9	8.0	8.1	8.2	8.0
Latacunga	13.6	13.5	13.4	13.4	13.2	12.4	12.1	12.1	12.6	13.4	13.6	13.7	13.1
Rumipamba	14.6	14.3	14.3	13.9	13.8	13.0	12.8	12.8	13.5	14.7	15.1	14.9	14.0
Pisayambo	7.1	7.3	7.4	7.5	7.2	6.3	5.7	5.7	6.3	7.3	7.6	7.3	6.9
Ambato	13.2	13.9	13.9	14.0	13.7	12.7	12.2	12.4	13.0	13.9	14.3	14.2	13.4
Patate	16.2	16.3	16.2	16.3	16.0	15.1	14.7	14.9	15.6	16.4	16.4	16.5	15.9
Riobamba	13.7	13.8	13.6	13.5	13.3	12.4	12.2	12.5	12.7	13.5	13.8	13.8	13.2
Guamote	13.5	13.4	13.3	13.4	13.5	13.2	13.0	13.7	13.7	13.0	13.4	13.4	13.4

10, Latacunga with 2, and Ambato with 7. Sunshine hours data are also limited. This has limited the defining of long-term climatological normals for these elements.

However, in spite of these limitations, it was possible to determine that: 1) rainfall is by far the most important meteorological element affecting crop yield and 2) long-term means can be used for other elements. Therefore, it was determined that monthly and decadal rainfall could be coupled with long-term means of other elements to estimate PET by different methods and calculate a soil moisture budget.

2. Agronomic

As noted in Chapter II, there are a large number of crops grown in the Central Sierra area. Four crops (Table 2.4) were examined in this climate/crop yield study, with concentration on rainfed crops because they are the most widely grown. The agricultural data (acreage, production and yield) were taken from the Agro-Social-Economic Survey that was carried out by PRONAREG in 1975.

As part of a preliminary study on the wheat yield modeling in the Central Sierra area, data for sixteen wheat varieties grown on nine soil types in the provinces of Cotopaxi, Tungurahua and Chimborazo were obtained from PRONAREG (1982).

Capabilities and Limitations

Acreage, production and yield data were only available for 1975. These were used to establish weights for the relative crop production indices (wheat, maize, barley and potatoes). Agroclimatic crop/condition indices for each crop at each station, as appropriate, were weighted by these data.

The available wheat yield data (1965, 1966, 1976, 1978 and 1980) were not sufficiently homogeneous for development of statistical climate/crop yield models. There is too much variability due to variety, soil and climate.

B. Methodology

1. Climatic Analysis Techniques-Ecuador Drought Studies

One objective of this study was to determine how climate influences the development and yield of crops, e.g., through knowledge of plant moisture requirements. Various agroclimatic tools which permit the study of moisture supply to crops and the demand on crops were used. Also, drought conditions particularly during 1977, 1978 and 1979 were compared to drought occurrence in previous years.

2. Agroclimatic Tbols

Several agroclimatic tools were investigated. These include various methods for estimating potential evapotranspiration (PET), soil moisture and crop water requirements. These tools are used in crop yield modeling and as input for land use studies involving climate impact.

Potential Evapotranspiration

Potential Evapotranspiration is the maximum quantity of water which may be evaporated by a uniform cover of dense short grass if the water supply to the soil is not limited (Penman, 1948). PET estimates are essential to establish environmental moisture demand on the crop, e.g., crop modeling and land use studies.

Various methods were used to estimate potential evapotranspiration. Each method requires as input a set of different meteorological elements. Four methods were examined in this study to determine the appropriate method for the Central Sierra area.

Hargreaves Method

Hargreaves (1977) uses air temperature and solar radiation as the main meteorological elements to estimate PET. Sunshine hours can be used instead of solar radiation when the latter is not available. Hargreaves' formula is:

$$PET = 0.0075\ (RSM)TF$$

where: PET = Potential Evapotranspiration (mm/day)

RSM = Solar Radiation (mm/day)

TF = Monthly Mean Temperature (°F).

Thornthwaite Method

Thornthwaite (1948) utilizes mean monthly air temperature and latitude (e.g., daylength) in the formula:

$$PET = 1.6\ \left(\frac{10\ T}{I}\right)^{a}$$

where: PET = is the estimated monthly potential evapotranspiration in centimeters.

T = Monthly mean air temperature in degrees centigrade

I = Annual heat index

a = polynomial function of I.

Because not all the months of the year have equal numbers of days and the numbers of the sunshine hours (daylength) change with the season of the year and latitude, this formula must be adjusted for daylength at each location.

Penman Method

Penman (1948) uses solar radiation (or sunshine), vapor pressure, wind speed and temperature to estimate potential evapotranspiration.

The modified Penman formula as presented by Rosenberg (1974) is:

$$PET = \frac{a\,Rn + bc\,(e_s - e_a)\,(1 + U \times 10^{-2})}{a + b}$$

where: PET = Potential Evapotranspiration (mm/day)

a = slope of the saturation water vapor pressure curve for pure water at mean air temperature (mm Hg F^{-1})

Rn = net solar radiation (mm/day)

b = constant in the hygrometer equation (0.27mm Hg F^{-1})

c = 0.35

e_s = saturation vapor pressure (mm Hg)

e_a = actual vapor pressure (mm Hg)

U = mean wind speed at 2 m (km/day).

Priestley and Taylor Method

Priestley and Taylor (1972), established a method to calculate the potential evapotranspiration. Their formula is similar to Penman's equation but simpler. It utilizes air temperature and the net radiation. The equation is:

$$PET = \frac{s}{s + g}\,A\,Rn,$$

where: PET = Potential Evapotranspiration (mm/day)

s = slope of the saturation water vapor pressure curve at mean air temperature (mmHgF^{-1})

g = constant in the hygrometer equation (0.27 mmHgF^{-1})

Rn = daily net radiation (mm/day)

A = empirical constant.

Soil Moisture

The soil moisture is usually the most important factor that affects crop production. Yields are determined by the water available for the development of crops. The soil moisture is an excellent indicator of crop conditions. Several methods have been proposed for estimating soil moisture. They are based on soil moisture balance.

Palmer Method for Estimating Soil Moisture

Palmer (1965) considers two arbitrary layers in the plant-soil system: 1) the upper layer is equivalent to the plough layer and assumed to hold about 2.5cm of plant available water which is lost at a potential rate and 2) it is assumed that the underlying layer loses water at that potential rate when the profile is saturated. The available water for the plants in the underlying layer depends on the depth of the root system and on the soil characteristics. The water loss due to actual evapotranspiration for the surface and also the underlying layer is expressed by the following equations:

1) $L_s = S_s$ or PET_c, whichever is smaller

2) $L_u = (PET - L_s)\ S_u / (PAW_{max} - 2.5)$

3) $AET = L_s + L_u$

where: PET = potential evapotranspiration

L_s = loss from the soil surface layer

L_u = loss from the underlying layer

S_s = actual available soil moisture in the surface layer from the previous month's budget

S_u = actual available soil moisture in the underlying layer from the previous month's budget

AET = actual evapotranspiration

PAW = plant available water previously defined.

The budget begins at some previous time when the soil moisture is at field capacity. Precipitation exceeding storage capacity of the soil is accounted for as runoff.

Evapotranspiration and Runoff

Terms associated with the water balance in a soil include PET, precipitation, the evapotranspiration, runoff and percolation.

Evapotranspiration is the sum of water evaporated from the soil and water transpired by the plant. Runoff is defined above.

Crop Coefficients

Crop coefficients help determine the crop water requirement for different crops at various stages of development. Factors affecting the value of the crop coefficient include: the crop characteristics, crop planting or sowing date, rate of crop development, length of growing season and climate conditions (PET). Doorenbos and Pruit (FAO, 1977) define the crop coefficient (KC) as the ratio:

$$KC = \frac{PET\ crop}{PET\ ref} \text{ or}$$

$$PET\ crop = KC \times PET\ ref = \text{Crop Water Requirement}.$$

The reference PET (PET ref) was defined in the previous section, e.g., Penman.

Crop coefficients in Table 3.4 can be used to establish the crop coefficient curve. This requires knowledge of the crop calendar and PET reference. Crop coefficients can be used to establish the water requirement for specific crops and each growth stage.

TABLE 3.4

Crop Coefficients (kc)

CROP	Crop Development stages					Total growing period
	Initial	Crop development	Mid-season	Late season	At harvest	
Banana						
tropical	0.4 -0.5	0.7 -0.85	1.0 -1.1	0.9 -1.0	0.75-0.85	0.7 -0.8
subtropical	0.5 -0.65	0.8 -0.9	1.0 -1.2	1.0 -1.15	1.0 -1.15	0.85-0.95
Bean						
green	0.3 -0.4	0.65-0.75	0.95-1.05	0.9 -0.95	0.85-0.95	0.85-0.9
dry	0.3 -0.4	0.7 -0.8	1.05-1.2	0.65-0.75	0.25-0.3	0.7 -0.8
Cabbage	0.4 -0.5	0.7 -0.8	0.95-1.1	0.9 -1.0	0.8 -0.95	0.7 -0.8
Cotton	0.4 -0.5	0.7 -0.8	1.05-1.25	0.8 -0.9	0.65-0.7	0.8 -0.9
Grape	0.35-0.55	0.6 -0.8	0.7 -0.9	0.6 -0.8	0.55-0.7	0.55-0.75
Groundnut	0.4 -0.5	0.7 -0.8	0.95-1.1	0.75-0.85	0.55-0.6	0.75-0.8
Maize						
sweet	0.3 -0.5	0.7 -0.9	1.05-1.2	1.0 -1.15	0.95-1.1	0.8 -0.95
grain	0.3 -0.5*	0.7 -0.85*	1.05-1.2*	0.8 -0.95	0.55-0.6*	0.75-0.9*
Onion						
dry	0.4 -0.6	0.7 -0.8	0.95-1.1	0.85-0.9	0.75-0.85	0.8 -0.9
green	0.4 -0.6	0.6 -0.75	0.95-1.05	0.95-1.05	0.95-1.05	0.65-0.8
Pea, fresh	0.4 -0.5	0.7 -0.85	1.05-1.2	1.0 -1.15	0.95-1.1	0.8 -0.95
Pepper, fresh	0.3 -0.4	0.6 -0.75	0.95-1.1	0.85-1.0	0.8 -0.9	0.7 -0.8
Potato	0.4 -0.5	0.7 -0.8	1.05-1.2	0.85-0.95	0.7 -0.75	0.75-0.9
Rice	1.1 -1.15	1.1 -1.5	1.1 -1.3	0.95-1.05	0.95-1.05	1.05-1.2
Safflower	0.3 -0.4	0.7 -0.8	1.05-1.2	0.65-0.7	0.2 -0.25	0.65-0.7
Sorghum	0.3 -0.4	0.7 -0.75	1.0 -1.15	0.75-0.8	0.5 -0.55	0.75-0.85
Soybean	0.3 -0.4	0.7 -0.8	1.0 -1.15	0.7 -0.8	0.4 -0.5	0.75-0.9
Sugarbeet	0.4 -0.5	0.75-0.85	1.05-1.2	0.9 -1.0	0.6 -0.7	0.8 -0.9
Sugarcane	0.4 -0.5	0.7 -1.0	1.0 -1.3	0.75-0.8	0.5 -0.6	0.85-1.05
Sunflower	0.3 -0.4	0.7 -0.8	1.05-1.2	0.7 -0.8	0.35-0.45	0.75-0.85
Tobacco	0.3 -0.4	0.7 -0.8	1.0 -1.2	0.9 -1.0	0.75-0.85	0.85-0.95
Tomato	0.4 -0.5	0.7 -0.8	1.05-1.25	0.8 -0.95	0.6 -0.65	0.75-0.9
Water melon	0.4 -0.5	0.7 -0.8	0.95-1.05	0.8 -0.9	0.65-0.75	0.75-0.85
Wheat	0.3 -0.4	0.7 -0.8	1.05-1.2	0.65-0.75	0.2 -0.25	0.8 -0.9
Alfalfa	0.3 -0.4				1.05-1.2	0.85-1.05
Citrus						
clean weeding						0.65-0.75
no weed control						0.85-0.9
Olive						0.4 -0.6

First figure : Under high humidity (RHmin >70%) and low wind (U <5 m/sec).
Second figure: Under low humidity (RHmin <20%) and strong wind (>5 m/sec).
Source: FAO (1977)

Crop Water Requirement

The crop water requirement (CWR) is defined as the depth of water needed to meet the water loss through evapotranspiration (PET crop) of a disease-free crop, growing in large fields under nonrestricting soil conditions, including soil water and fertility and achieving full production potential under the given growing environment.

Crop water requirements are calculated by considering the effects of climate, crop characteristics (as given by the crop coefficient KC), local conditions and agricultural practices, including the local climate, distances and altitude, size of fields, advection, soil water availability, salinity, irrigation and cultivation methods, and practices for which local field data are required as discussed by Dorrenbos and Pruit (FAO, 1977).

The crop water requirement is obtained by multiplying the reference potential evapotranspiration for each growing stage by the appropriate crop coefficient:

$$CWR = PET\ ref \times KC .$$

The CWR is a very important tool for land use studies. Climatic and soils information (e.g., maximum plant available soil moisture in the crop rooting zone) can be used to help determine which crops are appropriate and when they should be planted to minimize drought vulnerability. For example, plant available soil moisture (estimated from the soil moisture budget) and the water requirement for a specific crop can be calculated for a 15-30 year period. The empirical probability of the crop water requirement being satisified can be determined for some desired level (e.g., 3 of 4 year, 4 of 5 years, 9 of 10 years, etc.). Irrigation requirements (the expected frequency, timing during the growing season, amount required, etc.) can also be determined. Finally, this type of information provides the basis for crop/irrigation advisories to farmers during the growing season.

CHAPTER IV

DISCUSSION ON AGROCLIMATIC CROP CONDITION INDICES

1. Description of Indices

Drought can be defined by various methods including statistical analysis of rainfall data and estimated soil moisture (WMO, 1975). The nature of drought impact on agriculture may be examined by analysis of various agroclimatic indices including: 1) the Yield Moisture Index (YMI) developed by CEAS (1979), 2) the Palmer Drought Index (PDI) developed by Palmer (1965), 3) the Soil Moisture Index (SMI) developed by Ravelo and Decker (1979), and 4) the R-Index developed by Yao (1969). The agroclimatic tools discussed in the preceding chapter are used in computation of these indices.

Yield Moisture Index

The Yield Moisture Index (YMI) is defined as:

$$YMI_J = \sum_{i=1}^{n} P_i KC_{iJ}$$

where: YMI_J = the Yield Moisture Index for the jth crop (e.g., maize, wheat, etc.),

P_i is the precipitation for the ith crop growth stage (i=1,N) with P_i < soil moisture field capacity, and

KC_{iJ} is the appropriate crop coefficient for ith crop growth stage and the jth crop as determined from Table 3.4 with major growth stages of planting, vegetative and the reproductive.

As discussed by Steyaert et al. (1981), this index uses crop coefficients to weigh rainfall during the growing season according to the relative water requirement for each crop stage. For example, Table 3.4 shows that water is of most importance to the crop during the critical flowering stage. This is one of the primary agroclimatic indices used by CEAS in drought/crop condition assessments (Steyaert, Ravelo and Sakamoto, 1980).

Palmer Drought Index

The Palmer Drought Index (PDI) represents a potentially useful method for assessing the impact of drought on agriculture. The PDI is based on a soil moisture budgeting procedure which uses precipitation and potential evapotranspiration as major inputs.

The PDI treats wet and dry periods as a function of accumulated differences between supply (precipitation) and demand (evapotranspiration). Near normal rainfall should provide an average moisture supply to the surface layer of the soil. Furthermore, above normal precipitation is usually required after a drought to restore the soil moisture to normal conditions.

The Palmer Drought Index is designed to permit comparison of any month or region to average conditions. The index has been used as an indicator of general crop condition and the availability of soil moisture to meet the needs of the crop.

The PDI is scaled such that a period of "normal" temperature combined with "normal" precipitation has an index value of zero. Positive values of the index indicate wetter than normal conditions, while negative values represent drought. Table 4.5 shows the PDI classes for wet and dry periods.

Application of the Palmer Drought Index in the Caribbean Basin is discussed by Steyaert, Ravelo and Sakamoto (1980).

Soil Moisture Index

The Soil Moisture Index (SMI) is defined as the ratio between the plant available water (PAW) and the maximum plant available water (PAWmax). The plant available water is the difference between actual soil moisture (SW) and permanent wilting point (PWP), while the maximum plant available water (PAWmax) is the difference between the field capacity (FC) and the permanent wilting point (PWP). The Soil Moisture Index is defined as:

TABLE 4.1

Palmer Drought Index (PDI) classes for wet and dry periods

PDI			CLASS
	≥	4.00	Extremely wet
3.00	to	3.99	Very wet
2.00	to	2.99	Moderately wet
1.00	to	1.99	Slightly wet
0.50	to	0.99	Incipient wet spell
0.49	to	-0.49	Near normal
-0.50	to	-0.99	Incipient drought
-1.00	to	-1.99	Mild drought
-2.00	to	-2.99	Moderate drought
-3.00	to	-3.99	Severe drought
	≤	-4.00	Extreme drought

$$SMI = PAW/PAWmax$$

where: PAW is SW - PWP, and

PAWmax is FC - PWP.

The Soil Moisture Index is defined for values ranging from 0 through 1.0. A SMI of zero indicates extreme moisture stress while a value of 1 indicates no moisture stress on the crop. The computation of this index requires methods to estimate both PET and soil moisture.

R Index

This index is defined as the ratio of actual evapotranspiration to potential evapotranspiration, i.e.,

$$R = ET/PET.$$

It is the function of the atmospheric energy which causes evaporation from soil and plant surface, and precipitation which replenishes the soil moisture. These two variables constitute a supply and demand relationship which gives the R-Index the ability to measure plant water supply in relation to plant water requirements. The value of R is between 0 and 1, and as a ratio it approximates the Beta distribution.

The R-Index can be used as a tool to help solve the problems of agricultural land use capability, long term agricultural planning, irrigation project designing, and agricultural drought (see Steyaert et al, 1981). It can be used for analyzing the effect of water stress on crop response as well as to estimate optimum crop planting dates to ensure adequate moisture during critical growth stages. Optimum crop planting dates can be determined by first obtaining those periods when the R-Index is near unity, which would be ideal for the flowering stage of the crop. By designating this period as flowering, the optimum planting date may be obtained by extrapolating the crop calendar backwards.

Relative Crop Production Indices

As discussed by Steyaert, et al (1981), agroclimate has become increasingly recognized as a resource which can assist agricultural planners and decision makers. For example, the authors discuss an Econoclimate Program which was developed by the New Zealand Meteorological Service. It is based in part on a system of weighted weather indices which provide relative information on agricultural production. This system is designed to provide decision makers with real-time early warning information which is interpreted according to economic activity. The goal of the Econoclimate Program is to learn more of the direct effects of the weather on the economy, to alert national economic planners of the value of the weather information and to assist them in the use of such information.

Weather indices and agroclimatic models are developed for diverse crops (wheat, fruit, carrots, etc.) and other aspects of farming. Models are also developed for wool, lamb, dairy and beef production. These indices are based on historical and real-time weather data (e.g., precipitation and temperature), available from approximately 100 meteorological stations located throughout New Zealand. A national index for each commodity is determined by aggregating weather information at each location by using weights for each location. The weight corresponds to the percent of national production accounted for in the region containing the meteorological station for a particular commodity. The station weights add up to 1.0. Values for the national index for each commodity are determined for several years and displayed in both tabular and graphical form. More than 100 indices of relative production have been determined.

Analysts have spent considerable time determining which meteorological variable(s) are statistically and biologically related to yearly variations in the agricultural production. This involves determining the proper seasonal

relationships between variables. For example, the wool production forecast model is based on cumulative rainfall conditions (hence, pasture conditions for grazing) at the end of the autumn season which precedes spring shearing. This provides at least a three month forecast of expected wool production.

The current index value is compared to previous years index values. Some scenarios can be analyzed. One might include normal precipitation for the remainder of the forecast period. The impact of weather or climate conditions occurring several weeks or months before harvest may be associated with critical biological factors that determine the final "yield." Such models provide substantial lead-time for economic analysis in New Zealand. For example, representatives of wool, dairy and ranching industries in New Zealand rely heavily on this system of weather indices in the scheduling of container shipments necessary to export products.

B. Application of Indices

These agroclimatic indices provide an objective method to assess drought impact on agricultural crops. They are not intended to assess the impact of flooding, frost occurrence or other anomalous weather events or the many non-weather factors which also determine year-to-year variations in crop yield. Similarly, the indices are not designed to assess crop conditions in areas under effective irrigation.

Agroclimatic/crop condition indices can provide useful information on drought impact in terms of relative crop yield or production by the end of the flowering/reproductive crop stage, i.e. about 30-60 days before harvest. The index can be expressed in several forms: raw values, percentiles, percent of normal, percent of last year or as a percent of some base year.

The modeler determines which index or combination of indices (e.g., YMI for specific crops and PDI for general climatic impact on agriculture) are appropriate for the region. The index is computed for 15-30 years using historic climatic data. Interpretation of the index is accomplished by using episodic data (e.g., drought occurrence) to establish critical thresholds for categorical crop conditions, yield or production. The assessment of this year's crop is made by using observed weather data to calculate the index, interpreting the index in terms of similar values in previous years and then evaluating these results along with other information to prepare a written assessment.

CHAPTER V

DISCUSSION ON CROP YIELD MODELING CONCEPTS

A. Background

During the decade of the 1970's significant advances were made in the development and application of climate/crop yield forecast models. The increased availability of computers has permitted scientists to investigate climate/crop relationships from large amounts of historic data. Decision makers, planners and economists have come to recognize that these models can be used as a basis for climatic impact assessments, particularly to quantify the impact of drought on crop yield and agricultural production. Climatic impact assessments can provide reliable, timely and inexpensive information to supplement and complement other important information sources including: statistical area frame sampling programs, farm and marketing reports, agricultural census or the classical demand side economic analysis.

The crop model is the core of the assessment program and there are essentially three types of crop yield models: 1) agroclimatic/crop condition indices such as described in the previous chapter, 2) statistical climate/crop yield models, usually developed by linear regression analysis and 3) phenologic or "process" models which are based on plant processes such as photosynthesis to simulate the growth and development of individual plants (these models are still in the research and development phase and are not further discussed).

Although the primary focus of this chapter is on statistical crop yields, the relationship between these models and agroclimatic/crop condition indices is also provided. The statistical model is determined from multiple linear regression analysis using historic climatic and crop yield data. A validated

statistical model forecasts absolute crop yield (e.g., kilograms per hectare) which only reflects yield fluctuations due to climate. In contrast, the agroclimatic/crop condition index provides a measure of the relative crop yield (e.g., the index expressed as a percent of normal or in percentiles). Both types of models use predictors which are known to be highly associated with year-to-year yield fluctuations. Ideally, the same predictor should result from both approaches; however, this is not always true. For example, non-weather factors and "noise" in the yield or meteorological data frequently result in differences which must be carefully evaluated prior to operational use. As discussed below, the NOAA/CEAS Early Warning Program uses both statistical and agroclimatic/crop condition index models in assessing climatic impact on potential food supplies.

B. Statistical Crop Yield Model Applications

The statistical models can be used for several different purposes and include crop yield and production forecasting, disaster early warning, crop monitoring, scenario analysis, land use studies, soil erosion analysis, and crop/weather advisories for farmers.

Statistical models have been developed or at least attempted for most grain producing areas of the world. Some of the crops modeled include wheat, corn, barley, rice, cotton, sugar cane, sunflower, sorghum, millet, groundnuts, sesame, oil palm and others. If data are reliable (i.e., both meteorological and crop yield data) and if climate is a dominating factor which determines year-to-year fluctuations in yield, these models have produced very useful absolute yield information (Steyaert et al., 1981).

Another application involves the use of crop yield forecast models to provide early warning of disastrous food shortages resulting from severe drought. The United Nations, Food and Agricultural Organization (UN/FAO) and the U.S. National Oceanic and Atmospheric Administration/Center for Environmental Assessment Services (NOAA/CEAS) are two organizations involved in this type of effort. The FAO program is, in part, based on an objectively determined agroclimatic/crop condition index. The NOAA/CEAS program uses statistical climate/crop yield models and objectively determined agroclimatic/crop conditions indices as a basis for drought/potential food shortage assessments provided to AID (particularly the Office of U.S. Foreign Disaster Assistance), UN (FAO and UNDRO), and the U.S. Department of Agriculture.

Statistical models can also be used with long-term records of climatic data for risk analysis. The model can be used to simulate yield well beyond the period of record for observed yield data (yield is an integrator of climate and the models convert climate data into simulated yield data). Simulated yield time series can be used to determine the risk of crop failure by estimating probabilities of crop failure (2 consecutive or 3 consecutive years, etc.) or various probabilities for simultaneous crop failure in two or more regions.

As reported in CEAS (1979), a statistical crop yield model was used to investigate the vulnerability of corn to drought in Haiti. It was found that soil erosion (associated with deforestation) and the reduced water holding capacity of the soil resulted in increased vulnerability of corn to drought, i.e., shallow soils cannot store much water to carry the crop through dry spells.

C. Data Bases for Statistical Models

Year to year changes in crop yield can be caused by changes in: 1) climate (drought or anomalously wet conditions), 2) weather events (frost, flooding, high winds, etc.) and/or 3) technology and management decisions involving variety, fertilizer, irrigation, weed and pest control, etc. These factors together with the soil factor determine the potential yield. Time trends in yield can be associated with either changes in technology (e.g., increased technology impact each year), trend in climate or both.

The above suggests that an extensive data base is a very important requirement in model development. Data bases should include the following:

1) Meteorological data (precipitation and temperatures plus cloud cover and other meteorological elements, if available).
2) Climatological "normals" or average statistics.
3) Soils information including the water holding capacity and crop rooting depth.
4) Crop statistics including acreage, production and yield.
5) Agronomic data including information on technology if available.
6) Episodic data including historic occurrences of drought, floods pest/disease outbreaks and others.

In addition, very detailed information on cultural practices including crop calendars is necessary. Information on the method to estimate historic yield data is useful in determining reliability of these data.

D. Comments on Statistical Models

Precautions should be taken in the interpretation of empirical statistical models as there are many assumptions that are usually made in their development. It is not possible to get more out of a model than what is originally available

in the sample. The following gives a list of disadvantages and advantages of statistical climate/crop yield models based on monthly data.

Disadvantages

1) They use a fixed crop calendar, i.e., it is assumed that the planting and vegetative growth stages, etc., occur at the same time each year. For example, delayed planting could cause a shift in the crop calendar.
2) Monthly data are used. Crops are also responsive to more frequent changes in the weather or climate.
3) Shorter period weather phenomena, especially episodes such as extreme temperatures, high winds, freeze, or flooding cannot be modeled very well.
4) Episodes usually do not occur frequently enough for a quantitative regression analysis.
5) Regression models tend to predict "close to the mean yield" and do not predict extremes very well. The models should not be used to predict independently outside the extremes in the meteorological data used to develop the model.
6) The models use linear trend as a surrogate for technology. If not objectively specified, the trend term can be very misleading in the development and use of the model. Linear trend is used because the technology data are generally not available or are of low quality.
7) Future climate/crop relationships may change from historical relationships used to develop the model. For example, varieties could change such as traditional varieties to high yielding varieties. The climate responses could be different.

Advantages

1) If properly developed and tested, these models are based on the statistical/agronomic/physical significance between the climatic data and crop yield data. Physical significance means that any weather or climatic variables used in the model have a high degree of biological relationship with the known effect on the crop.

2) Models represent straight-forward relationships that make minimal assumptions and permit the yield data and climatic data to define the model according to historic interrelationships. They make the maximum use of historic climatic data and yield which is an integrator of climate.

3) The models are inexpensive to operate and produce useful information, particularly if they are evaluated according to their strengths and weaknesses along with other crop yield or crop condition forecast procedures.

CHAPTER VI

RESULTS AND DISCUSSION

Some of the results discussed in this chapter provide the foundation for a regional climatic impact assessment program and support land use studies for rural development in the Central Sierra. An Agroclimatic Resource Inventory was completed and provides extensive background information on climate, agricultural practices and crop calendars. Several methods for estimating potential evapotranspiration (PET) are compared and evaluated. Agroclimatic/crop condition indices for rainfed wheat, barley, corn and potatoes grown at various locations were developed. Relative Crop Production Indices for each of these crops were developed by objectively averaging the above agroclimatic/crop condition indices. The crop water requirement at each crop stage for wheat, barley, corn and potatoes at locations in the Central Sierra was estimated from adjusted crop coefficients and Penman PET (appropriate at the location).

A. Agroclimatic Resource Inventory

The information provided in the Agroclimatic Resource Inventory (Table 6.1) is fundamental to this study. Table 6.1 summarizes key information on station names, altitude, mean annual temperature and rainfall, irrigated and rainfed commerical crops, rainfed subsistence crops, crop calendars, crop coefficients and the recommended months for making climatic impact assessments of agricultural production (relative indices). Tables 6.2 - 6.4 supplement this resource inventory. Preliminary crop coefficients, as discussed below, are provided in Table 6.2. Table 6.3 provides mean crop production (metric tons) for barley, potatoes, corn and wheat grown in Ecuador; the Sierra, Central Sierra and the three provinces making up the Central Sierra (Cotapaxi, Tungurahua and

TABLE 6.1

CENTRAL SIERRA AREA - AGROCLIMATIC RESOURCE INVENTORY

NAME	ALT m.a.s.l	TEMP 0°C	RAINFALL mm	COMMER. IRRIGATED CROPS	RAINFED SUBSIST CROPS *	RAINFED COMMER. CROPS	PLANTING MONTH	50% PLANTING	RAINFED HARVEST MONTH	PEAK HARVEST	MONTH FLOWERING
PATATE	2360	15.9	591	FRUITS	BARLEY WHEAT MAIZ	X	JUN-JUL	JUN	DEC	DEC	NOV
AMBOTO	2540	13.4	738	X	BARLEY WHEAT MAIZ	X	FEB	FEB	JUL-AUG	JUL	MAY
RUMIPAMBA	2628	14.0	427	X	BARLEY WHEAT MAIZ	BARLEY	FEB	FEB	JUN-AUG	JUL	MAY
RIOBAMBA	2796	13.2	399	X	BARLEY WHEAT MAIZ	BARLEY WHEAT	FEB	FEB	JUN-AUG	JUL	MAY
LATACUNAG	2809	13.1	481	X	BARLEY WHEAT MAIZ	BARLEY WHEAT	FEB	FEB	JUN-AUG	JUL	MAY
GUAMOTE	3020	13.4	481	X	BARLEY MAIZ	BARLEY	OCT-FEB	OCT	JUN-AUG	JUN	MAR
COTOPAXI	3560	8	1171	X	WHEAT BARLEY POTATOES OCA, MELLOCO	WHEAT BARLEY POTATOES	OCT-FEB	OCT	JUN-JUL	JUN	MAR
PISAYAMBO	3615	6.9	1275	X	" " " "	" " " "	OCT-FEB	OCT	JUN-JUL	JUN	MAR

CROPS: HIGHLANDS - POTATOES, BARLEY-WHEAT, LIMA BEANS
LOWLANDS - BARLEY, WHEAT, CORN(MAIZ)

CROP CONDITION ASSESSMENT MONTHS

CROP COEFFICIENTS: HIGHLANDS - OCT - NOV - DEC - JAN - FEB - MAR - APR - MAY
.4 .5 .7 .8 1.0 1.2 1.2 .8

OCT, OCT-JAN, OCT-MAR, OCT-MAY

LOWLANDS - FEB - MAR - APR - MAY - JUN
1.0 1.2 1.2 0.8 0.5

FEB, MAR, APR, FEB-MAY

*SOCIO-ECONOMICAL FACTOR (RURAL DEVELOPMENT)

DROUGHT YEARS: 1977-78-79

TABLE 6.2

Crop coefficients for different crops

Belts	Crops	Months								
		O	N	D	J	F	M	A	M	
Highland		0.4	(I)							
	Wheat		0.5	0.7	0.8	(II)				
	and					1.0	1.2	(III)		
	Barley							1.2	0.8	(IV)
	Potatoes	0.4	(I)							
			0.5	0.7	0.8	(II)				
						1.0	1.2	(III)		
								1.2	0.8	(IV)
Lowland				0.7	0.8	(I)				
	Wheat					1.0	1.2	(II)		
	and							1.2	III	
	Barley								0.8	(IV)
	Corn			0.7	0.8	(I)				
						1.0	1.2	(II)		
								1.2	III	
									0.8	(IV)

(I) Planting, (II) Vegetative Growth, (III) Flowering, (IV) Ripening

TABLE 6.3

Production and percentage of the main crops of Central Sierra in relation a National, Sierra and Province of Ecuador

	National	Sierra		Central Sierra			Cotapaxi				Tungurdgua				Chimborazo			
	Mt	Mt	N%	Mt	N%	S%	Mt	N%	S%	CS%	Mt	N%	S%	CS%	Mt	N%	S%	CS%
Barley	66377.03	65653.74	98.91	37802.23	56.95	54.57	8741.52	13.16	13.31	23.12	9861.45	14.85	15.02	26.08	19199.26	28.92	29.24	50.78
Potatoes	436241.65	434944.17	99.70	253282.59	58.06	58.23	29319.80	6.72	6.74	11.57	100801.18	23.10	23.17	39.79	123161.61	28.23	28.31	48.63
Corn	95124.18	94211.76	99.04	22895.69	24.06	24.30	5591.49	5.88	5.93	24.42	2275.55	8.69	8.78	36.14	9028.65	9.49	9.58	39.43
Wheat	54602.34	54140.15	99.15	9375.77	17.17	17.31	1866.03	3.45	3.48	20.11	1367.99	2.50	2.52	14.59	6121.09	11.21	11.30	65.28

TABLE 6.4

Central Sierra, wheat, barley, potatoes, and crop production index weights for meteorological stations.

PROVINCE	STATION	WHEAT	BARLEY	POTATOES	CORN
Cotopaxi	Latacunga	.150	.17	-	.240
	Cotopaxi	.050	.06	.120	-
Tunagurogua	Ambato	.060	.100	-	.180
	Patate	.060	.100	-	.180
	Pisayambo	.030	.060	.400	-
Cuimborazo	Riobamba	.430	.380	-	.400
	Guamote	.160	.130	.480	-
TOTAL WEIGHT		1.00	1.00	1.00	1.00

Chimborazo). The percent of national production (N%), Sierra production (S%), and Central Sierra production (CS%) is also provided for each of these crops. These data were used to develop the crop production index weights in Table 6.4 and are used to aggregate the agroclimatic/crop indices (YMI) into a Relative Production Index for each of these crops in the Central Sierra as discussed below.

B. Crop Calendar Information

Crop calendar information for the primary crops grown in the Central Sierra are shown in Table 6.1. The subsistence crops grown under rainfed conditions are planted and cultivated at various locations in the region according to the accumulated experience of the farmer. It is this experience which determines that time period when climatic conditions can be expected to sufficiently meet the plant water requirement at planting and then during the critical crop stage, flowering/reproduction. Table 6.1 provides "normal" crop calendars. Although agroclimatic indices are based on these normal conditions, large delays in the beginning of the rainy season should be considered when making crop condition assessments.

C. Crop Coefficients

Preliminary crop coefficients for wheat, barley, corn and potatoes grown in the Central Sierra are provided in Tables 6.1 and 6.2. The standard crop coefficients presented in Table 3.4 have been adjusted to account for the large growing season for both highland and lowland stations. The calculation of the exact crop coefficients for conditions in the Central Sierra requires detailed field experiments. However, these preliminary coefficients were used for at least two purposes in Ecuador. The coefficients, crop calendar information and

historic monthly rainfall data were used to develop the Yield Moisture Index (YMI) at each location (Table 6.1) and for wheat, barley, corn and potatoes. These agroclimatic/crop condition indices can be used to monitor crops, provide relative yield information and prepare climate impact assessments. In the second application, the crop coefficients were used to estimate the crop water requirement for these same crops.

D. Potential Evapotranspiration Estimates

The investigation and evaluation of various methods to estimate potential evapotranspiration (PET) was one of the primary goals of this study. The appropriate methodology for making PET estimates is very important to land use studies. For example, PET is used in calculations to estimate the crop water requirement, soil moisture, moisture stress (R Index) and other derived variables which are used to determine which crops are suitable for a region, their planting date and irrigation requirement, drought vulnerability, etc.

Monthly PET was estimated at each Central Sierra location by using four methods: Penman, Hargreaves, Thornthwaite and Priestly-Taylor. Figure 6.1 provides results for Ambato and these are typical for other locations (Appendix A). Figure 6.1 shows the sample mean values for monthly temperature (T), Precipitation (P), Thornthwaite PET (O), Hargreaves PET (H), Penman PET (N), Priestly-Taylor PET (Y) and Pan evaporation (E). All units are in millimeters (mm) except temperature (°C). There is generally good agreement between Penman, Hargreaves and Pan Evaporation. The Priestly-Taylor method was not calibrated for the Central Sierra and probably is much too high in estimating PET. The Thornthwaite method probably underestimates PET. Ambato is in a very dry region which requires irrigation to grow crops. This is evident in Figure 6.1 by the

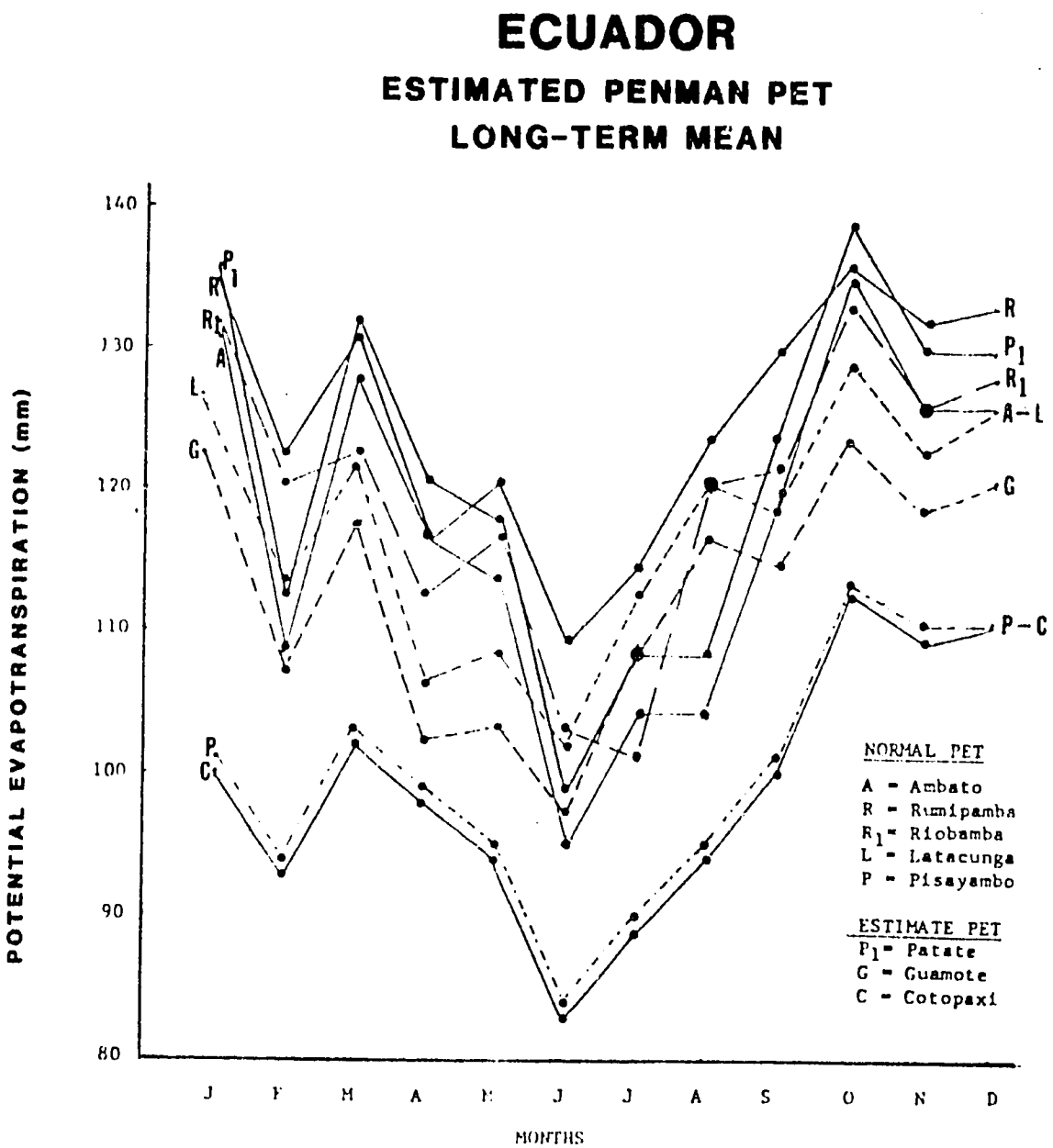

Figure 6.1. Long-term mean PET by Penman's method for indicated locations in Central Sierra

very low rainfall values compared to PET. In contrast, Pisayambo is a highland station which receives much more rainfall (Appendix A). In this case, the precipitation curve is substantially above the estimated PET values. The agreement between pan evaporation, which has recognized limitations, and Penman or Hargreaves methods at Ambato, Pisayambo and Laticunga provides strong evidence for their application instead of the Thornthwaite method.

In addition to the graphical plots such as in Figure 6.1, Appendix A also provides sample statistics for all stations. Tables include means, standard deviations, minimums and maximums for precipitation (P), temperature (T) and various PET estimates. These data were used in the plots. Several findings include:

1) The variance (standard deviation squared) of rainfall ranges from 10 to 100 times larger than the variance of PET. This suggests that year-to-year variations in crop yield are more likely due to rainfall than PET. Furthermore, "normal" values of PET can be used, rather than calculations for each month.

2) The variability of Thornthwaite PET is quite small compared to other methods, probably because temperature variability is quite small in the Central Sierra. The variability in other techniques is due to solar radiation variability each year.

3) The ratio between Thornthwaite and Penman PET is quite uniform at about 0.45. Furthermore, analysis of Penman PET estimates at five locations of different altitudes suggested that Penman PET decreases about 2 mm for every 100 m increase in elevation.

Figure 6.2 and Table 6.5 show the "normal" (sample mean of available data) Penman PET values for locations in the Central Sierra. As indicated in Figure 6.2, sufficient data (solar radiation, humidity, etc.) were available to calculate PET at five of the eight locations. Penman PET was interpolated ("Estimate PET") at Patate, Guamote and Cotopaxi. This interpolation was made using the empirical results in item 3) above. Both methods produced essentially the same results. This close agreement using the 0.45 ratio and 2mm/100m gradient are quite noteworthy. The result is that Penman PET "normals" can probably be interpolated at stations which do not have records other than rainfall and temperature.

Major findings of this PET analysis include:

1) Both Penman and Hargreave's PET methods appear appropriate for the Central Sierra. Slight preference is given to the Penman method which has been used by other agencies in Ecuador. Further verification is necessary in future research to be conducted in the Central Sierra.

2) "Normal" PET values can be used in many instances because of the small variability of PET relative to rainfall variability.

3) PET can be interpolated from nearby stations for locations not having sufficient data.

4) These findings should be carefully considered by decision makers and scientists involved with land use studies. For example, land classification (arid, moist, etc.) based on temperature-precipitation, crop water requirement and PET should be carefully investigated.

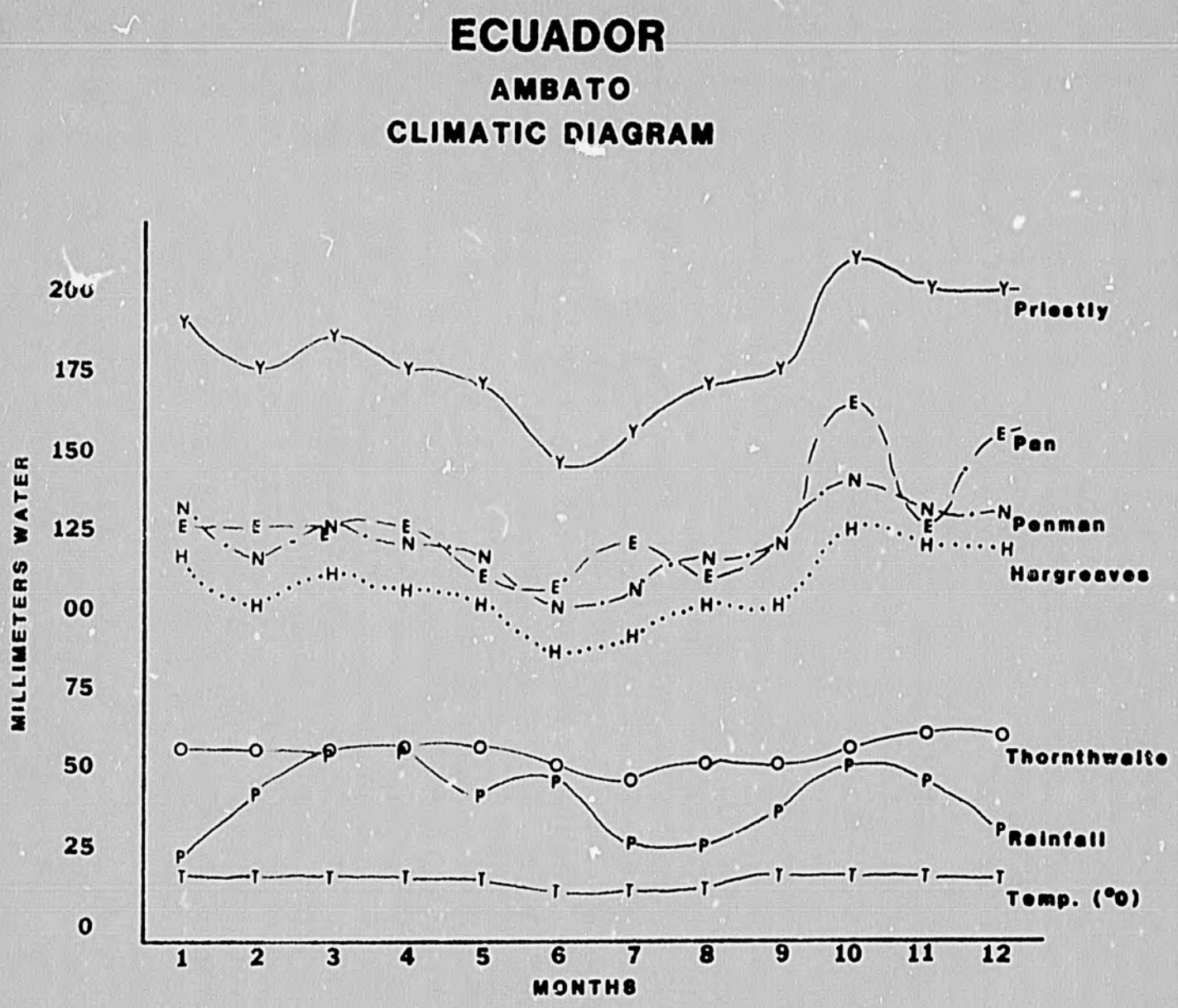

Figure 6.2. Comparison of computed mean monthly PET by Hargreaves (H), Thornthwaite (O), Penman (N), Priestly and Taylor (Y), Pan Evaporation (E), Precipitation (P) and Temperature (T) at Ambato

TABLE 6.5

"NORMAL" PENMAN PET

(m. m.)

STATION	ALTITUDE	COD	J	F	M	A	M	T	T	A	S	O	N	D
AMBATO	2540	PET	131	108	127	116	113	95	104	104	119	134	125	125
RUMIPAMBA	2628	PET	134	122	130	116	120	109	114	123	129	135	131	132
RIOBAMBA	2796	PET	130	129	122	112	116	103	111	120	121	132	125	127
LATACUNGA	2809	PET	126	113	121	106	108	102	112	120	118	128	122	125
PISAYAMBO	3615	PET	101	94	103	99	95	84	90	95	101	113	110	110
ESTIMATED														
PATATE	2360	PET	135	112	121	120	117	99	108	108	123	138	129	129
GUAMOTE	3020	PET	122	107	117	102	103	97	108	116	114	123	118	120
COTOPAXI	3560	PET	100	93	102	98	94	83	89	94	100	112	109	110

E. Yield Moisture Index (YMI)

The YMI was computed for rainfed crops at each location as indicated in Table 6.1. Available monthly precipitation data (1965-1979), crop coefficients adapted for the Central Sierra and crop calendars for each crop were used to compute the index as discussed in Chapter IV. However, there was one important exception; monthly rainfall amount was not censored to field capacity values due to semi-arid conditions (see Chapter IV). The graphical plot of the YMI for corn at Ambato is shown in Figure 6.3a. Index values are provided each year for the planting (RYMICL1), vegetative (RYMICL2), flowering (RYMICL3) and ripening (RYMICL4) crop stages. Each index is expressed in percentiles. Similar graphical plots expressed in percentiles and as a percent of normal YMI plus tabularized values are provided in Appendix B for all stations.

The index is most reliable (as an indicator of crop conditions) at the end of the critical flowering crop stage. Analysis suggests that YMI values in the 20 to 40 percentile ranking indicate moderate drought while YMI values below the 20th percentile suggest drought impact on the crop.

F. Central Sierra Relative Crop Production Indices (CSRCPI)

Relative crop production indices were developed for corn, wheat, potatoes and barley grown in the Central Sierra, i.e., a single Central Sierra index for each crop. The individual crop indices are graphically displayed in Figure 6.3b. Table 6.6 provides the numerical values of the index (POTCSRPI = potatoes, WHTCSRPI = wheat, CORCSRPI = corn and BARCSRPI = barley). The variable name has as the first three letters the crop (POT = potatoes, WHT = wheat, COR = corn and BAR = barley), and the last five letters "CSRPI" stand for "Central Sierra Relative Production Index." The CSRCPI for each crop was computed by using the weights in Table 6.4 to average the agroclimatic/crop

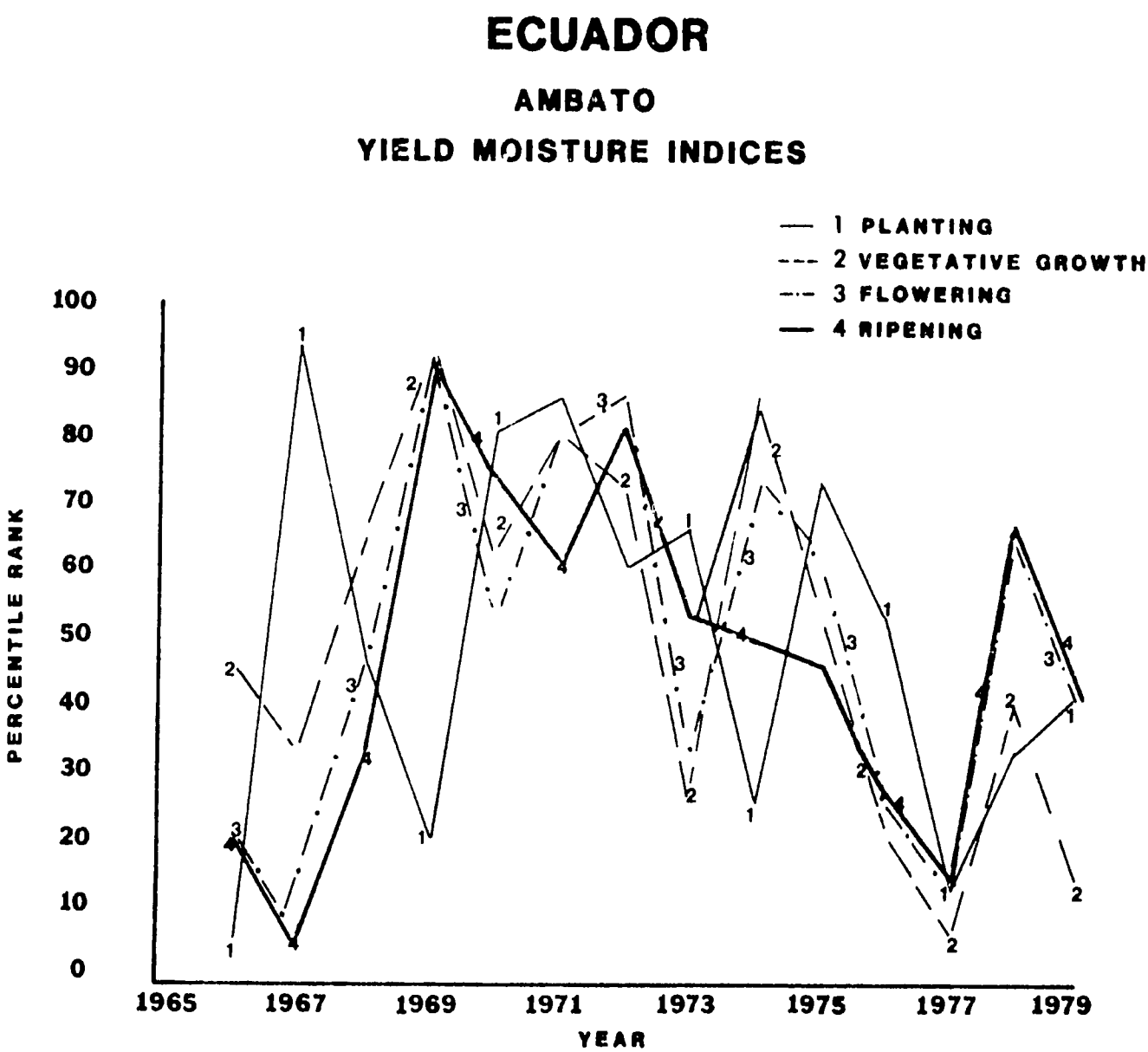

Figure 6.3a. Yield Moisture Index for Ambato, expressed as percentile ranking for corn

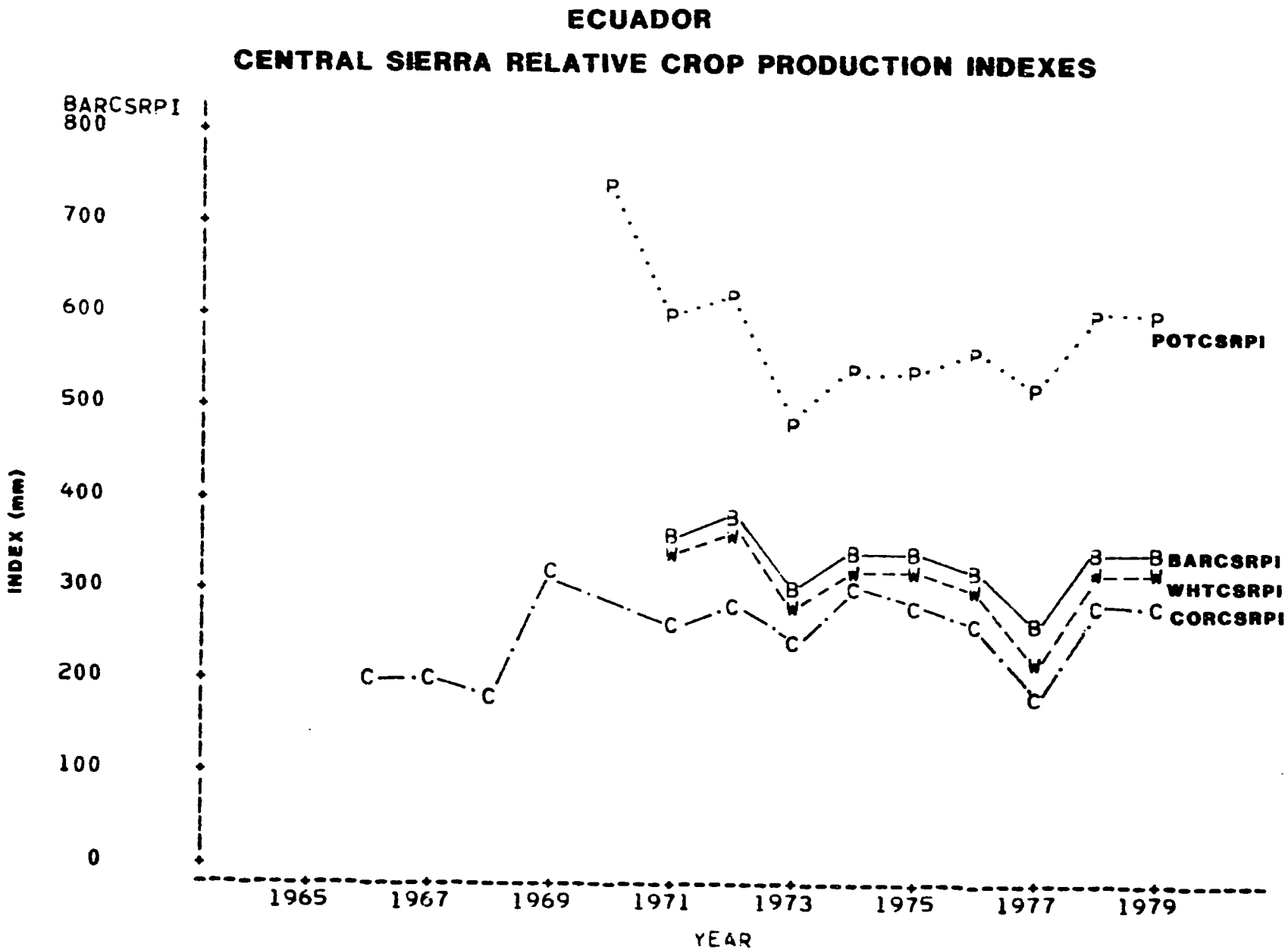

Figure 3.6b. Relative Crop Production Indexes for Central Sierra Area, expressed in milimeters for potatoes, barley, wheat and corn

TABLE 6.6

CENTRAL SIERRA RELATIVE PRODUCTION INDEXES

OBS	YEAR	LAYMICL4	LAYMIWL4	COYMIPU4	COYMIWU4	AMYMICL4	AMYMIWL4	PAYMICL4	PAYMIWL4	PIYMIWU4
1	1965	.	.	.	.	.	.	.	.	.
2	1966	224.6	224.6	850.0	807.0	171.7	171.7	214.1	214.1	.
3	1967	269.9	269.9	719.1	676.1	140.7	140.7	183.4	183.4	.
4	1968	250.1	250.1	631.6	608.6	221.4	221.4	157.4	157.4	.
5	1969	287.6	287.6	746.2	687.2	369.0	369.0	298.8	298.8	.
6	1970	.	.	1051.2	1016.2	297.2	297.2	229.4	229.4	721.6
7	1970	.	.	1051.2	1016.2	297.2	297.2	229.4	229.4	721.6
8	1971	260.2	260.2	1023.6	989.6	278.0	278.0	239.5	239.5	553.6
9	1972	212.5	212.5	1009.7	988.7	306.7	306.7	280.2	280.2	581.7
10	1973	269.5	269.5	847.3	826.3	255.5	255.5	338.8	338.8	509.8
11	1974	370.0	370.0	1097.8	995.3	315.1	315.1	307.2	307.2	591.2
12	1975	306.9	306.9	1183.7	1113.2	252.4	252.4	286.7	286.7	580.4
13	1976	353.4	353.4	658.7	638.7	206.8	206.8	312.9	312.9	671.1
14	1977	222.0	222.0	752.5	717.5	148.7	148.7	188.1	188.1	759.3
15	1978	288.3	288.3	663.8	634.3	281.1	281.1	272.6	272.6	799.8
16	1979	347.2	347.2	799.4	756.9	247.3	247.3	299.1	299.1	647.7

OBS	PIYMIPU4	RIYMICL4	RIYMIWL4	GUYMIWU4	GUYMIPU4	POTCSRPI	WHTCSRPI	CORCSRPI	BARCSRPI
1	.	.	.	.	.	.	.	.	.
2	.	203.4	203.4	375.4	388.9	.	.	204.708	.
3	.	177.8	177.8	296.0	329.0	.	.	194.234	.
4	.	133.8	133.8	285.6	312.1	.	.	181.728	.
5	.	344.1	344.1	461.9	479.9	.	.	326.868	.
6	786.6	298.7	298.7	579.6	604.1	730.752	.	.	.
7	786.6	298.7	298.7	579.6	604.1	730.752	.	.	.
8	627.6	278.8	278.8	468.1	489.1	608.640	347.676	267.118	355.373
9	652.2	322.4	322.4	464.8	488.8	616.668	366.319	285.602	371.975
10	594.8	191.7	191.7	287.4	294.9	481.148	272.609	248.334	295.619
11	652.2	232.2	232.2	288.3	299.8	536.520	320.245	293.694	[illegible].035
12	665.4	280.2	280.2	246.3	269.6	537.708	328.159	282.774	346.194
13	831.1	222.6	222.6	305.8	306.8	558.748	294.262	[illegible].402	314.078
14	870.3	183.4	183.4	158.3	169.3	519.684	227.326	167.264	250.299
15	921.8	271.8	271.8	290.3	297.3	591.080	311.806	277.578	[illegible].450
16	697.7	226.3	226.3	459.1	475.6	603.296	326.483	272.200	343.617

condition index (YMI) at each location and crop as appropriate for crops grown at the location. The YMI for the ripening crop stage (subscript 4) was used and not the YMI for previous crop stages. Table 6.6 shows the YMI variables used for all crops and stations. These are the 14 variables which precede the CSRCPI values in Table 6.6 and they correspond to the same variables in Appendix B. Each YMI variable has 8 characters. The first two stand for the station name ("LA" = Laticunga, "CO" = Cotopaxi, "AM" = Ambato, "PA" = Patate, "PI" = Pisayambo, "RI" = Riobamba, and "GU" = Guamote). The next 3 characters, "YMI", stand for Yield Moisture Index. The sixth character is the crop: "C" = corn, "W" = wheat, "B" = barley, and "P" = potatoes. The seventh character is "L" for lowland and "U" for upland location and the last character "4", as discussed above, refers the YMI at the end of ripening. Note that the CSRCPI for wheat and barley are exactly the same; therfore only one appears in Figure 6.3b.

Calculation of the CSRCPI is illustrated for potatoes, an upland crop, as follows:

POTCSRPI = .12 (COYMIPU4) + .400 (PIYMIPU4) + .480 (GUYMIPU4).

Unfortunately, missing monthly rainfall data at Pisayambo and Laticunga 1966-1970 precluded the definition of the CSRCPI for years other than 1971-1979. These missing data should be estimated and then the YMI and CSRCPI can be calculated for several additional years. This permits a much wider range of climatic conditions to appear in the index.

The CSRCPI is presented in meteorological units, i.e., total millimeters. The values of the index for two different crops should not be compared in an absolute sense. The CSRCPI for potatoes is about 600 mm while CSRCPI for other crops is about 300 mm. This does not necessarily indicate that the production of potatoes is twice other crops. Potatoes are grown in the moist uplands over a longer growing season, hence more rainfall in the index.

Relative fluctuations among the indices can be compared to see general drought impact. The index is really designed to provide a relative comparison between years for a particular crop. In the future, it is desirable to also convert each index to "percentiles" and "percent of normal" values. Another way would be to calculate "percent of last year" values for each index. How is the index used?

The CSRPI must be fully tested and evaluated to determine:

1) Does the CSRPI detect crop failure due to drought? Possibly using the YMT through flowering may be a better index variable.

2) How does one interpret the range of fluctuation in the index in terms of crop production? This requires calibration using episodic data, available crop statistics and qualitative information.

The CSRPI provides relative information on production, not absolute production values. After satisfactory test and evaluation, it can be used in assessments. Furthermore, this concept can be extended to other regions, even all of Ecuador, to provide regional or national indices for these crops, wool or lamb production, dairy production and others. It could also be computed using population estimates as a socio-economic index.

G. Palmer Drought Index (PDI)

The Palmer Drought Index was computed as discussed in Palmer (1965) except that "normal" Penman PET data were used (Table 6.5). The PDI is potentially a useful crop condition assessment tool, but these results must be fully tested and evaluated prior to operational use. Episodic data should be used for this purpose to determine if drought, normal crops or flooding actually occurred.

The PDI plot for seven meteorological stations in the Central Sierra are provided in Appendix C. Extreme drought was probably experienced at Amboto during 1957, 1963, and 1964, and at Patate in 1979. Periods of severe drought

probably affected agriculture at Ambato during 1946 and 1957, (see Figure 6.4), Cotopaxi in 1960, and 1961, and Patate in 1968 and 1969. Moderate drought conditions occurred at Guamote and Cotopaxi in 1978, Patate and Cotopaxi in 1968, Latacunga and Pisayambo in 1972, and Amboto in 1975 and 1967. The relationship between the PDI and the YMI is also evident (See Appendices).

H. Climatic Impact Assessment

A thorough test and evaluation is required before the Penman PET results and the agroclimatic/crop indices (YMI, CSRCPI or PDI) are used in test assessments. This requires calibration of the indices. The beginning of test and evaluation is discussed below.

The time series of each index was analyzed and compared with documented drought and crop damage and food shortages which took place in the Central Sierra of Ecuador during the years 1977, 1978, and 1979 (INAMHI, 1980). A good association between the indices (YMI and PDI) and reported crop conditions was found for these years, but other years must be tested.

I. Crop Water Requirements

The water requirement for the crops growing in the lowlands and the highlands of the Central Sierra are shown in Figures 6.5 and 6.6 (Ambato and Cotopaxi, respectively), and for the other stations in Appendix D. In the highlands, the "normal" precipitation is greater than "normal" Penman PET, and the crop water requirement is usually satisfied. In the lowlands the "normal" value of the Penman PET is greater than the "normal" precipitation, therefore irrigation is usually required in order to satisfy the crop water requirement. It is not surprising that the stations located in the lowlands correspond to the dry area of the Central Sierra. These results clearly indicate the difficulty posed to farmers using rainfed agricultural practices.

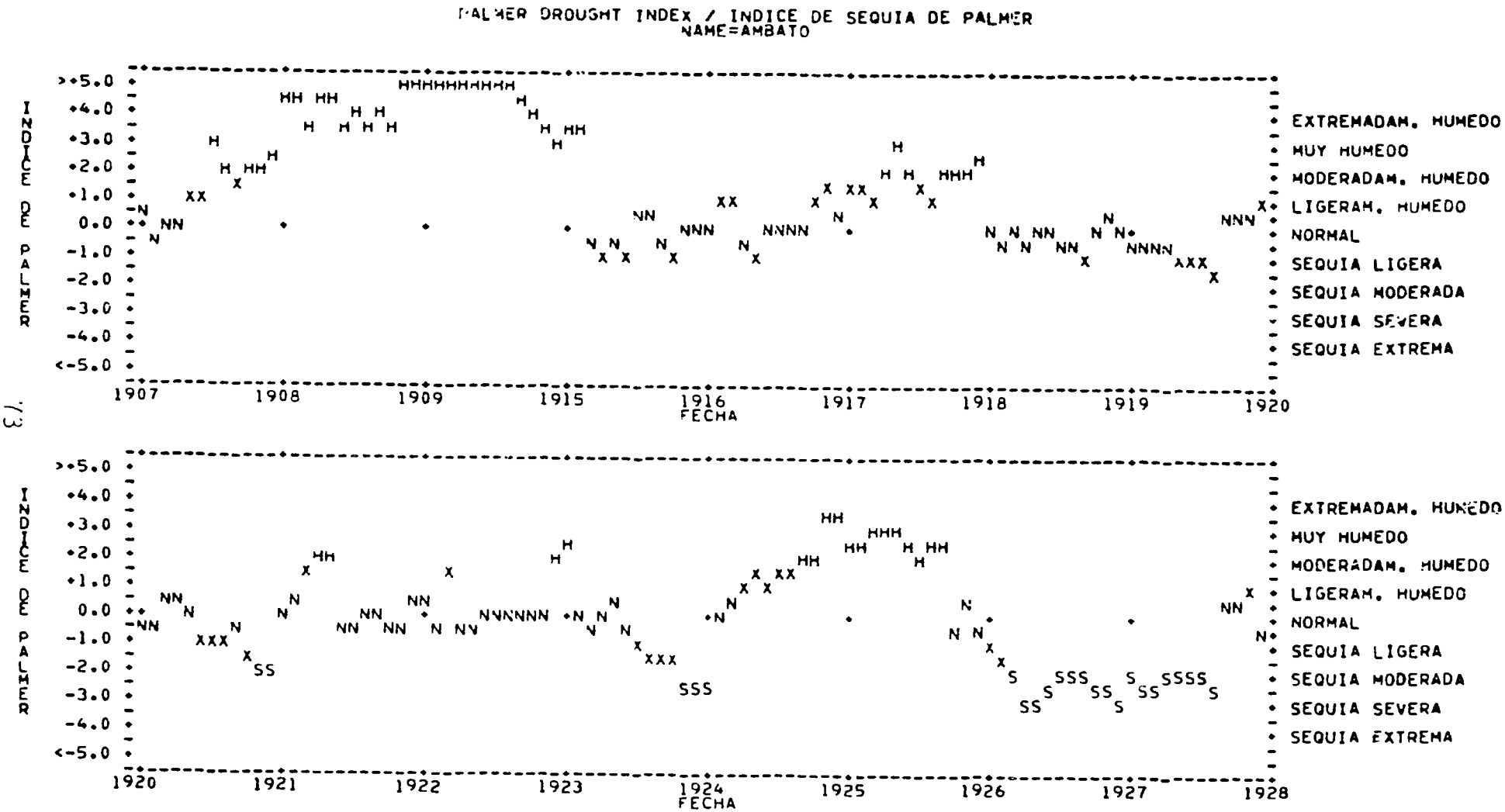

Figure 6. 4a Palmer Drought Index (PDI) for Ambato

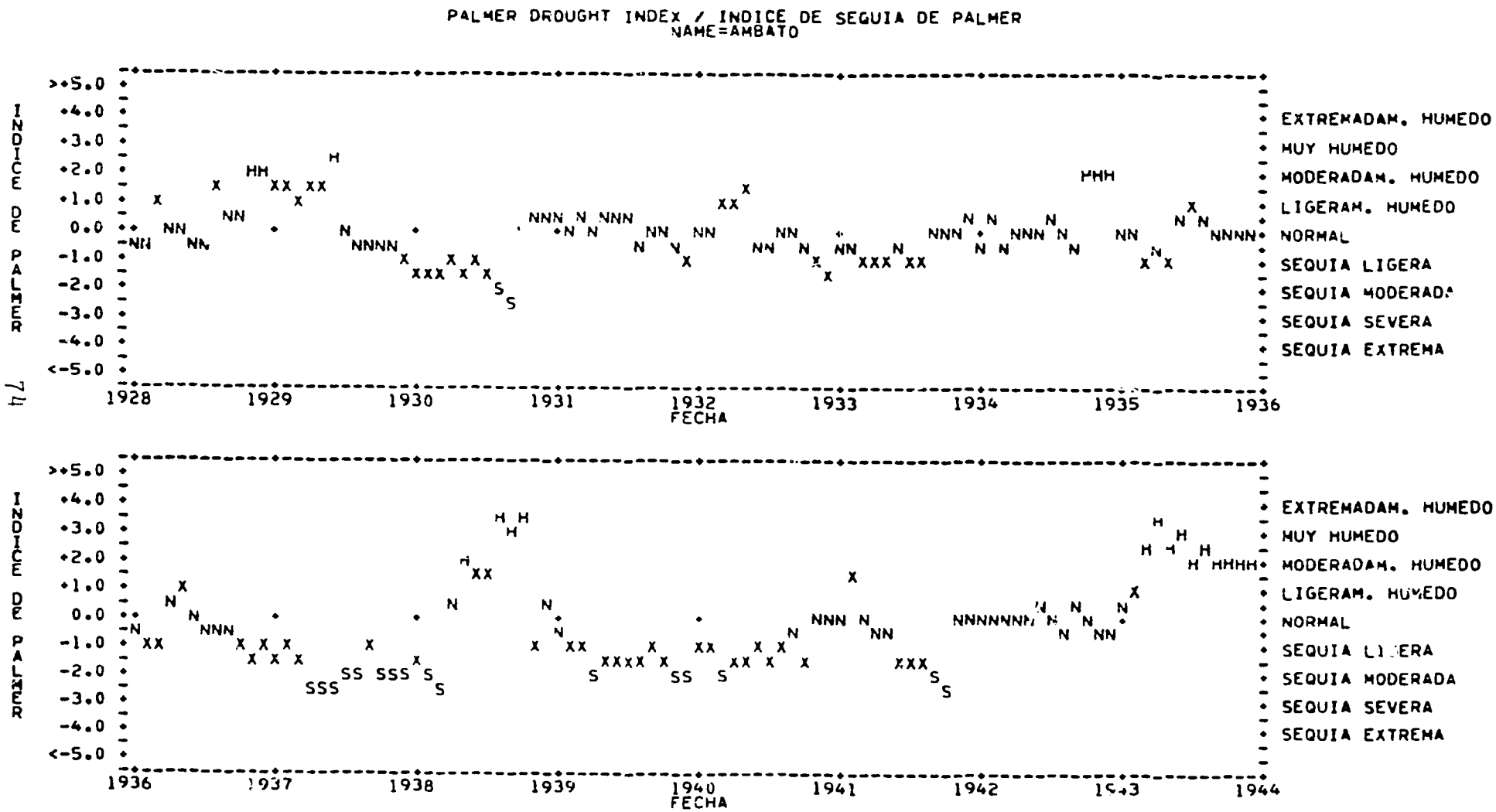

Figure 6 . 4b Palmer Drought Index (PDI) for Ambato

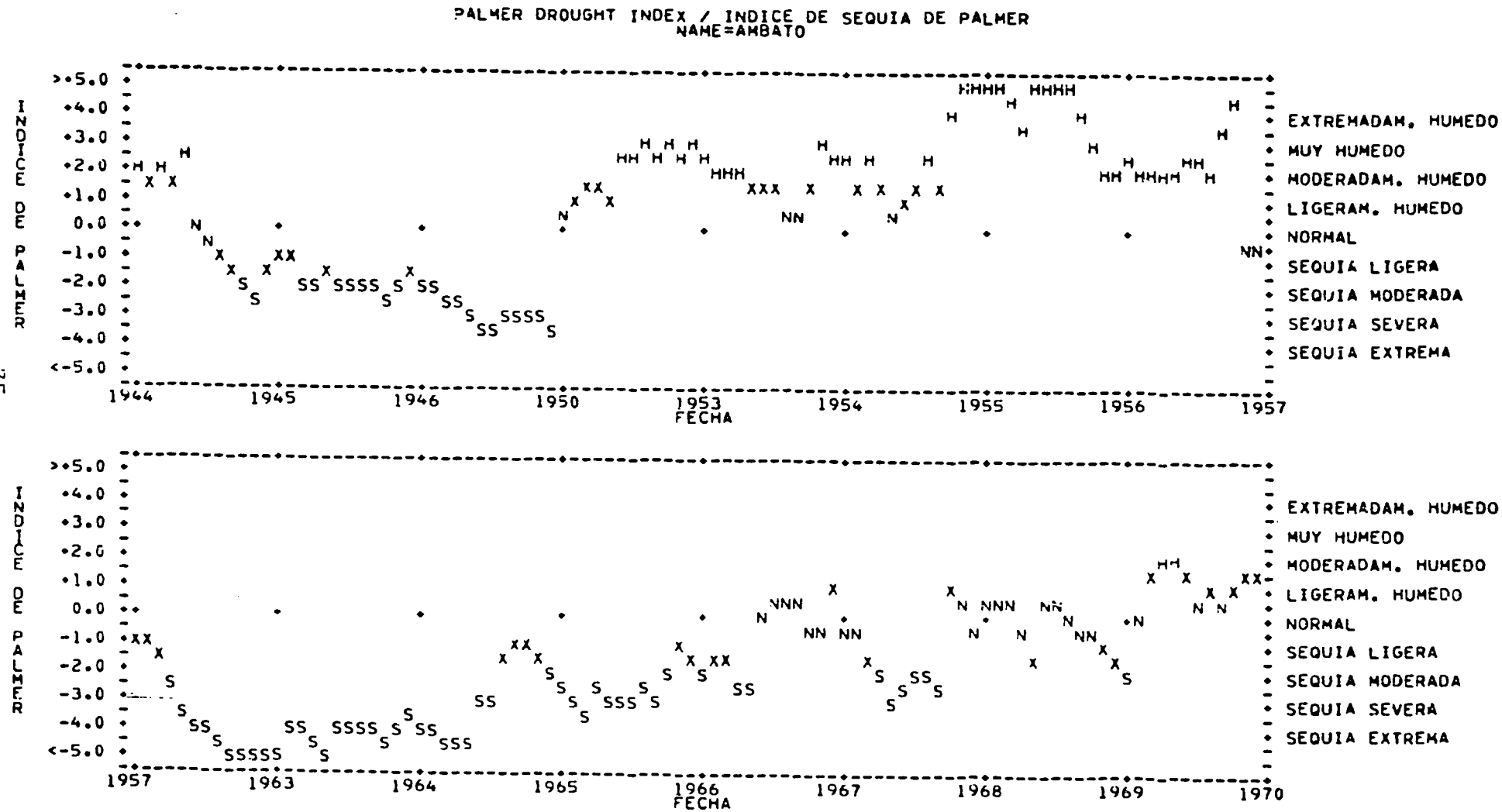

Figure 6. 4C Palmer Drought Index (PDI) for Ambato

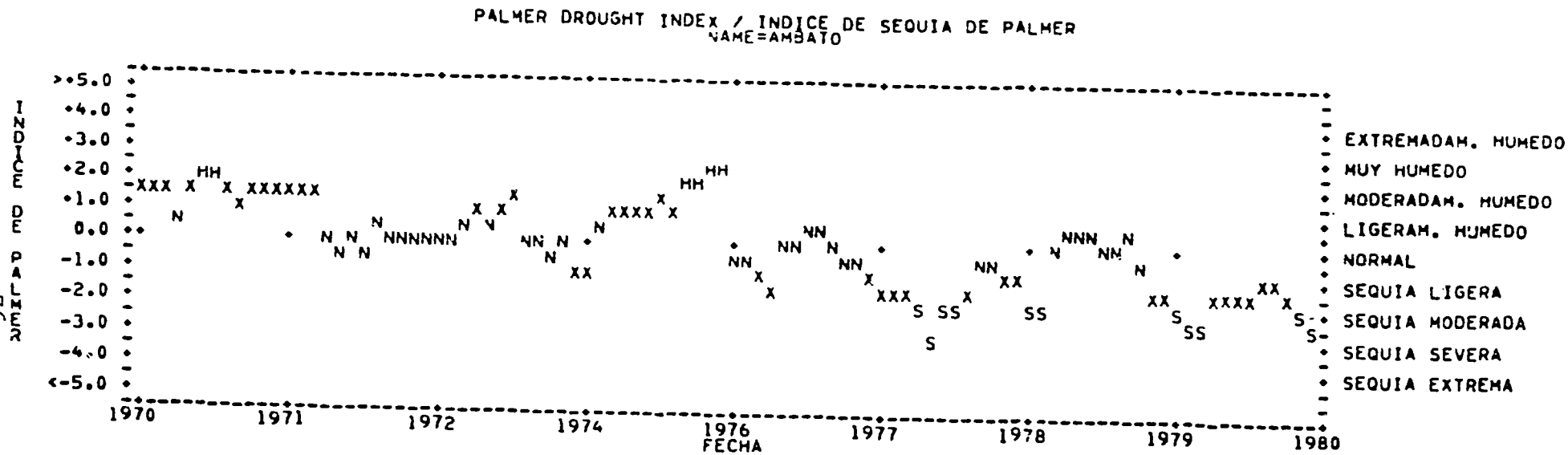

Figure 6. 4d Palmer Drought Index (PDI) for Ambato

PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER
NAME=AMBATO

PERIODOS CON SEQUIA

SEQUIA EXTREMA

1	JUN 1957	HASTA	NOV 1963	18	MESES
2	ENE 1964	HASTA	MAY 1964	5	MESES

SEQUIA SEVERA

1	MAY 1946	HASTA	DIC 1946	8	MESES
2	MAY 1957	HASTA	JUL 1964	27	MESES

SEQUIA MODERADA

1	MAR 1926	HASTA	AGO 1927	18	MESES
2	ABR 1937	HASTA	AGO 1937	5	MESES
3	JUN 1945	HASTA	NOV 1945	6	MESES
4	ENE 1946	HASTA	DIC 1946	12	MESES
5	ABR 1957	HASTA	JUL 1964	28	MESES
6	DIC 1964	HASTA	OCT 1965	11	MESES
7	ABR 1967	HASTA	SEP 1967	6	MESES

PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER
NAME=AMBATO

PERIODOS HUMEDOS

EXTREMADAM. HUMEDO

1	NOV 1908	HASTA	OCT 1909	12	MESES
2	OCT 1954	HASTA	MAR 1955	6	MESES
3	MAY 1955	HASTA	SEP 1955	5	MESES

MUY HUMEDO

1	ENE 1908	HASTA	FEB 1915	26	MESES
2	OCT 1954	HASTA	OCT 1955	13	MESES

MODERADAM. HUMEDO

1	OCT 1907	HASTA	FEB 1915	29	MESES
2	SEP 1924	HASTA	SEP 1925	13	MESES
3	MAR 1943	HASTA	ENE 1944	11	MESES
4	JUN 1950	HASTA	ABR 1953	11	MESES
5	OCT 1954	HASTA	OCT 1956	25	MESES

Figure 6.4e Palmer Drought Index (PDI) for Ambato

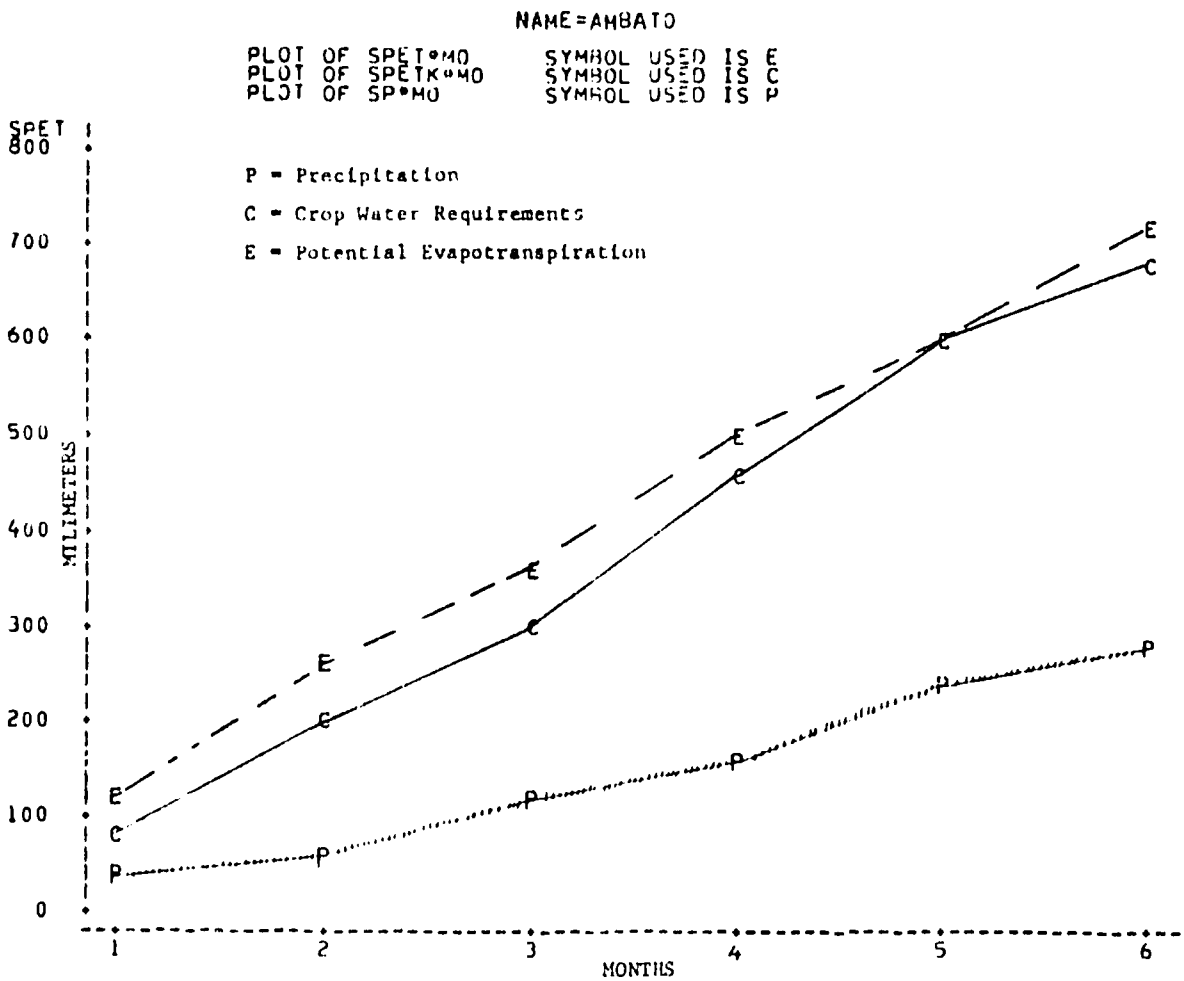

Figure 6. 5 Crop Water Requirements for wheat, barley and corn grown in Ambato

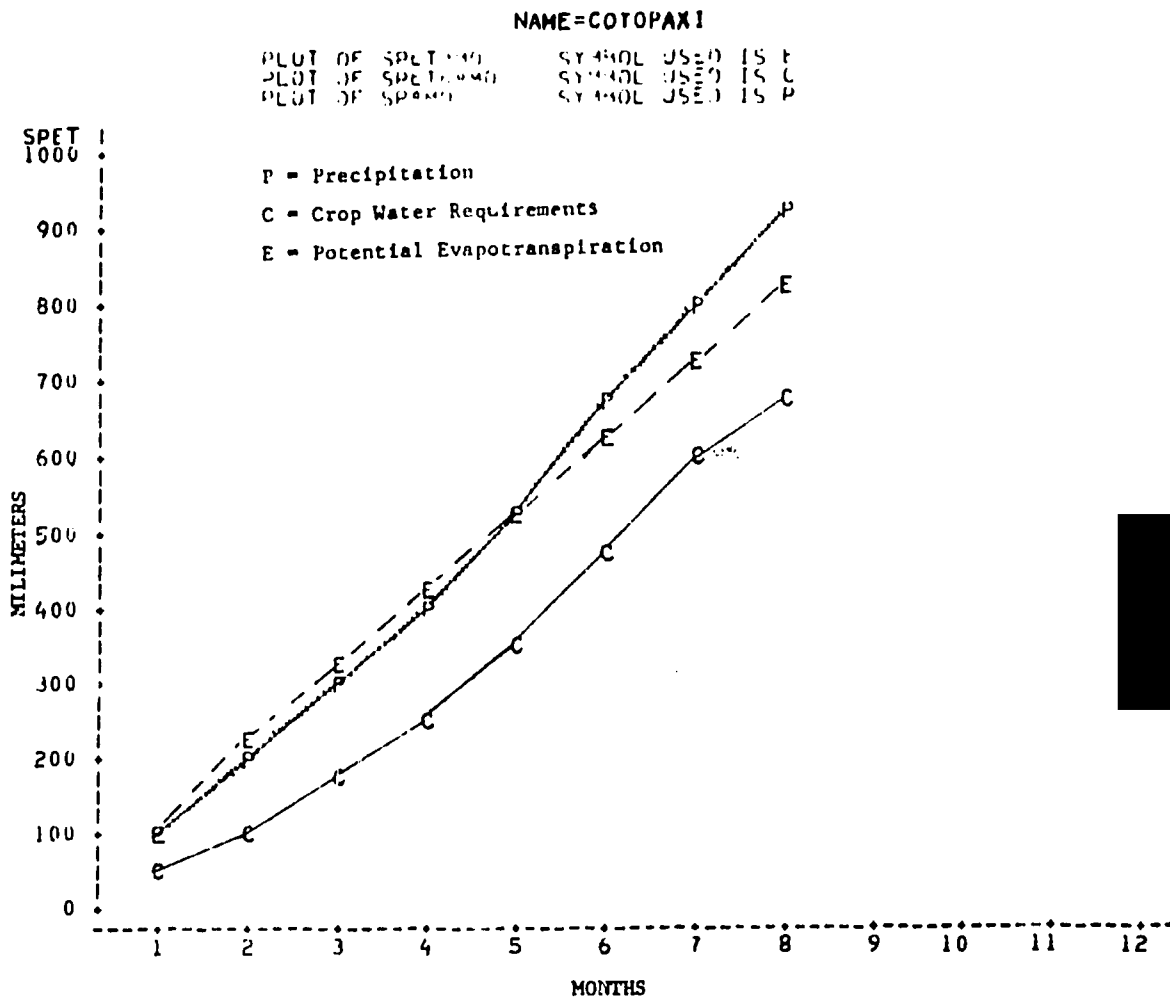

Figure 6 .6 Crop Water Requeriments for wheat,barley and potatoes grown in Cotopaxi

CHAPTER VII

CONCLUSIONS

Based on analysis of these case studies and on examination of Appendices, the following preliminary conclusions are shown:

1) The variance of precipitation is about 10-100 times larger than that of PET, therefore "normal" PET values can be used in land use studies. This also suggests that indices for crops could be based only on rainfall. To evaluate the potential evapotranspiration methods, both Penman and Hargreaves seem to be good methods for the region. In addition, more experimental work in the field for a number of years is needed in order to be able to clearly select the best method.

2) The agroclimatic/crop condition indices (YMI, PDI, CSRCCPI) could be used in the Assessment Program after test and evaluation. The YMI appears to provide a quick response to variable weather conditions for specific crop stages while the PDI appears to be a useful indicator of long-term effects of drought on general agricultural conditions.

3) If the YMI is expressed as a percentile ranking, the critical breaking-point for severe drought impact on crops is tentatively estimated at below the 20th percentile.

4) If the Palmer Drought Index exhibits a severity of less than or equal to 2.0 for at least two months during the growing season, the potential for drought impact on crops exists.

5) The Relative Crop Production Index appears to be a potentially useful index for Central Sierra relative crop production. After satisfactory test and evaluation, this concept could be extended to other regions and crops.

6) In general, the crops grown in the lowlands require irrigation during one or several growth stages in order to satisfy the crop water requirements. Upland crops normally receive enough rainfall to meet the crop water requirements. These results are clearly indicated in crop/water requirement estimates made for each location and for each crop.

CHAPTER VIII

RECOMMENDATIONS

This training program in agrometeorological assessment models at NOAA/CEAS is part of the proposed "Agroclimatic Analysis Program" for Ecuador in which the following institutions will participate:

1) National Institute of Meteorology and Hydrology of the Ministry of Natural Resources and Energy, Quito (Instituto Nacional de Meteorologia e Hidrologia, Quito)
2) National Program of Agrarian Regionalization, Quito. (Programa Nacional de Regionalizacion Agraria, Ministerio de Agricultura, Quito)
3) National Development Council, Quito (Consejo Nacional de Desarrollo, Quito).

The main goal of this project is to increase the national agricultural production through the best use of the agroclimatic resources of the country and by mitigating the impact of the weather and climate anomalies to crops. This involves the development of an Early Warning Assessment Program to provide reliable information on the potential for disastrous subsistence food shortages due to drought.

The agroclimatic models developed during this training program will be tested and evaluated with future crop yields. However, additional meteorological and crop yield data should be considered for testing purposes before the models may be released to users. There is also a need to acquire more agronomic data and to verify the crop calendars. More information on crops and soils will be needed to develop models and to determine better understanding of the crop/weather relationships.

An observational program needs to be established to include observations of soil moisture and solar radiation. Furthermore, additional precipitation stations are desirable in some areas of the country. It is very important that methods be developed to ensure that precipitation data are routinely forwarded for analysis within a few days after the end of each month.

The staff for the proposed "Agroclimatic Analysis Program" should receive technical training as soon as possible on climate/crop yield modeling. In this field of research, the Models Branch of NOAA/CEAS could provide technical assistance. Thus, technical support for the implementation as well as for answering specific questions on crop condition assessments, especially during the first stage of the project, are needed. Additionally there is need for a continuous improvement in the climatological and agricultural data used in crop yield modeling.

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APPENDIX A[1/]

COMPARISON OF SEVERAL METHODS FOR DETERMINING POTENTIAL EVAPOTRANSPIRATION (PET):

- o Meteorological Data
- o Statistics
- o PET Comparison

Notes: 1/ The monthly meteorological data, simple statistics for meteorological data and PET estimates are included.

"P" is precipitation (mm), "T" is mean temperature (°C), "W" is wind speed (m/s). "S" is total hours sunshine, "HR" relative humidity and "E" is pan evaporation (mm).

* CODE = T: *** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***
TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

---------- NAME=AMBATO ----------

OBS	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
1	1965	12	7	7	88	33	20	14	22	6	77	75	11
2	1966	13	52	50	14	31	47	34	28	37	24	40	79
3	1967	13	27	23	13	6	41	31	13	10	100	34	14
4	1968	48	46	68	28	15	64	22	9	18	44	17	8
5	1969	18	47	113	108	46	25	8	31	24	71	73	44
6	1970	34	56	46	44	94	55	26	22	23	62	52	40
7	1971	44	40	72	59	22	47	15	43	21	50	50	29
8	1972	38	42	72	85	32	72	29	20	22	20	57	7
9	1973	8	27	29	71	69	29	46	38	83	36	23	.
10	1974	20	65	90	55	69	33	42	10	76	57	65	52
11	1975	23	52	.	.	.	.	.	.	26	82	39	56
12	1976	13	32	26	45	50	47	34	20	25	18	52	19
13	1977	8	29	43	33	11	48	16	31	69	37	13	27
14	1978	10	31	60	100	39	46	10	20	47	6	1	27

---------- NAME=COTOPAXI ----------

OBS	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
15	1965	108	55	136	167	133	63	24	35	151	131	157	105
16	1966	168	77	138	106	123	86	44	25	103	101	79	90
17	1967	100	180	106	53	103	86	52	19	29	167	83	27
18	1968	135	89	118	99	30	45	44	35	102	133	53	67
19	1969	73	113	107	160	86	118	0	21	77	58	113	225
20	1970	116	151	110	202	201	70	39	41	101	61	114	102
21	1971	112	200	298	108	75	68	31	26	122	283	122	87
22	1972	126	154	245	72	148	42	21	75	32	33	181	96
23	1973	87	35	117	230	168	42	115	91	209	84	100	57
24	1974	69	259	168	140	235	205	75	16	209	189	163	157
25	1975	50	206	252	121	189	141	124	80	52	117	145	46
26	1976	81	82	82	103	148	40	24	19	50	105	139	82
27	1977	136	73	170	81	82	70	29	47	113	123	53	86
28	1978	64	74	78	151	123	59	68	38	84	13	41	88
29	1979	.	.	.	141	172	.	.	56	145	71	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

---------- NAME=GUAMOTE ----------

OBS	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
30	1965	32	24	25	102	45	9	3	9	18	96	140	46
31	1966	26	46	60	52	42	27	13	12	15	41	29	47
32	1967	49	69	44	44	23	66	34	3	9	106	19	1
33	1968	40	83	64	27	11	53	24	10	71	98	16	19
34	1969	37	83	78	156	10	36	5	9	39	81	83	125
35	1970	93	127	46	52	124	49	16	12	7	60	80	19
36	1971	41	54	169	75	14	42	3	17	42	102	26	18
37	1972	43	58	137	96	33	45	13	15	6	20	75	23
38	1973	18	65	90	18	21	15	22	21	59	31	14	37
39	1974	19	81	42	59	32	23	11	7	73	37	9	12
40	1975	2	113	61	17	13	47	68	4	26	108	58	2
41	1976	27	71	54	39	35	2	1	0	10	.	11	44
42	1977	23	12	24	38	0	22	3	22	59	43	23	22
43	1978	32	23	73	55	55	14	13	18	69	36	31	72
44	1979	.	90	140	.	.	.	.	129	0	8	.	.

---------- NAME=LATACUNGA ----------

OBS	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
45	1965	28	17	24	69	35	2	5	3	27	45	108	36
46	1966	17	19	72	37	45	28	17	13	37	89	52	63
47	1967	31	69	34	40	29	32	22	9	6	88	56	15
48	1968	39	62	89	29	6	44	9	34	32	48	55	36
49	1969	25	34	19	132	34	51	0	13	16	88	67	.
50	1970	.	72	25	62	88	25	6	8	7	63	50	24
51	1971	21	49	94	38	24	46	14	0	11	98	62	5
52	1972	51	69	46	28	13	8	0	31	9	17	51	31
53	1973	19	51	33	89	44	17	15	15	68	32	26	30
54	1974	18	87	95	74	56	29	37	2	69	68	88	37
55	1975	7	133	58	32	43	44	83	53	27	89	68	58
56	1976	27	40	96	72	62	29	14	6	16	55	44	46
57	1977	64	31	23	46	31	39	5	43	53	59	5	73
58	1978	10	28	56	77	52	3	34	3	46	6	36	66
59	1979	.	.	.	.	.	.	.	.	.	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

---------- NAME=PATATE ----------

OBS	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
60	1965	24	5	22	55	34	43	34	69	25	93	38	11
61	1966	12	38	84	13	53	79	75	61	58	35	51	124
62	1967	23	25	22	15	11	107	76	60	.	85	24	24
63	1968	40	33	52	1	15	39	42	12	30	19	13	12
64	1969	8	34	118	67	35	40	11	59	38	33	80	22
65	1970	31	60	34	17	85	64	66	141	25	41	40	11
66	1971	37	37	58	63	25	92	45	76	33	27	52	30
67	1972	32	50	59	60	51	108	101	32	43	23	126	18
68	1973	14	29	54	109	113	46	71	79	93	51	21	30
69	1974	32	53	65	40	102	72	106	15	99	74	54	31
70	1975	18	61	57	57	66	125	127	71	52	101	31	45
71	1976	28	37	51	66	87	102	79	33	30	27	50	21
72	1977	14	43	36	40	35	121	34	66	121	39	17	24
73	1978	14	33	59	88	44	87	21	43	55	13	1	15
74	1979	.	12	74	92	66	34	.	84	49	20	.	.
75	1979	.	.	.	.	.	.	.	.	.	.	.	.

---------- NAME=PISAYAMBO ----------

OBS	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
76	1965	.	.	.	.	.	.	.	.	.	.	.	.
77	1966	.	.	.	.	.	.	.	.	.	.	.	.
78	1967	.	.	.	.	.	.	.	.	.	.	.	.
79	1968	.	.	.	.	.	.	.	.	.	.	.	.
80	1969	27	40	104	159	98	103	63	148	53	155	94	64
81	1970	79	125	132	85	149	130	213	103	89	87	96	40
82	1971	53	86	111	99	78	148	93	195	86	71	62	65
83	1972	90	68	102	116	74	141	150	40	76	93	135	61
84	1973	42	70	63	92	91	.	97	87	116	46	53	85
85	1974	70	110	78	102	131	122	154	58	156	143	92	116
86	1975	54	124	50	72	103	.	.	125	76	140	52	83
87	1976	72	85	79	128	175	320	293	241	97	67	121	64
88	1977	17	172	156	161	93	222	148	169	159	68	55	85
89	1978	58	126	172	189	100	244	142	133	107	56	41	32
90	1979	.	.	91	201	.	100	118	92	89	56	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=RIOBAMBA

OBS	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
91	1965	15	9	15	74	48	14	7	13	23	103	118	40
92	1966	6	37	79	21	17	45	21	8	17	35	45	40
93	1967	23	43	43	26	7	46	13	8	16	86	30	18
94	1968	29	36	40	9	4	55	14	2	42	11	1	9
95	1969	26	31	106	119	20	43	7	.	13	31	52	35
96	1970	39	87	28	46	84	62	.	.	17	50	110	30
97	1971	49	27	76	67	25	39	16	26	53	54	61	36
98	1972	36	70	81	69	23	67	23	12	7	11	47	29
99	1973	18	25	23	61	39	7	1	24	28	22	13	16
100	1974	2	29	82	56	31	35	21	10	57	77	29	24
101	1975	19	99	55	58	17	74	82	24	47	76	48	22
102	1976	16	40	41	39	73	29	11	24	8	23	65	22
103	1977	21	32	51	41	11	26	3	50	58	22	18	32
104	1978	14	47	26	105	44	29	22	5	47	12	3	21
105	1979	.	20	.	55	58	6	.	18	46	.	.	.

NAME=RUMIPAMBA

OBS	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
106	1965	.	.	.	.	.	.	.	.	.	.	.	.
107	1966	.	.	.	.	.	.	.	.	.	.	.	.
108	1967	.	.	.	.	.	.	.	.	.	.	.	.
109	1968	.	.	.	.	.	.	.	.	.	.	.	.
110	1969	.	.	.	.	.	.	.	.	.	.	.	.
111	1970	.	.	.	.	.	.	.	.	.	.	.	.
112	1971	.	.	.	.	.	.	.	.	.	.	.	.
113	1972	.	.	.	.	.	.	.	.	.	.	.	.
114	1973	.	.	.	.	.	.	.	.	.	.	.	.
115	1974	.	.	.	.	.	.	.	.	.	.	.	.
116	1975	.	.	.	.	.	.	.	.	.	.	.	.
117	1976	.	.	.	.	.	.	.	.	.	.	.	.
118	1977	30	29	44	68	14	24	25	16	17	23	84	72
119	1978	14	47	26	105	44	29	9	32	76	45	28	73
120	1979	.	18	93	93	55	13	22	5	47	12	3	21
								17	0	49	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=AMBATO

OBS	YEAR	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
1	1965	14.0	13.0	13.0	14.0	14.0	12.0	12.0	12.0	14.0	14.0	14.0	14.0
2	1966	14.0	14.0	14.0	14.0	14.0	13.0	12.0	13.0	13.0	14.0	15.0	14.0
3	1967	13.0	14.0	14.0	14.0	14.0	12.0	12.0	12.0	12.0	13.0	14.0	14.0
4	1968	13.0	13.0	12.0	14.0	13.0	12.0	11.0	12.0	13.0	14.0	14.0	14.0
5	1969	14.0	14.0	14.0	14.0	13.0	13.0	12.0	12.0	13.0	14.0	14.0	14.0
6	1970	13.0	14.0	13.0	14.0	13.0	12.0	12.0	11.0	12.0	14.0	14.0	13.0
7	1971	14.0	13.0	13.0	13.0	13.0	12.0	12.0	12.0	12.0	13.0	14.0	13.0
8	1972	13.0	13.0	14.0	14.0	14.0	13.0	13.0	13.0	13.0	14.0	15.0	14.0
9	1973	14.0	15.0	14.0	14.0	13.0	13.0	12.0	12.0	13.0	13.0	14.0	14.0
10	1974	13.3	13.0	12.8	12.9	12.4	12.0	11.3	12.1	12.4	13.1	13.5	13.0
11	1975	12.3	13.1	13.2	13.4	13.0	12.1	11.7	11.9	12.0	12.6	13.5	13.3
12	1976	12.8	13.1	13.8	13.6	13.0	12.1	11.4	11.6	13.1	14.2	13.4	14.0
13	1977	14.3	13.1	13.8	14.1	13.5	12.5	12.3	13.1	12.8	14.1	14.4	15.0
14	1978	14.7	14.5	14.4	14.3	14.4	12.8	12.8	12.4	13.5	14.3	15.5	15.1

NAME=COTOPAXI

OBS	YEAR	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
15	1965	7.5	7.7	7.6	7.4	7.6	7.1	7.3	7.1	8.0	8.0	7.8	8.1
16	1966	8.4	8.3	8.3	7.8	8.3	7.7	7.3	7.7	7.6	7.9	8.1	7.9
17	1967	7.7	7.8	8.1	8.2	8.0	7.2	7.6	7.5	7.8	7.6	8.0	7.7
18	1968	7.7	7.8	7.8	8.1	7.7	7.8	7.7	7.9	17.7	8.0	8.0	7.9
19	1969	7.9	8.1	8.5	6.4	8.0	7.9	8.0	8.0	8.2	8.3	8.2	8.3
20	1970	8.4	8.2	8.5	8.1	8.3	8.1	8.2	7.9	8.1	8.2	7.9	8.3
21	1971	8.2	8.1	7.9	8.2	8.3	8.3	8.1	8.0	7.8	7.7	8.0	7.9
22	1972	8.1	7.9	8.2	8.2	8.4	8.0	8.1	8.2	8.2	8.2	8.5	8.0
23	1973	8.1	8.5	8.5	8.6	8.5	8.1	8.6	8.7	8.6	8.4	8.6	8.6
24	1974	8.4	8.1	8.4	8.6	8.5	8.3	8.3	8.3	8.3	8.4	8.6	8.5
25	1975	8.4	8.4	8.5	8.4	8.5	8.1	7.9	8.0	8.1	8.4	8.5	8.6
26	1976	8.3	8.4	8.5	8.5	8.5	8.3	8.1	8.2	8.3	8.6	8.5	8.6
27	1977	8.6	8.6	8.7	8.7	8.5	8.4	8.5	8.4	8.1	8.5	9.0	8.6
28	1978	.	8.8	8.8	8.5	8.6	8.5	8.8	8.4	8.4	8.5	8.8	8.6
29	1979	.	.	.	.	.	.	.	.	.	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

---------- NAME=GUAMOTE ----------

OBS	YEAR	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
30	1965	12.4	12.4	12.2	11.6	12.0	11.8	12.2	11.3	12.0	12.2	12.5	13.1
31	1966	12.8	13.1	13.1	12.8	13.3	12.8	12.0	12.4	12.7	13.1	13.1	13.0
32	1967	12.9	13.1	13.2	13.5	13.3	12.7	13.3	13.7	13.2	13.1	13.7	14.4
33	1968	13.4	13.6	13.1	14.5	13.5	12.1	11.8	13.0	13.3	13.0	14.1	13.9
34	1969	14.1	14.2	13.5	13.1	13.6	13.4	13.3	12.6	13.0	13.3	13.8	13.3
35	1970	13.7	13.2	13.6	14.0	13.4	13.2	14.0	13.3	13.5	14.0	12.8	14.2
36	1971	13.9	13.4	12.5	13.5	14.2	13.7	13.5	12.7	13.2	13.1	14.2	13.7
37	1972	13.4	13.3	12.9	13.3	14.2	13.3	13.6	13.6	13.9	13.4	13.4	13.6
38	1973	13.8	13.7	14.0	13.2	13.7	13.8	13.3	13.1	13.3	13.7	13.9	13.3
39	1974	14.0	13.2	13.4	13.5	13.3	13.8	13.4	13.7	13.2	13.8	14.1	13.8
40	1975	14.0	13.0	13.9	13.8	14.4	13.9	12.4	13.2	13.5	13.3	13.6	13.8
41	1976	14.4	13.9	14.3	13.5	13.9	14.2	14.1	14.2	14.3	.	13.9	13.7
42	1977	14.5	14.2	14.7	14.3	14.6	14.9	14.6	12.7	12.4	12.3	13.2	13.3
43	1978	13.0	13.0	13.3	13.1	13.1	12.5	11.9	11.7	11.7	12.2	12.2	11.7
44	1979	.	13.2	12.0	.	.	.	.	13.8	13.1	12.7	.	.

---------- NAME=LATACUNGA ----------

OBS	YEAR	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
45	1965	13.6	13.4	13.0	13.2	13.3	12.5	12.5	12.0	13.4	13.7	13.8	14.0
46	1966	13.8	13.6	13.5	13.1	14.0	12.8	12.5	12.6	12.8	13.5	14.0	13.6
47	1967	13.1	13.4	13.9	13.1	13.7	11.6	11.8	11.3	12.1	12.8	13.9	14.1
48	1968	13.1	13.1	12.6	14.1	13.3	12.2	11.7	12.8	13.1	13.3	13.4	14.1
49	1969	14.2	14.5	14.2	13.9	13.4	12.8	12.1	11.9	13.1	14.0	13.4	.
50	1970	13.4	13.7	13.6	13.7	12.9	12.5	12.7	11.7	12.6	13.5	13.1	13.6
51	1971	13.6	12.8	12.6	12.7	13.1	12.5	12.1	11.9	12.3	13.1	13.6	13.4
52	1972	13.9	13.7	12.9	12.9	13.1	12.4	12.1	12.7	13.2	13.5	13.6	14.0
53	1973	13.8	14.3	14.1	13.7	13.3	13.4	13.1	12.4	12.3	13.2	14.2	13.2
54	1974	13.5	12.8	13.1	12.8	12.6	12.5	11.8	12.4	12.1	12.8	13.2	13.1
55	1975	12.8	13.1	12.9	13.5	13.1	11.9	11.3	11.9	12.3	12.3	12.8	13.2
56	1976	12.8	13.1	13.5	13.3	12.7	12.1	11.5	11.7	13.0	13.6	13.3	13.8
57	1977	14.1	13.2	13.6	13.7	13.3	12.6	12.8	12.5	13.1	14.2	.	14.4
58	1978	14.1	14.6	14.3	13.8	13.4	12.4	12.5	12.2	12.8	14.1	14.9	14.3
59	1979	.	.	.	.	.	.	.	.	.	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

---------- NAME=PATATE ----------

OBS	YEAR	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
60	1965	16.2	16.0	15.4	16.1	15.7	14.3	14.4	14.6	15.7	16.3	16.4	15.9
61	1966	15.8	15.6	15.8	16.0	16.1	15.3	14.4	15.1	15.4	16.1	16.7	16.2
62	1967	15.1	15.6	16.1	16.0	15.7	14.1	13.9	13.9	.	15.5	17.0	16.5
63	1968	15.5	16.6	15.5	16.4	15.4	15.0	14.2	15.2	15.9	16.3	17.0	16.8
64	1969	16.8	17.4	16.6	16.6	16.2	15.7	15.0	14.6	16.1	16.6	16.5	16.7
65	1970	16.4	16.4	15.9	16.3	15.7	15.8	15.1	14.7	15.5	16.4	16.2	16.1
66	1971	16.5	15.9	15.9	16.1	16.1	15.0	14.4	14.4	14.9	16.2	16.5	15.7
67	1972	16.1	16.1	16.3	16.3	16.4	15.8	15.3	15.7	15.8	16.6	16.5	16.6
68	1973	15.9	16.2	16.8	16.4	15.8	16.0	15.6	15.5	15.7	16.7	17.3	16.5
69	1974	16.0	15.8	16.2	16.5	15.7	15.4	14.8	15.4	15.3	16.2	16.5	16.2
70	1975	15.6	16.0	15.9	16.3	15.9	14.6	14.1	14.7	15.0	15.6	16.3	16.3
71	1976	15.9	16.1	16.4	15.9	15.6	14.6	13.8	14.3	15.8	16.7	16.3	17.1
72	1977	17.2	16.0	16.7	16.8	16.1	15.3	15.4	15.5	16.0	17.0	17.2	17.3
73	1978	17.5	17.1	17.0	16.7	16.7	15.5	15.2	14.6	15.8	16.8	17.8	17.6
74	1979	.	17.1	17.2	16.8	16.8	15.7	15.6	16.1	16.4	17.3	.	.
75	1979	.	.	.	.	.	.	.	.	.	.	.	.

---------- NAME=PISAYAMBO ----------

OBS	YEAR	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
76	1965	.	.	.	.	.	.	.	.	.	.	.	.
77	1966	.	.	.	.	.	.	.	.	.	.	.	.
78	1967	.	.	.	.	.	.	.	.	.	.	.	.
79	1968	.	.	.	.	.	.	.	.	.	.	.	.
80	1969	7	7	8	8	8	7	5	6	7	8	8	8
81	1970	7	7	7	8	7	6	6	5	6	7	7	7
82	1971	7	7	7	7	7	6	5	5	5	7	7	6
83	1972	7	7	7	7	8	7	6	6	6	7	8	8
84	1973	7	8	8	8	7	.	7	6	6	7	7	7
85	1974	7	7	7	7	7	6	5	6	6	7	7	7
86	1975	6	7	7	7	7	6	.	6	6	6	7	7
87	1976	7	7	8	8	7	6	5	5	6	8	8	8
88	1977	8	7	8	8	7	7	6	6	7	8	8	8
89	1978	8	8	8	8	8	6	6	6	7	8	8	8
90	1979	.	8	8	8	.	7	6	7	8	8	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=RIOBAMBA

OBS	YEAR	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
91	1965	14	14	14	14	13	12	13	13	14	14	14	14
92	1966	14	14	14	14	15	13	13	13	13	14	15	14
93	1967	13	14	14	13	14	12	12	12	13	14	14	14
94	1968	13	14	13	15	14	13	12	13	14	14	14	15
95	1969	14	15	14	14	14	13	12	.	13	14	14	14
96	1970	14	14	14	14	13	12	.	.	12	14	13	13
97	1971	14	13	13	13	13	13	12	12	13	14	14	13
98	1972	14	13	13	14	14	13	13	13	13	14	.	15
99	1973	14	15	15	14	14	14	13	12	13	14	15	.
100	1974	14	13	14	14	13	13	12	13	13	13	14	13
101	1975	14	13	13	14	14	12	12	12	12	13	14	14
102	1976	14	14	14	14	13	12	12	12	13	14	14	14
103	1977	15	14	14	14	14	13	.	13	13	14	14	15
104	1978	14	15	14	14	14	13	13	12	13	14	15	15
105	1979	.	14	.	10	14	13	13	13	14	.	.	.

NAME=RUMIPAMBA

OBS	YEAR	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
106	1965	.	.	.	.	.	.	.	.	.	.	.	.
107	1966	.	.	.	.	.	.	.	.	.	.	.	.
108	1967	.	.	.	.	.	.	.	.	.	.	.	.
109	1968	.	.	.	.	.	.	.	.	.	.	.	.
110	1969	.	.	.	.	.	.	.	.	.	.	.	.
111	1970	.	.	.	.	.	.	.	.	.	.	.	.
112	1971	.	.	.	.	.	.	.	.	.	.	.	.
113	1972	.	.	.	.	.	.	.	.	.	.	.	.
114	1973	.	.	.	.	.	.	.	.	.	.	.	.
115	1974	.	.	.	.	.	.	.	.	.	.	.	.
116	1975	.	.	.	.	.	.	.	.	.	.	.	.
117	1976	.	.	.	.	.	.	.	.	.	.	.	.
118	1977	15	14	15	14	14	13	12	12	13	14	14	14
119	1978	14	15	14	14	14	13	14	13	14	15	16	15
120	1979	.	15	15	14	13	13	13	12	13	14	15	15
									14	14	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=AMBATO

OBS	YEAR	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
1	1965	3.1	3.3	1.6	2.0	2.6	2.7	3.0	3.1	3.0	2.4	1.9	2.5
2	1966	2.7	2.5	2.7	2.5	3.1	2.7	3.1	4.0	3.0	2.6	2.4	2.2
3	1967	2.3	2.3	2.6	2.6	2.7	1.9	2.1	2.7	2.8	2.0	1.8	2.2
4	1968	2.2	1.6	1.8	2.0	2.5	2.1	2.2	2.8	2.3	2.1	1.7	2.1
5	1969	2.4	1.8	1.6	1.5	1.8	2.9	3.9	1.8	2.5	1.8	1.9	2.1
6	1970	2.3	3.5	2.4	2.5	2.9	3.6	3.8	3.6	4.3	3.8	2.3	2.9
7	1971	1.7	2.1	1.6	1.6	1.9	2.0	2.6	2.4	2.8	2.6	2.4	3.3
8	1972	2.0	1.9	2.1	1.7	1.9	2.7	3.4	2.8	3.8	2.8	2.0	2.3
9	1973	3.1	3.0	3.1	2.1	2.4	2.3	3.1	2.6	2.6	2.0	3.1	.
10	1974	2.1	1.6	1.6	1.7	1.5	1.4	2.5	2.3	2.1	2.0	2.1	2.1
11	1975	2.1	1.7	.	.	.	.	.	.	1.7	0.9	1.1	1.4
12	1976	1.3	1.2	1.1	1.0	1.0	0.7	1.4	1.3	1.4	1.1	1.0	1.2
13	1977	1.1	1.0	1.2	1.0	1.1	1.2	1.0	.	1.0	1.2	0.8	1.0
14	1978	1.2	1.3	1.2	1.0	1.0	0.8	0.8	1.0	0.9	1.1	1.0	0.9

NAME=COTOPAXI

OBS	YEAR	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
15	1965	5.0	3.4	2.8	2.9	3.8	5.6	5.6	6.4	4.3	5.1	4.5	4.7
16	1966	4.8	5.1	4.7	4.6	4.5	4.7	5.1	4.9	4.6	3.8	4.4	4.7
17	1967	3.8	4.4	5.2	5.9	4.8	5.5	6.7	8.8	7.4	7.2	8.2	8.8
18	1968	8.6	7.7	7.3	7.7	8.8	7.5	9.0	8.9	7.4	6.7	8.3	7.2
19	1969	.	7.3	7.3	6.7	6.8	6.3	10.7	7.0	8.0	6.9	5.9	4.7
20	1970	6.2	6.0	6.2	5.2	5.4	7.0	8.0	7.5	6.1	6.3	6.8	7.3
21	1971	6.0	6.9	5.7	7.5	7.8	8.9	9.0	8.5	7.8	7.9	8.3	8.6
22	1972	8.9	7.8	7.3	7.9	8.5	8.9	10.5	9.1	8.0	7.8	6.0	6.7
23	1973	7.8	7.5	5.9	4.1	5.8	5.4	8.7	.	6.7	7.1	7.2	6.5
24	1974	7.5	6.4	7.9	8.0	7.6	7.9	10.5	9.5	7.0	7.9	7.5	8.8
25	1975	8.5	7.6	7.3	7.6	7.4	8.7	7.1	7.6	8.5	6.1	7.8	9.7
26	1976	8.3	7.8	7.7	7.9	8.8	9.0	10.2	8.6	8.4	7.2	6.7	8.2
27	1977	6.9	6.1	7.4	7.5	7.6	8.0	8.6	7.8	6.9	5.8	6.5	6.9
28	1978	.	6.7	5.9	5.6	6.4	7.6	5.8	7.9	5.6	6.6	5.7	4.1
29	1979	.	1.9	2.0	1.9	2.0	1.6	1.5	.	.	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=GUAMOTE

OBS	YEAR	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
30	1965	4.9	4.6	3.9	4.0	4.7	4.5	5.1	5.1	4.4	4.4	4.9	5.6
31	1966	5.2	5.4	5.4	5.3	4.4	6.1	5.8	5.6	6.0	5.8	6.6	5.5
32	1967	5.1	5.5	6.2	6.8	6.3	5.7	6.0	8.2	7.4	5.6	7.7	8.6
33	1968	7.2	6.8	6.1	7.7	7.7	6.8	6.9	7.4	6.7	6.6	8.2	7.0
34	1969	7.8	7.0	5.5	3.9	6.2	4.9	7.8	7.5	6.6	6.9	5.8	6.4
35	1970	8.5	7.8	5.2	7.2	5.8	7.4	8.1	8.1	8.9	7.6	6.6	8.1
36	1971	8.9	7.5	5.9	9.7	8.6	8.2	9.5	7.7	8.6	6.7	7.8	6.7
37	1972	7.0	6.5	4.9	6.0	6.8	7.1	8.2	8.4	8.2	8.6	6.4	8.0
38	1973	7.5	6.3	6.4	4.4	6.3	6.6	7.0	6.8	5.9	7.6	9.1	8.4
39	1974	8.7	5.5	7.4	7.1	6.3	6.3	8.3	8.4	6.9	7.8	7.9	7.2
40	1975	8.3	5.7	6.1	7.9	8.5	8.0	5.5	8.5	7.0	5.8	5.6	7.8
41	1976	6.7	5.3	6.0	6.5	6.7	7.4	9.3	11.2	9.5	.	6.9	7.7
42	1977	8.1	7.3	9.3	8.8	9.4	8.8	9.3	9.4	9.5	9.1	8.8	8.3
43	1978	7.8	5.9	4.8	4.8	5.2	4.2	2.7	2.8	2.2	3.3	4.0	3.0
44	1979	.	5.7	.	4.8	9.3	6.2	10.8	7.3	9.0	6.5	.	.

NAME=LATACUNGA

OBS	YEAR	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
45	1965	2.0	1.9	1.8	2.0	2.0	2.8	2.8	2.8	2.5	2.9	1.8	2.6
46	1966	2.6	4.9	4.4	4.5	2.4	2.5	1.4	.	4.5	3.1	3.1	3.0
47	1967	3.1	2.3	2.4	2.5	2.8	3.0	3.5	3.4	3.2	3.4	2.6	2.4
48	1968	2.3	1.5	1.6	1.8	2.4	2.5	3.5	3.2	2.3	2.4	2.2	2.7
49	1969	3.0	1.4	1.6	2.2	2.7	3.0	7.2	3.2	3.1	2.6	2.7	.
50	1970	5.1	3.0	2.3	3.3	2.6	2.9	3.4	3.0	2.9	2.6	1.9	2.1
51	1971	1.5	1.4	0.3	1.3	1.6	1.6	1.9	0.7	1.5	1.3	1.6	1.9
52	1972	1.7	1.5	1.3	1.3	1.2	1.7	2.4	1.5	2.6	1.6	1.4	1.6
53	1973	1.6	1.6	2.7	1.5	1.6	0.7	1.5	4.1	1.8	2.1	0.7	1.4
54	1974	1.9	1.6	1.5	1.7	2.7	2.4	2.8	3.3	2.2	1.5	2.0	1.6
55	1975	2.2	0.9	1.2	1.5	1.5	2.5	2.0	2.8	2.2	1.6	1.5	1.5
56	1976	1.9	1.4	1.5	1.7	1.9	2.3	3.4	3.1	3.1	1.6	1.7	1.6
57	1977	1.6	2.5	2.5	1.4	2.8	2.9	4.1	2.8	2.2	0.9	.	1.6
58	1978	2.6	2.1	1.6	1.4	1.8	2.7	2.7	3.4	2.1	2.4	2.3	1.3
59	1979	.	4.1	.	4.0	3.9	5.4	5.2	5.0	4.5	3.8	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=PATATE

OBS	YEAR	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
60	1965	3.5	3.3	3.3	3.0	6.3	6.4	5.6	6.4	4.5	5.1	4.7	6.0
61	1966	5.0	5.9	5.8	6.6	5.5	5.4	5.9	6.4	6.1	5.6	5.4	5.0
62	1967	6.0	6.1	6.3	5.7	7.2	4.1	5.7	6.7	.	5.7	4.7	5.8
63	1968	6.5	6.0	5.0	6.5	5.7	4.8	5.4	7.0	6.1	5.3	7.1	6.8
64	1969	7.0	6.2	5.0	4.3	5.4	5.9	5.1	3.8	5.4	5.3	5.3	6.0
65	1970	9.1	10.0	6.2	8.0	8.0	10.2	10.2	9.6	8.5	8.8	7.4	8.0
66	1971	4.7	4.4	3.5	4.7	5.1	3.9	4.7	3.3	4.1	4.3	4.6	4.0
67	1972	4.4	3.6	3.8	3.4	5.2	3.8	4.0	3.9	5.7	4.7	3.6	4.1
68	1973	3.8	4.4	4.4	4.3	4.2	4.7	4.4	3.3	3.7	3.4	3.8	2.6
69	1974	3.8	3.3	3.0	4.0	4.3	3.7	4.6	5.6	4.0	3.1	3.0	3.0
70	1975	3.5	2.7	2.4	2.7	2.5	3.5	2.4	3.5	3.5	2.4	3.0	3.5
71	1976	3.3	3.2	3.0	3.5	3.3	3.2	4.0	3.5	4.6	0.8	3.4	4.3
72	1977	5.2	3.7	4.4	4.9	4.8	4.2	4.9	4.6	4.5	4.8	4.1	4.5
73	1978	4.4	3.4	3.8	3.1	3.3	3.5	3.9	4.2	4.0	3.6	4.4	4.1
74	1979	.	6.2	7.0	.	.	.	.	7.1	6.8	5.9	.	.
75	1979	.	7.2	8.5	6.4	7.8	7.5	10.0	7.0	10.5	5.8	.	.

NAME=PISAYAMBO

OBS	YEAR	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
76	1965	.	.	.	.	.	.	.	.	.	.	.	.
77	1966	.	.	.	.	.	.	.	.	.	.	.	.
78	1967	.	.	.	.	.	.	.	.	.	.	.	.
79	1968	.	.	.	.	.	.	.	.	.	.	.	.
80	1969	3.6	3.7	3.1	2.3	3.7	3.3	5.6	4.2	4.1	2.9	2.0	3.3
81	1970	7.0	6.6	6.0	6.1	5.0	5.1	6.1	5.5	6.9	5.5	5.0	5.4
82	1971	2.0	3.7	3.4	3.4	3.8	4.9	6.4	5.6	4.5	3.5	4.2	4.7
83	1972	4.1	3.5	3.3	3.3	4.3	4.9	6.5	4.7	6.2	5.1	3.5	4.5
84	1973	5.3	4.8	4.7	3.9	4.4	.	6.9	6.5	5.0	4.8	4.3	3.9
85	1974	4.7	3.4	3.8	4.3	5.5	5.6	6.6	6.4	5.1	3.4	5.5	5.6
86	1975	7.0	4.1	4.8	4.9	5.2	6.2	.	6.3	5.7	4.3	5.2	5.3
87	1976	3.9	2.8	2.9	3.5	3.5	4.3	5.4	4.1	3.4	3.0	3.9	.
88	1977	.	.	.	.	.	.	.	.	.	.	.	.
89	1978	.	.	.	.	.	.	.	.	.	.	.	.
90	1979	.	.	.	.	.	.	.	.	.	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

---------- NAME=RIOBAMBA ----------

OBS	YEAR	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
91	1965	2.3	4.4	2.1	1.5	2.2	3.2	3.3	2.3	2.9	2.1	1.2	1.9
92	1966	2.5	2.1	1.8	1.6	1.8	1.7	1.7	1.8	1.5	2.5	2.4	1.3
93	1967	2.8	1.1	1.1	1.2	1.6	0.9	2.7	4.1	4.4	3.6	2.5	2.6
94	1968	3.9	2.3	2.7	2.2	3.5	2.4	2.9	2.2	1.5	1.3	1.5	.
95	1969	1.9	2.3	1.5	0.8	1.2	0.8	2.0	.	2.9	1.6	1.6	2.5
96	1970	4.6	3.3	3.9	5.1	4.5	5.9	.	.	12.6	8.7	3.6	6.6
97	1971	3.0	2.6	1.8	1.7	3.1	2.8	3.0	2.4	3.0	2.5	2.4	3.0
98	1972	2.3	2.2	1.6	1.2	1.3	1.5	2.6	2.3	1.8	1.4	0.9	1.4
99	1973	1.8	1.3	2.1	1.0	1.1	2.0	2.6	2.0	2.4	1.8	2.0	.
100	1974	2.6	1.4	0.9	0.3	1.0	0.9	1.4	1.9	0.9	0.9	1.1	1.0
101	1975	1.8	0.5	1.1	0.9	0.8	1.5	1.4	1.8	1.5	1.3	1.3	1.0
102	1976	1.5	0.8	1.1	1.0	1.3	1.8	2.8	3.0	3.8	1.5	2.0	2.0
103	1977	2.3	2.7	2.8	2.0	2.3	2.6	.	1.8	2.7	2.4	2.1	2.6
104	1978	2.8	2.8	1.8	1.2	1.7	2.2	3.1	3.5	2.2	2.0	2.9	2.4
105	1979	.	6.3	.	5.2	7.7	6.6	6.7	5.3	9.0	.	.	.

---------- NAME=RUMIPAMBA ----------

OBS	YEAR	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
106	1965	.	.	.	.	.	.	.	.	.	.	.	.
107	1966	.	.	.	.	.	.	.	.	.	.	.	.
108	1967	.	.	.	.	.	.	.	.	.	.	.	.
109	1968	.	.	.	.	.	.	.	.	.	.	.	.
110	1969	.	.	.	.	.	.	.	.	.	.	.	.
111	1970	.	.	.	.	.	.	.	.	.	.	.	.
112	1971	.	.	.	.	.	.	.	.	.	.	.	.
113	1972	.	.	.	.	.	.	.	.	.	.	.	.
114	1973	.	.	.	.	.	.	.	.	.	.	.	.
115	1974	.	.	.	.	.	.	.	.	.	.	.	.
116	1975	.	.	.	.	.	.	.	.	.	.	.	.
117	1976	.	.	.	.	.	.	.	.	.	.	.	.
118	1977	2.0	1.8	2.5	1.6	2.4	1.9	3.8	3.5	3.5	2.4	2.0	1.7
119	1978	2.3	2.1	2.7	2.1	2.2	2.2	2.4	2.1	1.9	1.7	2.2	1.7
120	1979	.	3.2	4.0	6.0	3.2	2.8	2.3	2.4	2.4	1.9	2.3	1.5

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

---------- NAME=AMBATO ----------

OBS	YEAR	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
1	1965	187	167	137	145	138	94	119	158	125	166	176	160
2	1966	121	137	143	126	169	159	133	162	165	199	190	173
3	1967	142	138	172	156	156	117	137	137	160	160	105	199
4	1968	169	140	125	191	160	125	103	170	135	155	201	212
5	1969	198	164	142	137	126	117	133	126	144	169	165	181
6	1970	151	145	120	95	114	146	167	143	122	200	184	160
7	1971	167	111	98	148	154	124	1.9	127	142	166	192	186
8	1972	153	143	138	156	145	123	148	167	144	168	168	170
9	1973	124	139	132	145	137	151	169	137	158	199	188	.
10	1974	170	102	161	158	.	.	.	.	.	.	.	.
11	1975	.	.	.	.	.	.	.	.	110	137	149	168
12	1976	133	137	153	132	116	112	147	108	151	169	141	158
13	1977	178	98	129	137	161	106	136	143	115	192	168	169
14	1978	198	123	126	116	167	138	127	122	124	176	182	159

---------- NAME=COTOPAXI ----------

OBS	YEAR	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
15	1965	.	.	.	.	.	.	.	.	.	.	.	.
16	1966	.	.	.	.	.	.	.	.	.	.	.	.
17	1967	.	.	.	.	.	.	.	.	.	.	.	.
18	1968	.	.	.	.	.	.	.	.	.	.	.	.
19	1969	.	.	.	.	.	.	.	.	.	.	.	.
20	1970	.	.	.	.	.	.	.	.	.	.	.	.
21	1971	.	.	.	.	.	.	.	.	.	.	.	.
22	1972	.	.	.	.	.	.	.	.	.	.	.	.
23	1973	.	.	.	.	.	.	.	.	.	.	.	.
24	1974	.	.	.	.	.	.	.	.	.	.	.	.
25	1975	.	.	.	.	.	.	.	.	.	.	.	.
26	1976	.	.	.	.	.	.	.	.	.	.	.	.
27	1977	.	.	.	.	.	.	.	.	.	.	.	.
28	1978	.	.	.	.	.	.	.	.	.	.	.	.
29	1979	.	148	115	103	131	148	130	148	158	191	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=GUAMOTE

OBS	YEAR	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
30	1965	.	.	.	.	.	.	.	.	.	.	.	.
31	1966	.	.	.	.	.	.	.	.	.	.	.	.
32	1967	.	.	.	.	.	.	.	.	.	.	.	.
33	1968	.	.	.	.	.	.	.	.	.	.	.	.
34	1969	.	.	.	.	.	.	.	.	.	.	.	.
35	1970	.	.	.	.	.	.	.	.	.	.	.	.
36	1971	.	.	.	.	.	.	.	.	.	.	.	.
37	1972	.	.	.	.	.	.	.	.	.	.	.	.
38	1973	.	.	.	.	.	.	.	.	.	.	.	.
39	1974	.	.	.	.	.	.	.	.	.	.	.	.
40	1975	.	.	.	.	.	.	.	.	.	.	.	.
41	1976	.	.	.	.	.	.	.	.	.	.	.	.
42	1977	.	.	.	.	.	.	.	.	.	.	.	.
43	1978	.	.	.	.	.	.	.	.	.	.	.	.
44	1979	.	.	.	.	.	.	.	.	.	.	.	.

NAME=LATACUNGA

OBS	YEAR	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
45	1965	167	159	86	108	117	151	143	180	146	157	124	136
46	1966	125	131	152	110	145	172	171	182	180	174	168	161
47	1967	.	.	160	129	131	144	.	155	192	131	203	200
48	1968	173	61	128	178	171	152	142	168	150	153	202	205
49	1969	194	172	143	105	132	150	118	183	.	.	146	.
50	1970	.	133	155	80	.	179	182	161	133	170	113	146
51	1971	135	77	76	101	94	120	161	122	110	113	166	165
52	1972	138	115	113	120	109	.	.	158	153	111	73	53
53	1973	107	134	91	86	71	97	135	128	118	150	.	.
54	1974	150	85	128	114	135	105	155	170	80	103	104	136
55	1975	147	96	112	87	122	106	137	120	116	121	126	160
56	1976	149	120	110	106	.	.	.	.	.	.	.	.
57	1977	.	.	132	116	178	106	154	116	137	166	.	176
58	1978	192	132	133	97	144	131	149	173	116	171	174	161
59	1979	.	148	77	95	130	188	.	164	146	188	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=PATATE

OBS	YEAR	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
60	1965	.	.	.	.	.	.	.	.	.	.	.	.
61	1966	.	.	.	.	.	.	.	.	.	.	.	.
62	1967	.	.	.	.	.	.	.	.	.	.	.	.
63	1968	.	.	.	.	.	.	.	.	.	.	.	.
64	1969	.	.	.	.	.	.	.	.	.	.	.	.
65	1970	.	.	.	.	.	.	.	.	.	.	.	.
66	1971	.	.	.	.	.	.	.	.	.	.	.	.
67	1972	.	.	.	.	.	.	.	.	.	.	.	.
68	1973	.	.	.	.	.	.	.	.	.	.	.	.
69	1974	.	.	.	.	.	.	.	.	.	.	.	.
70	1975	.	.	.	.	.	.	.	.	.	.	.	.
71	1976	.	.	.	.	.	.	.	.	.	.	.	.
72	1977	.	.	.	.	.	.	.	.	.	.	.	.
73	1978	.	.	.	.	.	.	.	.	.	.	.	.
74	1979	.	.	.	.	.	.	.	.	.	.	.	.
75	1979	.	.	.	.	.	.	.	.	.	.	.	.

NAME=PISAYAMBO

OBS	YEAR	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
76	1965	.	.	.	.	.	.	.	.	.	.	.	.
77	1966	.	.	.	.	.	.	.	.	.	.	.	.
78	1967	.	.	.	.	.	.	.	.	.	.	.	.
79	1968	.	.	.	.	.	.	.	.	.	.	.	.
80	1969	.	.	.	.	.	.	.	.	.	.	.	.
81	1970	.	.	92	79	99	120	107	83	.	142	114	117
82	1971	107	60	69	100	94	91	88	84	102	124	128	127
83	1972	104	85	95	94	113	78	90	117	119	113	107	.
84	1973	73	96	76	94	87	.	.	.	103	127	123	.
85	1974	.	.	.	107	118	89	89	101	.	92	.	.
86	1975	.	.	.	76	73	53	80	65	72	78	122	123
87	1976	.	.	.	.	.	.	.	.	.	.	.	.
88	1977	.	.	.	.	.	.	.	.	.	.	.	.
89	1978	.	.	.	.	.	.	.	.	.	.	.	.
90	1979	.	.	.	.	.	.	.	.	.	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=RIOBAMBA

OBS	YEAR	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
91	1965	192	174	123	124	145	128	183	202	157	156	142	171
92	1966	140	135	128	134	171	178	43	.	.	.	.	.
93	1967	.	.	.	.	.	.	.	.	.	.	.	.
94	1968	172	137	114	172	185	143	153	181	133	133	175	172
95	1969	162	140	117	120	152	139	.	.	111	122	99	144
96	1970	138	148	123	104	133	158	.	.	144	171	146	.
97	1971	151	103	96	130	167	134	136	138	136	151	166	.
98	1972	160	134	118	112	136	.	.	.	166	155	118	165
99	1973	118	115	123	78	122	149	184	.	119	176	.	.
100	1974	.	.	128	138	.	.	.	.	.	.	156	140
101	1975	130	.	123	112	126	109	150	136	130	146	144	158
102	1976	.	125	131	128	108	101	172	151	154	134	141	166
103	1977	176	.	122	94	150	87	166	166	104	166	166	189
104	1978	177	134	142	112	163	160	166	100	151	176	197	151
105	1979	.	138	110	112	141	.	.	.	.	.	.	.

NAME=RUMIPAMBA

OBS	YEAR	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
106	1965	.	.	.	.	.	.	.	.	.	.	.	.
107	1966	.	.	.	.	.	.	.	.	.	.	.	.
108	1967	.	.	.	.	.	.	.	.	.	.	.	.
109	1968	.	.	.	.	.	.	.	.	.	.	.	.
110	1969	.	.	.	.	.	.	.	.	.	.	.	.
111	1970	.	.	.	.	.	.	.	.	.	.	.	.
112	1971	.	.	.	.	.	.	.	.	.	.	.	.
113	1972	.	.	.	.	.	.	.	.	.	.	.	.
114	1973	.	.	.	.	.	.	.	.	.	.	.	.
115	1974	.	.	.	.	.	.	.	.	.	.	.	.
116	1975	.	.	.	.	.	.	.	.	.	.	.	.
117	1976	.	.	.	.	.	.	166	146	157	132	142	169
118	1977	172	122	146	133	188	132	165	156	.	.	.	195
119	1978	171	140	138	126	162	151	155	162	153	194	188	170
120	1979	.	158	124	111	131	181	132	170	164	201	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

---------- NAME=AMBATO ----------

OBS	YEAR	HR1	HR2	HR3	HR4	HR5	HR6	HR7	HR8	HR9	HR10	HR11	HR12
1	1965	75	73	79	78	79	81	79	77	76	76	73	73
2	1966	75	76	76	76	75	74	77	74	73	71	71	75
3	1967	77	76	74	72	75	77	78	74	72	77	73	74
4	1968	76	73	80	75	75	78	81	77	76	79	72	72
5	1969	74	77	80	84	81	82	78	78	77	78	78	79
6	1970	78	81	81	82	83	82	79	80	78	75	79	78
7	1971	79	81	83	81	79	81	79	79	76	78	77	77
8	1972	79	80	79	80	80	81	81	76	78	71	79	76
9	1973	79	78	79	83	83	81	81	80	78	75	74	.
10	1974	77	84	79	79	82	82	80	77	78	79	79	80
11	1975	81	83	.	.	.	.	.	.	75	80	77	74
12	1976	78	78	77	78	80	78	78	78	73	72	78	75
13	1977	73	78	77	78	77	79	78	74	75	76	73	72
14	1978	72	77	76	83	78	77	75	75	75	71	69	72

---------- NAME=COTOPAXI ----------

OBS	YEAR	HR1	HR2	HR3	HR4	HR5	HR6	HR7	HR8	HR9	HR10	HR11	HR12
15	1965	90	88	82	92	92	90	87	87	90	91	92	93
16	1966	95	92	93	94	92	90	94	90	91	91	90	90
17	1967	92	94	92	90	93	94	92	93	92	93	93	92
18	1968	93	93	93	92	92	93	93	92	93	93	93	93
19	1969	93	93	92	92	92	91	90	89	89	90	89	90
20	1970	89	89	89	91	89	90	91	90	90	92	92	92
21	1971	92	2	94	92	91	92	91	91	91	92	92	92
22	1972	91	92	92	92	91	93	93	92	91	92	92	92
23	1973	92	92	91	92	91	92	93	94	94	93	93	93
24	1974	93	94	95	94	94	95	95	95	94	95	95	96
25	1975	95	95	96	95	95	95	95	95	95	96	95	95
26	1976	96	96	94	95	95	95	95	94	95	94	95	95
27	1977	95	95	94	94	95	95	95	94	91	92	92	92
28	1978	.	92	92	91	92	93	92	92	92	92	91	90
29	1979	.	69	75	77	78	79	78	.	.	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=GUAMOTE

OBS	YEAR	HR1	HR2	HR3	HR4	HR5	HR6	HR7	HR8	HR9	HR10	HR11	HR12
30	1965	78	78	78	78	78	76	76	74	73	73	76	76
31	1966	77	75	76	79	75	72	76	75	74	75	71	72
32	1967	76	74	74	74	73	76	76	72	73	75	73	73
33	1968	75	78	79	74	73	75	78	75	74	75	71	70
34	1969	71	76	77	79	77	78	76	78	77	79	77	79
35	1970	77	79	77	78	79	79	76	76	77	76	76	73
36	1971	76	76	78	76	76	75	75	76	75	77	75	76
37	1972	78	78	79	79	79	79	80	80	81	81	80	79
38	1973	81	80	81	82	82	81	80	81	82	79	79	80
39	1974	79	84	81	80	83	84	84	85	88	86	84	83
40	1975	84	86	85	85	83	85	85	82	84	83	84	85
41	1976	87	84	96	96	96	95	96	96	95	.	88	86
42	1977	87	86	85	86	85	85	84	86	85	82	84	82
43	1978	84	86	81	88	88	86	82	79	82	81	84	87
44	1979	.	92	93	92	92	91	92	90	91	92	.	.

NAME=LATACUNGA

OBS	YEAR	HR1	HR2	HR3	HR4	HR5	HR6	HR7	HR8	HR9	HR10	HR11	HR12
45	1965	78	77	77	82	82	81	77	76	74	75	77	77
46	1966	79	77	77	79	77	74	78	74	73	73	70	73
47	1967	77	78	73	71	74	77	77	75	70	77	70	70
48	1968	74	.	.	.	.	.	.	70	74	78	68	69
49	1969	69	72	73	80	77	76	73	73	74	74	76	.
50	1970	.	79	76	79	81	77	72	74	73	72	77	75
51	1971	76	80	85	80	80	80	75	76	73	76	73	72
52	1972	75	77	78	76	77	78	77	73	75	71	80	73
53	1973	86	74	78	82	79	77	74	76	71	71	70	74
54	1974	76	84	77	79	80	80	78	75	77	78	80	78
55	1975	86	81	82	78	81	84	80	80	76	79	77	76
56	1976	77	78	78	79	81	80	76	76	79	73	78	76
57	1977	76	81	81	83	84	85	79	75	75	77	.	76
58	1978	72	72	77	80	80	77	76	73	75	69	70	74
59	1979	70	.	80	80	76	79	75	77	70	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

---------- NAME=PATATE ----------

OBS	YEAR	HR1	HR2	HR3	HR4	HR5	HR6	HR7	HR8	HR9	HR10	HR11	HR12
60	1965	87	87	88	87	88	89	88	86	86	86	87	87
61	1966	88	88	87	88	88	89	90	89	88	87	88	87
62	1967	88	87	87	87	88	90	89	90	.	88	88	88
63	1968	89	87	89	88	89	89	90	88	88	87	86	87
64	1969	87	86	88	88	88	89	89	90	87	87	87	87
65	1970	87	87	89	88	88	89	89	89	87	87	87	88
66	1971	88	88	88	87	88	89	90	89	89	88	87	89
67	1972	87	86	86	88	87	88	88	88	88	86	87	86
68	1973	88	88	87	88	89	88	88	89	89	87	87	88
69	1974	90	90	89	89	91	91	92	91	91	90	91	91
70	1975	92	92	92	91	92	91	92	91	91	91	89	90
71	1976	91	90	90	91	92	93	92	92	90	90	91	90
72	1977	89	90	88	90	90	91	91	90	89	88	88	87
73	1978	86	89	90	90	91	92	91	91	90	89	87	89
74	1979	.	84	74	.	.	.	.	82	83	84	.	.
75	1979	.	90	91	92	91	92	91	91	90	90	.	.

---------- NAME=PISAYAMBO ----------

OBS	YEAR	HR1	HR2	HR3	HR4	HR5	HR6	HR7	HR8	HR9	HR10	HR11	HR12
76	1965	.	.	.	.	.	.	.	.	.	.	.	.
77	1966	.	.	.	.	.	.	.	.	.	.	.	.
78	1967	.	.	.	.	.	.	.	.	.	.	.	.
79	1968	.	.	.	.	.	.	.	.	.	.	.	.
80	1969	84	87	86	88	89	90	90	91	90	85	87	86
81	1970	87	90	90	90	90	89	88	92	91	86	87	88
82	1971	87	89	89	88	90	90	92	91	89	88	88	88
83	1972	90	89	88	89	91	90	92	88	91	88	88	90
84	1973	92	91	91	90	89	.	89	91	88	84	86	83
85	1974	89	91	84	89	91	93	93	92	89	84	89	88
86	1975	92	97	90	89	91	97	.	94	90	92	86	85
87	1976	88	88	87	88	88	89	90	89	88	83	.	87
88	1977	87	90	91	89	88	90	90	90	88	87	86	88
89	1978	95	96	96	90	91	91	90	91	90	88	88	87
90	1979	.	85	87	89	.	87	91	88	88	87	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=RIOBAMBA

OBS	YEAR	HR1	HR2	HR3	HR4	HR5	HR6	HR7	HR8	HR9	HR10	HR11	HR12
91	1965	70	68	74	76	78	75	71	69	71	73	76	74
92	1966	72	70	73	73	70	69	74	72	74	72	69	75
93	1967	75	74	72	73	71	77	73	73	69	73	68	68
94	1968	70	72	75	70	68	73	73	66	69	72	67	64
95	1969	68	68	75	80	75	79	75	.	74	76	77	77
96	1970	76	81	79	79	80	77	.	.	83	76	76	71
97	1971	74	77	79	76	76	73	75	77	75	76	74	67
98	1972	77	78	82	85	85	82	81	77	77	74	.	75
99	1973	70	72	69	72	71	68	67	72	71	64	65	.
100	1974	67	72	66	66	68	65	68	66	69	68	68	70
101	1975	70	74	.	70	72	72	72	69	68	71	70	66
102	1976	66	68	69	71	73	69	65	67	66	68	70	68
103	1977	70	74	72	72	69	72	.	69	70	69	67	69
104	1978	69	73	74	75	77	75	73	72	73	68	69	73
105	1979	.	70	.	77	79	72	69	70	74	.	.	.

NAME=RUMIPAMBA

OBS	YEAR	HR1	HR2	HR3	HR4	HR5	HR6	HR7	HR8	HR9	HR10	HR11	HR12
106	1965	.	.	.	.	.	.	.	.	.	.	.	.
107	1966	.	.	.	.	.	.	.	.	.	.	.	.
108	1967	.	.	.	.	.	.	.	.	.	.	.	.
109	1968	.	.	.	.	.	.	.	.	.	.	.	.
110	1969	.	.	.	.	.	.	.	.	.	.	.	.
111	1970	.	.	.	.	.	.	.	.	.	.	.	.
112	1971	.	.	.	.	.	.	.	.	.	.	.	.
113	1972	.	.	.	.	.	.	.	.	.	.	.	.
114	1973	.	.	.	.	.	.	.	.	.	.	.	.
115	1974	.	.	.	.	.	.	.	.	.	.	.	.
116	1975	.	.	.	.	.	.	.	.	.	.	.	.
117	1976	.	.	.	.	.	.	.	.	.	.	.	.
118	1977	75	78	77	80	75	76	75	76	74	75	79	76
119	1978	70	75	75	79	75	76	74	72	73	73	68	73
120	1979	.	67	76	80	81	77	77	76	76	70	72	75

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=GUAMOTE

OBS	YEAR	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
30	1965	.	.	.	.	.	.	.	.	.	.	.	.
31	1966	.	.	.	.	.	.	.	.	.	.	.	.
32	1967	.	.	.	.	.	.	.	.	.	.	.	.
33	1968	.	.	.	.	.	.	.	.	.	.	.	.
34	1969	.	.	.	.	.	.	.	.	.	.	.	.
35	1970	.	.	.	.	.	.	.	.	.	.	.	.
36	1971	.	.	.	.	.	.	.	.	.	.	.	.
37	1972	.	.	.	.	.	.	.	.	.	.	.	.
38	1973	.	.	.	.	.	.	.	.	.	.	.	.
39	1974	.	.	.	.	.	.	.	.	.	.	.	.
40	1975	.	.	.	.	.	.	.	.	.	.	.	.
41	1976	.	.	.	.	.	.	.	.	.	.	.	.
42	1977	.	.	.	.	.	.	.	.	.	.	.	.
43	1978	.	.	.	.	.	.	.	.	.	.	.	.
44	1979	.	.	.	.	.	.	.	.	.	.	.	.

NAME=LATACUNGA

OBS	YEAR	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
45	1965	.	.	.	.	.	.	.	.	.	.	.	.
46	1966	.	.	.	.	.	.	.	.	.	.	.	.
47	1967	.	.	.	.	.	.	.	.	.	.	.	.
48	1968	.	.	.	.	.	.	.	.	.	.	.	.
49	1969	.	.	.	.	.	.	.	.	.	.	.	.
50	1970	.	.	.	.	.	.	.	.	.	.	.	.
51	1971	140	98	106	124	122	123	118	144	130	.	125	150
52	1972	148	131	123	129	113	.	.	.	.	.	.	.
53	1973	.	.	.	.	.	.	.	.	.	.	.	.
54	1974	.	.	.	.	.	.	.	.	.	.	.	.
55	1975	.	.	.	.	.	.	.	.	.	.	.	.
56	1976	.	.	.	.	.	.	.	.	.	.	.	.
57	1977	.	.	.	.	.	.	.	.	.	.	.	.
58	1978	.	.	.	.	.	.	.	.	.	.	.	.
59	1979	.	.	.	.	.	.	.	.	.	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

---------- NAME=RIOBAMBA ----------

OBS	YEAR	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
91	1965	.	.	.	.	.	.	.	.	.	.	.	.
92	1966	.	.	.	.	.	.	.	.	.	.	.	.
93	1967	.	.	.	.	.	.	.	.	.	.	.	.
94	1968	.	.	.	.	.	.	.	.	.	.	.	.
95	1969	.	.	.	.	.	.	.	.	.	.	.	.
96	1970	.	.	.	.	.	.	.	.	.	.	.	.
97	1971	.	.	.	.	.	.	.	.	.	.	.	.
98	1972	.	.	.	.	.	.	.	.	.	.	.	.
99	1973	.	.	.	.	.	.	.	.	.	.	.	.
100	1974	.	.	.	.	.	.	.	.	.	.	.	.
101	1975	.	.	.	.	.	.	.	.	.	.	.	.
102	1976	.	.	.	.	.	.	.	.	.	.	.	.
103	1977	.	.	.	.	.	.	.	.	.	.	.	.
104	1978	.	.	.	.	.	.	.	.	.	.	.	.
105	1979	.	.	.	.	.	.	.	.	.	.	.	.

---------- NAME=RUMIPAMBA ----------

OBS	YEAR	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
106	1965	.	.	.	.	.	.	.	.	.	.	.	.
107	1966	.	.	.	.	.	.	.	.	.	.	.	.
108	1967	.	.	.	.	.	.	.	.	.	.	.	.
109	1968	.	.	.	.	.	.	.	.	.	.	.	.
110	1969	.	.	.	.	.	.	.	.	.	.	.	.
111	1970	.	.	.	.	.	.	.	.	.	.	.	.
112	1971	.	.	.	.	.	.	.	.	.	.	.	.
113	1972	.	.	.	.	.	.	.	.	.	.	.	.
114	1973	.	.	.	.	.	.	.	.	.	.	.	.
115	1974	.	.	.	.	.	.	.	.	.	.	.	.
116	1975	.	.	.	.	.	.	.	.	.	.	.	.
117	1976	.	.	.	.	.	.	.	.	.	.	.	.
118	1977	.	.	.	.	.	.	.	.	.	.	.	.
119	1978	.	.	.	.	.	.	.	.	.	.	.	.
120	1979	.	.	.	.	.	.	.	.	.	.	.	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***
T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=PATATE

YEAR	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
1965	.	.	.	.	.	.	.	.	.	.	.	.
1966	.	.	.	.	.	.	.	.	.	.	.	.
1967	.	.	.	.	.	.	.	.	.	.	.	.
1968	.	.	.	.	.	.	.	.	.	.	.	.
1969	.	.	.	.	.	.	.	.	.	.	.	.
1970	.	.	.	.	.	.	.	.	.	.	.	.
1971	.	.	.	.	.	.	.	.	.	.	.	.
1972	.	.	.	.	.	.	.	.	.	.	.	.
1973	.	.	.	.	.	.	.	.	.	.	.	.
1974	.	.	.	.	.	.	.	.	.	.	.	.
1975	.	.	.	.	.	.	.	.	.	.	.	.
1976	.	.	.	.	.	.	.	.	.	.	.	.
1977	.	.	.	.	.	.	.	.	.	.	.	.
1978	.	.	.	.	.	.	.	.	.	.	.	.
1979	.	.	.	.	.	.	.	.	.	.	.	.
1979	.	.	.	.	.	.	.	.	.	.	.	.

NAME=PISAYAMBO

YEAR	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
1965	.	.	.	.	.	.	.	.	.	.	.	.
1966	.	.	.	.	.	.	.	.	.	.	.	.
1967	.	.	.	.	.	.	.	.	.	.	.	.
1968	.	.	.	.	.	.	.	.	.	.	.	.
1969	104	80	94	87	59	44	58	47	72	91	91	86
1970	69	71	73	81	68	61	60	56	56	106	82	87
1971	.	52	73	79	62	45	.	.	.	.	.	.
1972	.	.	.	.	.	.	54	75	79	92	81	110
1973	60	90	.	72	57	.	.	.	81	.	.	.
1974	.	.	78	.	.	40	.	.	64	112	.	.
1975	.	.	.	.	84	.	.	.	.	96	.	.
1976	.	.	.	.	.	.	.	.	.	.	.	.
1977	45	76	65	.	66	.	.	55	.	95	93	86
1978	96	67	85	81	76	62	.	49	68	85	88	.
1979	108	93	100	.	73	74	59	73	85	103	100	.

*** METEOROLOGICAL DATA / DATOS METEOROLOGICOS ***

* CODE = T: TEMPERATURE, P: PRECIPITATION, E: EVAPORATION

NAME=AMBATO

OBS	YEAR	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
1	1965	.	.	.	.	.	.	.	.	.	.	.	.
2	1966	.	.	.	.	.	.	.	.	.	.	.	.
3	1967	.	.	.	.	.	.	.	.	.	.	.	.
4	1968	.	.	.	.	.	.	.	.	.	.	.	.
5	1969	.	.	.	.	.	.	.	.	.	.	.	.
6	1970	112	128	125	119	101	116	119	91	117	166	140	147
7	1971	145	.	113	118	.	109	126	113	118	.	.	.
8	1972	.	122	130	132	128	105	123	.	129	.	120	160
9	1973	.	.	.	.	.	116	135	122	.	.	.	.
10	1974	.	.	.	.	116	.	108	.	.	.	.	.
11	1975	.	.	.	.	.	.	.	.	.	.	129	.
12	1976	117	.	133	.	99	87	.	.	.	.	119	.
13	1977	.	.	.	.	.	.	.	.	.	.	.	.
14	1978	.	.	.	.	.	.	.	.	.	.	.	.

NAME=COTOPAXI

OBS	YEAR	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
15	1965	.	.	.	.	.	.	.	.	.	.	.	.
16	1966	.	.	.	.	.	.	.	.	.	.	.	.
17	1967	.	.	.	.	.	.	.	.	.	.	.	.
18	1968	.	.	.	.	.	.	.	.	.	.	.	.
19	1969	.	.	.	.	.	.	.	.	.	.	.	.
20	1970	.	.	.	.	.	.	.	.	.	.	.	.
21	1971	.	.	.	.	.	.	.	.	.	.	.	.
22	1972	.	.	.	.	.	.	.	.	.	.	.	.
23	1973	.	.	.	.	.	.	.	.	.	.	.	.
24	1974	.	.	.	.	.	.	.	.	.	.	.	.
25	1975	.	.	.	.	.	.	.	.	.	.	.	.
26	1976	.	.	.	.	.	.	.	.	.	.	.	.
27	1977	.	.	.	.	.	.	.	.	.	.	.	.
28	1978	.	.	.	.	.	.	.	.	.	.	.	.
29	1979	.	.	.	.	.	.	.	.	.	.	.	.

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=AMBATO

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
P1	14	21.6	13.7	8.0	48.0	3.7
P2	14	39.5	15.1	7.0	65.0	4.0
P3	13	53.8	29.5	7.0	113.0	8.2
P4	13	57.2	31.5	13.0	108.0	8.7
P5	13	39.8	25.6	6.0	94.0	7.1
P6	13	44.2	14.8	20.0	72.0	4.1
P7	13	25.2	12.1	8.0	46.0	3.4
P8	13	23.6	10.3	9.0	43.0	2.8
P9	14	34.8	24.6	6.0	83.0	6.6
P10	14	48.9	27.5	6.0	100.0	7.3
P11	14	42.9	23.3	1.0	75.0	6.2
P12	13	31.8	21.6	7.0	79.0	6.0
T1	14	13.5	0.7	12.3	14.7	0.2
T2	14	13.6	0.7	13.0	15.0	0.2
T3	14	13.5	0.7	12.0	14.4	0.2
T4	14	13.8	0.4	12.9	14.3	0.1
T5	14	13.4	0.6	12.4	14.4	0.2
T6	14	12.4	0.5	12.0	13.0	0.1
T7	14	12.0	0.5	11.0	13.0	0.1
T8	14	12.1	0.6	11.0	13.1	0.2
T9	14	12.8	0.6	12.0	14.0	0.2
T10	14	13.7	0.6	12.6	14.3	0.2
T11	14	14.2	0.6	13.4	15.5	0.2
T12	14	13.9	0.7	13.0	15.1	0.2
E1	3	124.7	17.8	112.0	145.0	10.3
E2	2	125.0	4.2	122.0	128.0	3.0
E3	4	125.3	8.8	113.0	133.0	4.4
E4	3	123.0	7.8	118.0	132.0	4.5
E5	4	111.0	13.6	99.0	128.0	6.8
E6	5	106.6	11.9	87.0	116.0	5.3
E7	5	122.2	9.9	108.0	135.0	4.4
E8	3	108.7	15.9	91.0	122.0	9.2
E9	3	121.3	6.7	117.0	129.0	3.8
E10	1	166.0	.	166.0	166.0	.
E11	4	127.0	9.8	119.0	140.0	4.9
E12	2	153.5	9.2	147.0	160.0	6.5

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=AMBATO

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
PENMAN1	13	129.0	9.1	116.7	143.3	2.5
PENMAN2	13	117.5	9.0	101.6	131.9	2.5
PENMAN3	13	126.0	7.8	110.0	141.8	2.2
PENMAN4	13	119.5	8.4	104.0	137.6	2.3
PENMAN5	12	114.1	6.9	102.1	125.0	2.0
PENMAN6	12	99.2	7.0	90.0	113.7	2.0
PENMAN7	12	106.3	6.7	94.7	117.6	1.9
PENMAN8	11	115.9	8.4	102.1	127.3	2.5
PENMAN9	13	118.9	7.1	107.0	130.0	2.0
PENMAN10	13	138.5	8.3	121.5	152.9	2.3
PENMAN11	13	131.0	10.0	108.3	141.3	2.8
PENMAN12	12	131.3	6.4	123.9	144.3	1.8
THORT1	14	55.8	3.6	49.2	62.3	1.0
THORT2	14	56.0	3.7	53.0	63.9	1.0
THORT3	14	55.7	3.6	47.7	60.6	1.0
THORT4	14	57.3	2.3	52.4	60.0	0.6
THORT5	14	55.0	3.2	49.8	60.6	0.9
THORT6	14	49.7	2.4	47.7	52.9	0.7
THORT7	14	47.5	2.8	42.5	52.9	0.7
THORT8	14	48.5	3.0	42.5	53.5	0.8
THORT9	14	51.8	3.3	47.7	58.4	0.9
THORT10	14	56.6	3.1	50.8	60.0	0.8
THORT11	14	59.3	3.4	55.1	66.8	0.9
THORT12	14	57.8	3.6	53.0	64.5	1.0
PRSTLY1	13	192.2	17.8	165.5	218.1	4.9
PRSTLY2	13	173.3	14.8	147.6	196.0	4.1
PRSTLY3	13	184.7	13.5	157.4	210.1	3.7
PRSTLY4	13	177.0	15.6	145.5	210.4	4.3
PRSTLY5	12	168.5	12.1	148.7	183.6	3.5
PRSTLY6	12	145.5	12.4	125.9	170.6	3.6
PRSTLY7	12	155.9	11.6	135.5	175.3	3.3
PRSTLY8	12	170.2	12.6	148.4	188.2	3.6
PRSTLY9	13	173.9	12.0	154.7	192.2	3.3
PRSTLY10	13	208.1	13.5	181.9	226.8	3.7
PRSTLY11	13	197.7	17.8	153.3	218.7	4.9
PRSTLY12	12	197.9	11.3	186.9	222.7	3.3
HARGRS1	13	113.9	11.7	99.1	133.3	3.3
HARGRS2	13	101.7	9.3	85.3	115.5	2.6
HARGRS3	13	108.0	8.8	90.4	124.5	2.4
HARGRS4	13	105.4	9.1	87.1	126.0	2.5
HARGRS5	12	101.2	8.3	88.0	112.6	2.4
HARGRS6	12	85.9	8.0	73.3	102.3	2.3
HARGRS7	12	90.4	7.2	76.0	101.5	2.1
HARGRS8	12	97.6	8.2	83.5	109.8	2.4
HARGRS9	13	100.5	7.3	87.2	111.7	2.0
HARGRS10	13	122.7	8.9	103.7	134.8	2.5
HARGRS11	13	119.0	11.6	91.7	130.8	3.2
HARGRS12	12	118.8	6.9	109.6	134.0	2.0

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=AMBATO

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
PENMAN1	13	129.0	9.1	116.7	143.3	2.5
PENMAN2	13	117.5	9.0	101.6	131.9	2.5
PENMAN3	13	126.0	7.8	110.0	141.8	2.2
PENMAN4	13	119.5	8.4	104.0	137.6	2.3
PENMAN5	12	114.1	6.9	102.1	125.0	2.0
PENMAN6	12	99.2	7.0	90.0	113.7	2.0
PENMAN7	12	106.3	6.7	94.7	117.6	1.9
PENMAN8	11	115.9	8.4	102.1	127.3	2.5
PENMAN9	13	118.9	7.1	107.0	130.0	2.0
PENMAN10	13	138.5	8.3	121.5	152.9	2.3
PENMAN11	13	131.0	10.0	108.3	141.3	2.8
PENMAN12	12	131.3	6.4	123.9	144.3	1.8
THORT1	14	55.8	3.8	49.2	62.3	1.0
THORT2	14	56.0	3.7	53.0	63.9	1.0
THORT3	14	55.7	3.6	47.7	60.6	1.0
THORT4	14	57.3	2.3	52.4	60.0	0.6
THORT5	14	55.0	3.2	49.8	60.6	0.9
THORT6	14	49.7	2.4	47.7	52.9	0.7
THORT7	14	47.5	2.8	42.5	52.9	0.7
THORT8	14	48.5	3.0	42.5	53.5	0.8
THORT9	14	51.8	3.3	47.7	58.4	0.9
THORT10	14	56.6	3.1	50.8	60.0	0.8
THORT11	14	59.3	3.4	55.1	66.8	0.9
THORT12	14	57.8	3.6	53.0	64.5	1.0
PRSTLY1	13	192.2	17.8	165.5	218.1	4.9
PRSTLY2	13	173.3	14.8	147.6	196.0	4.1
PRSTLY3	13	184.7	13.5	157.1	210.1	3.7
PRSTLY4	13	177.0	15.6	145.5	210.4	4.3
PRSTLY5	12	168.5	12.1	148.7	183.6	3.5
PRSTLY6	12	145.5	12.4	125.9	170.6	3.6
PRSTLY7	12	155.9	11.6	135.5	175.3	3.3
PRSTLY8	12	170.2	12.6	148.4	188.2	3.6
PRSTLY9	13	173.9	12.0	154.7	192.2	3.3
PRSTLY10	13	208.1	13.5	181.9	226.8	3.7
PRSTLY11	13	197.7	17.8	153.3	218.7	4.9
PRSTLY12	12	197.9	11.3	186.9	222.7	3.3
HARGRS1	13	113.9	11.7	99.1	133.3	3.3
HARGRS2	13	101.7	9.3	85.3	115.5	2.6
HARGRS3	13	108.0	8.8	90.4	124.5	2.4
HARGRS4	13	105.4	9.1	87.1	126.0	2.5
HARGRS5	12	101.2	8.3	88.0	112.6	2.4
HARGRS6	12	85.9	8.0	73.3	102.3	2.3
HARGRS7	12	90.4	7.2	76.0	101.5	2.1
HARGRS8	12	97.6	8.2	83.5	109.8	2.4
HARGRS9	13	100.5	7.3	87.2	111.7	2.0
HARGRS10	13	122.7	8.9	103.7	134.8	2.5
HARGRS11	13	119.0	11.6	91.7	130.8	3.2
HARGRS12	12	118.8	6.9	109.6	134.0	2.0

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=COTOPAXI

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
P1	14	101.8	33.1	50.0	168.0	8.9
P2	14	124.9	67.1	35.0	259.0	17.9
P3	14	151.8	67.7	78.0	298.0	18.1
P4	15	128.9	48.3	53.0	230.0	12.5
P5	15	134.4	54.3	30.0	235.0	14.0
P6	14	81.1	46.0	40.0	205.0	12.3
P7	14	49.3	35.4	0.0	124.0	9.5
P8	15	41.6	23.9	16.0	91.0	6.2
P9	15	105.3	56.0	29.0	209.0	14.5
P10	15	111.3	67.3	13.0	283.0	17.4
P11	14	110.2	44.2	41.0	181.0	11.8
P12	14	93.9	48.5	27.0	225.0	12.9
T1	13	8.1	0.3	7.5	8.6	0.1
T2	14	8.2	0.3	7.7	8.8	0.1
T3	14	8.3	0.3	7.6	8.8	0.1
T4	14	8.1	0.6	6.4	8.7	0.2
T5	14	8.3	0.3	7.6	8.6	0.1
T6	14	8.0	0.4	7.1	8.5	0.1
T7	14	8.0	0.4	7.3	8.8	0.1
T8	14	8.0	0.4	7.1	8.7	0.1
T9	14	8.8	2.6	7.6	17.7	0.7
T10	14	8.2	0.3	7.6	8.6	0.1
T11	14	8.3	0.4	7.8	9.0	0.1
T12	14	8.3	0.3	7.7	8.6	0.1
E1	0	.	.	.	.	.
E2	0	.	.	.	.	.
E3	0	.	.	.	.	.
E4	0	.	.	.	.	.
E5	0	.	.	.	.	.
E6	0	.	.	.	.	.
E7	0	.	.	.	.	.
E8	0	.	.	.	.	.
E9	0	.	.	.	.	.
E10	0	.	.	.	.	.
E11	0	.	.	.	.	.
E12	0	.	.	.	.	.

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=COTOPAXI

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
PENMAN1	0	.	.	.	.	.
PENMAN2	0	.	.	.	.	.
PENMAN3	0	.	.	.	.	.
PENMAN4	0	.	.	.	.	.
PENMAN5	0	.	.	.	.	.
PENMAN6	0	.	.	.	.	.
PENMAN7	0	.	.	.	.	.
PENMAN8	0	.	.	.	.	.
PENMAN9	0	.	.	.	.	.
PENMAN10	0	.	.	.	.	.
PENMAN11	0	.	.	.	.	.
PENMAN12	0	.	.	.	.	.
THORT1	13	46.0	1.7	42.7	48.4	0.5
THORT2	14	46.3	1.7	43.8	49.4	0.4
THORT3	14	46.9	1.8	43.2	49.4	0.5
THORT4	14	45.9	3.1	37.0	48.9	0.8
THORT5	14	46.7	1.6	43.2	48.4	0.4
THORT6	14	45.2	2.2	40.6	47.9	0.6
THORT7	14	45.5	2.3	41.7	49.4	0.6
THORT8	14	45.4	2.1	40.6	48.9	0.6
THORT9	14	49.3	12.8	43.2	93.4	3.4
THORT10	14	46.3	1.6	43.2	48.4	0.4
THORT11	14	47.0	1.9	44.3	50.5	0.5
THORT12	14	46.6	1.7	43.8	48.4	0.5
PRSTLY1	0	.	.	.	.	.
PRSTLY2	0	.	.	.	.	.
PRSTLY3	0	.	.	.	.	.
PRSTLY4	0	.	.	.	.	.
PRSTLY5	0	.	.	.	.	.
PRSTLY6	0	.	.	.	.	.
PRSTLY7	0	.	.	.	.	.
PRSTLY8	0	.	.	.	.	.
PRSTLY9	0	.	.	.	.	.
PRSTLY10	0	.	.	.	.	.
PRSTLY11	0	.	.	.	.	.
PRSTLY12	0	.	.	.	.	.
HARGRS1	0	.	.	.	.	.
HARGRS2	0	.	.	.	.	.
HARGRS3	0	.	.	.	.	.
HARGRS4	0	.	.	.	.	.
HARGRS5	0	.	.	.	.	.
HARGRS6	0	.	.	.	.	.
HARGRS7	0	.	.	.	.	.
HARGRS8	0	.	.	.	.	.
HARGRS9	0	.	.	.	.	.
HARGRS10	0	.	.	.	.	.
HARGRS11	0	.	.	.	.	.
HARGRS12	0	.	.	.	.	.

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=LATACUNGA

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
P1	13	27.5	16.0	7.0	64.0	4.4
P2	14	55.8	32.3	17.0	133.0	8.6
P3	14	54.6	29.7	19.0	96.0	7.9
P4	14	58.9	29.2	28.0	132.0	7.8
P5	14	40.1	20.8	5.0	88.0	5.6
P6	14	28.4	16.0	2.0	51.0	4.3
P7	14	18.6	21.7	0.0	83.0	5.8
P8	14	16.6	16.8	0.0	53.0	4.5
P9	14	30.3	21.7	6.0	69.0	5.8
P10	14	60.4	28.7	6.0	98.0	7.7
P11	14	54.9	25.0	5.0	108.0	6.7
P12	13	40.0	20.4	5.0	73.0	5.7
T1	14	13.6	0.5	12.8	14.2	0.1
T2	14	13.5	0.6	12.8	14.6	0.2
T3	14	13.4	0.6	12.6	14.3	0.2
T4	14	13.4	0.4	12.7	14.1	0.1
T5	14	13.2	0.4	12.6	14.0	0.1
T6	14	12.4	0.4	11.6	13.4	0.1
T7	14	12.2	0.5	11.3	13.1	0.1
T8	14	12.1	0.4	11.3	12.8	0.1
T9	14	12.7	0.4	12.1	13.4	0.1
T10	14	13.4	0.5	12.3	14.2	0.1
T11	13	13.6	0.5	12.8	14.9	0.2
T12	13	13.8	0.4	13.1	14.4	0.1
E1	2	144.0	5.7	140.0	148.0	4.0
E2	2	114.5	23.3	98.0	131.0	16.5
E3	2	114.5	12.0	106.0	123.0	8.5
E4	2	126.5	3.5	124.0	129.0	2.5
E5	2	117.5	6.4	113.0	122.0	4.5
E6	1	123.0	.	123.0	123.0	.
E7	1	118.0	.	118.0	118.0	.
E8	1	144.0	.	144.0	144.0	.
E9	1	130.0	.	130.0	130.0	.
E10	0	.	.	.	.	.
E11	1	126.0	.	126.0	126.0	.
E12	1	150.0	.	150.0	150.0	.

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=LATACUNGA

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
PENMAN1	11	126.0	10.8	108.2	144.3	3.3
PENMAN2	11	113.2	12.0	94.2	130.9	3.6
PENMAN3	13	120.9	11.8	99.3	137.4	3.3
PENMAN4	13	106.4	5.3	98.8	116.9	1.5
PENMAN5	11	107.6	9.8	89.4	125.0	3.0
PENMAN6	11	101.6	9.3	88.7	116.1	2.8
PENMAN7	10	112.2	5.3	104.8	123.3	1.7
PENMAN8	12	120.5	8.9	105.7	130.8	2.6
PENMAN9	12	118.4	12.3	97.6	138.8	3.5
PENMAN10	12	127.5	10.9	110.5	141.3	3.2
PENMAN11	11	122.5	15.9	94.9	144.4	4.8
PENMAN12	11	124.6	14.3	89.8	144.0	4.3
THORT1	14	56.4	2.5	52.3	59.9	0.7
THORT2	14	56.2	3.2	52.3	62.1	0.9
THORT3	14	55.6	3.1	51.2	60.4	0.8
THORT4	14	55.5	2.4	51.8	59.3	0.6
THORT5	14	54.6	2.0	51.2	58.8	0.5
THORT6	14	50.4	2.3	46.0	55.5	0.6
THORT7	14	49.0	2.8	44.4	53.9	0.7
THORT8	14	48.8	2.3	44.4	52.3	0.6
THORT9	14	51.9	2.3	48.6	55.5	0.6
THORT10	14	55.5	2.9	49.6	59.9	0.8
THORT11	13	56.8	3.0	52.3	63.8	0.8
THORT12	13	57.5	2.4	53.9	61.0	0.7
PRSTLY1	11	186.5	18.3	155.9	215.0	5.5
PRSTLY2	12	161.9	23.4	121.6	200.5	6.8
PRSTLY3	14	174.9	18.6	141.4	201.5	5.0
PRSTLY4	14	155.2	16.2	135.2	201.7	4.3
PRSTLY5	12	158.2	18.8	121.9	188.8	5.4
PRSTLY6	12	149.9	16.3	128.3	176.2	4.7
PRSTLY7	11	163.9	10.7	144.8	183.5	3.2
PRSTLY8	13	178.8	16.0	153.9	196.5	4.4
PRSTLY9	12	172.4	21.0	134.5	209.9	6.1
PRSTLY10	12	186.8	18.4	158.3	208.2	5.3
PRSTLY11	11	180.6	28.3	131.3	220.0	8.5
PRSTLY12	11	184.5	26.9	117.3	218.1	8.1
HARGRS1	11	110.3	11.3	92.9	129.5	3.4
HARGRS2	12	95.0	15.0	70.3	120.7	4.3
HARGRS3	14	101.9	11.7	80.3	119.1	3.1
HARGRS4	14	91.3	9.9	80.2	121.1	2.6
HARGRS5	12	94.5	11.4	72.8	112.7	3.3
HARGRS6	12	88.5	9.6	77.1	104.1	2.8
HARGRS7	11	95.8	6.9	84.2	108.6	2.1
HARGRS8	13	102.5	9.4	88.7	114.0	2.6
HARGRS9	12	99.3	12.5	76.1	118.6	3.6
HARGRS10	12	108.9	12.0	90.8	123.1	3.5
HARGRS11	11	106.9	17.5	77.6	131.2	5.3
HARGRS12	11	110.3	16.4	70.6	131.6	5.0

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME =RUMIPAMBA

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
P1	2	22.0	11.3	14.0	30.0	8.0
P2	3	31.3	14.6	18.0	47.0	8.5
P3	3	54.3	34.7	26.0	93.0	20.0
P4	3	88.7	18.9	68.0	105.0	10.9
P5	3	37.7	21.2	14.0	55.0	12.3
P6	3	22.0	8.2	13.0	29.0	4.7
P7	4	18.3	7.0	9.0	25.0	3.5
P8	4	13.3	14.2	0.0	32.0	7.1
P9	4	47.3	24.1	17.0	76.0	12.1
P10	3	26.7	16.8	12.0	45.0	9.7
P11	3	38.3	41.5	3.0	84.0	23.9
P12	3	55.3	29.7	21.0	73.0	17.2
T1	2	14.5	0.7	14.0	15.0	0.5
T2	3	14.7	0.6	14.0	15.0	0.3
T3	3	14.7	0.6	14.0	15.0	0.3
T4	3	14.0	0.0	14.0	14.0	0.0
T5	3	13.7	0.6	13.0	14.0	0.3
T6	3	13.0	0.0	13.0	13.0	0.0
T7	4	13.0	0.8	12.0	14.0	0.4
T8	4	12.8	1.0	12.0	14.0	0.5
T9	4	13.5	0.6	13.0	14.0	0.3
T10	3	14.3	0.6	14.0	15.0	0.3
T11	3	15.0	1.0	14.0	16.0	0.6
T12	3	14.7	0.6	14.0	15.0	0.3
E1	0	.	.	.	.	.
E2	0	.	.	.	.	.
E3	0	.	.	.	.	.
E4	0	.	.	.	.	.
E5	0	.	.	.	.	.
E6	0	.	.	.	.	.
E7	0	.	.	.	.	.
E8	0	.	.	.	.	.
E9	0	.	.	.	.	.
E10	0	.	.	.	.	.
E11	0	.	.	.	.	.
E12	0	.	.	.	.	.

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=RUMIPAMBA

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
PENMAN1	2	134.2	0.3	134.0	134.5	0.2
PENMAN2	3	122.1	9.7	112.8	132.1	5.6
PENMAN3	3	130.3	2.2	128.6	132.8	1.3
PENMAN4	3	116.0	1.1	114.8	116.9	0.6
PENMAN5	3	120.2	9.2	110.8	129.2	5.3
PENMAN6	3	108.5	8.1	101.1	117.1	4.6
PENMAN7	4	114.3	4.1	109.5	118.1	2.0
PENMAN8	4	122.9	4.4	119.3	129.3	2.2
PENMAN9	3	129.3	5.7	124.1	135.4	3.3
PENMAN10	2	135.3	15.0	124.7	146.0	10.6
PENMAN11	2	130.5	13.3	121.1	139.9	9.4
PENMAN12	3	132.5	5.6	128.8	138.9	3.2
THORT1	2	58.6	4.0	55.8	61.4	2.8
THORT2	3	59.5	3.2	55.8	61.4	1.9
THORT3	3	59.5	3.2	55.8	61.4	1.9
THORT4	3	55.7	0.0	55.7	55.7	0.0
THORT5	3	53.9	3.1	50.3	55.7	1.8
THORT6	3	50.3	0.0	50.3	50.3	0.0
THORT7	4	50.3	4.4	45.0	55.7	2.2
THORT8	4	49.0	5.1	45.0	55.7	2.6
THORT9	4	53.0	3.1	50.3	55.8	1.6
THORT10	3	57.6	3.2	55.8	61.4	1.9
THORT11	3	61.4	5.7	55.8	67.1	3.3
THORT12	3	59.5	3.2	55.8	61.4	1.9
PRSTLY1	2	200.0	1.0	199.3	200.7	0.7
PRSTLY2	3	178.0	13.0	164.9	191.0	7.5
PRSTLY3	3	185.0	7.9	176.6	192.3	4.5
PRSTLY4	3	164.6	7.6	156.3	171.2	4.4
PRSTLY5	3	178.0	18.2	159.3	195.5	10.5
PRSTLY6	3	162.2	14.6	148.8	177.7	8.4
PRSTLY7	4	167.2	9.5	153.6	174.1	4.8
PRSTLY8	4	181.3	6.9	172.9	189.4	3.4
PRSTLY9	3	187.7	4.1	184.1	192.1	2.4
PRSTLY10	2	200.9	30.7	179.2	222.6	21.7
PRSTLY11	2	194.6	22.7	178.5	210.6	16.1
PRSTLY12	3	200.7	10.0	194.2	212.2	5.8
HARGRS1	2	121.5	3.0	119.4	123.7	2.1
HARGRS2	3	107.8	9.4	97.9	116.6	5.4
HARGRS3	3	111.7	5.0	107.7	117.3	2.9
HARGRS4	3	98.6	4.6	93.6	102.5	2.6
HARGRS5	3	107.5	12.5	94.2	119.2	7.2
HARGRS6	3	97.3	8.7	89.2	106.6	5.0
HARGRS7	4	99.8	6.3	91.8	107.1	3.1
HARGRS8	4	105.8	6.7	98.5	114.7	3.3
HARGRS9	3	110.2	4.3	107.0	115.1	2.5
HARGRS10	2	119.4	18.2	106.5	132.3	12.9
HARGRS11	2	118.1	16.1	106.7	129.5	11.4
HARGRS12	3	123.1	7.5	116.8	131.3	4.3

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=PISAYAMBO

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
P1	10	56.2	22.9	17.0	90.0	7.2
P2	10	100.6	38.2	40.0	172.0	12.1
P3	11	103.5	37.7	50.0	172.0	11.4
P4	11	127.6	43.6	72.0	201.0	13.2
P5	10	109.2	32.4	74.0	175.0	10.2
P6	9	170.0	75.2	100.0	320.0	25.1
P7	10	147.1	65.9	63.0	293.0	20.8
P8	11	126.5	59.7	40.0	241.0	18.0
P9	11	100.4	32.8	53.0	159.0	9.9
P10	11	89.3	38.9	46.0	155.0	11.7
P11	10	80.1	32.1	41.0	135.0	10.2
P12	10	69.5	24.2	32.0	116.0	7.6
T1	10	7.1	0.6	6.0	8.0	0.2
T2	11	7.3	0.5	7.0	8.0	0.1
T3	11	7.5	0.5	7.0	8.0	0.2
T4	11	7.6	0.5	7.0	8.0	0.2
T5	10	7.3	0.5	7.0	8.0	0.2
T6	10	6.4	0.5	6.0	7.0	0.2
T7	10	5.7	0.7	5.0	7.0	0.2
T8	11	5.8	0.6	5.0	7.0	0.2
T9	11	6.4	0.8	5.0	8.0	0.2
T10	11	7.4	0.7	6.0	8.0	0.2
T11	10	7.5	0.5	7.0	8.0	0.2
T12	10	7.4	0.7	6.0	8.0	0.2
E1	6	80.3	25.9	45.0	108.0	10.6
E2	7	75.6	14.0	52.0	93.0	5.3
E3	7	81.1	12.5	65.0	100.0	4.7
E4	5	80.0	5.4	72.0	87.0	2.4
E5	8	68.1	9.2	57.0	84.0	3.2
E6	6	54.3	13.3	40.0	74.0	5.4
E7	4	57.8	2.6	54.0	60.0	1.3
E8	6	59.2	12.0	47.0	75.0	4.9
E9	7	72.1	10.3	56.0	85.0	3.9
E10	8	97.5	8.9	85.0	112.0	3.1
E11	6	89.2	7.1	81.0	100.0	2.9
E12	4	92.3	11.8	86.0	110.0	5.9

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=PISAYA480

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
PENMAN1	3	101.1	6.2	93.9	104.7	3.6
PENMAN2	3	93.9	7.1	86.2	100.1	4.1
PENMAN3	4	102.6	4.9	96.8	106.8	2.5
PENMAN4	6	98.8	3.8	93.6	104.0	1.5
PENMAN5	6	95.1	5.3	87.5	101.9	2.2
PENMAN6	5	84.1	7.7	72.9	94.5	3.5
PENMAN7	4	90.2	3.4	88.1	95.3	1.7
PENMAN8	5	95.0	6.9	86.4	104.3	3.1
PENMAN9	4	101.2	6.8	92.0	108.4	3.4
PENMAN10	6	112.6	9.5	98.3	124.4	3.9
PENMAN11	5	109.7	3.1	104.9	112.3	1.4
PENMAN12	3	110.2	1.5	108.5	111.2	0.9
THORT1	10	45.7	3.0	39.8	50.4	1.0
THORT2	11	46.6	2.5	45.2	50.4	0.7
THORT3	11	48.0	2.7	45.2	50.4	0.8
THORT4	11	48.5	2.6	45.2	50.4	0.8
THORT5	10	46.8	2.5	45.2	50.4	0.8
THORT6	10	42.0	2.8	39.8	45.2	0.9
THORT7	10	38.1	3.7	34.3	45.2	1.2
THORT8	11	38.8	3.3	34.3	45.2	1.0
THORT9	11	41.7	4.4	34.3	50.4	1.3
THORT10	11	47.1	3.6	39.8	50.4	1.1
THORT11	10	47.8	2.8	45.2	50.4	0.9
THORT12	10	47.3	3.7	39.8	50.4	1.2
PRSTLY1	3	146.1	12.6	131.6	154.3	7.3
PRSTLY2	3	134.1	12.8	120.0	145.0	7.4
PRSTLY3	4	145.4	8.8	135.6	153.8	4.4
PRSTLY4	6	141.6	8.0	131.2	151.9	3.3
PRSTLY5	5	137.0	10.3	122.0	149.8	4.2
PRSTLY6	3	120.7	14.2	101.3	140.6	6.3
PRSTLY7	4	129.6	5.3	126.5	137.6	2.6
PRSTLY8	5	136.6	12.5	120.5	153.7	5.6
PRSTLY9	4	146.8	13.2	128.6	160.1	6.6
PRSTLY10	6	163.9	16.4	140.1	184.2	6.7
PRSTLY11	5	160.9	5.6	152.9	167.1	2.5
PRSTLY12	3	161.5	3.4	157.9	164.7	2.0
HARGRS1	3	68.5	5.9	61.8	72.4	3.4
HARGRS2	3	63.3	7.2	55.7	70.2	4.2
HARGRS3	4	68.1	3.8	62.9	71.4	1.9
HARGRS4	6	67.3	3.6	61.5	71.2	1.5
HARGRS5	6	66.0	5.6	58.3	73.0	2.3
HARGRS6	5	56.5	6.5	47.0	65.2	2.9
HARGRS7	4	58.6	3.6	55.8	63.6	1.8
HARGRS8	5	61.0	6.3	54.8	69.8	2.8
HARGRS9	4	65.2	5.9	57.8	71.9	3.0
HARGRS10	6	75.8	8.5	62.4	85.7	3.5
HARGRS11	5	76.0	1.8	73.9	78.3	0.8
HARGRS12	3	75.0	1.1	74.3	76.3	0.6

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=PATATE

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
P1	14	23.4	10.2	8.0	40.0	2.7
P2	15	36.7	15.7	5.0	61.0	4.1
P3	15	56.3	24.3	22.0	118.0	6.3
P4	15	52.2	31.4	1.0	109.0	8.1
P5	15	54.8	31.1	11.0	113.0	8.0
P6	15	77.3	31.7	34.0	125.0	8.2
P7	14	63.4	33.9	11.0	127.0	9.1
P8	15	60.1	31.8	12.0	141.0	8.2
P9	14	53.6	30.0	25.0	121.0	8.0
P10	15	45.4	28.9	13.0	101.0	7.5
P11	14	42.7	31.5	1.0	126.0	8.4
P12	14	29.9	28.7	11.0	124.0	7.7
T1	14	16.2	0.7	15.1	17.5	0.2
T2	15	16.3	0.6	15.6	17.4	0.1
T3	15	16.2	0.5	15.4	17.2	0.1
T4	15	16.3	0.3	15.9	16.8	0.1
T5	15	16.0	0.4	15.4	16.8	0.1
T6	15	15.2	0.6	14.1	16.0	0.1
T7	15	14.7	0.6	13.8	15.6	0.2
T8	15	15.0	0.6	13.9	16.1	0.2
T9	14	15.7	0.4	14.9	16.4	0.1
T10	15	16.4	0.5	15.5	17.3	0.1
T11	14	16.7	0.5	16.2	17.8	0.1
T12	14	16.5	0.5	15.7	17.6	0.1
E1	0	.	.	.	.	.
E2	0	.	.	.	.	.
E3	0	.	.	.	.	.
E4	0	.	.	.	.	.
E5	0	.	.	.	.	.
E6	0	.	.	.	.	.
E7	0	.	.	.	.	.
E8	0	.	.	.	.	.
E9	0	.	.	.	.	.
E10	0	.	.	.	.	.
E11	0	.	.	.	.	.
E12	0	.	.	.	.	.

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=PATATE

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
PENMAN1	0	.	.	.	.	.
PENMAN2	0	.	.	.	.	.
PENMAN3	0	.	.	.	.	.
PENMAN4	0	.	.	.	.	.
PENMAN5	0	.	.	.	.	.
PENMAN6	0	.	.	.	.	.
PENMAN7	0	.	.	.	.	.
PENMAN8	0	.	.	.	.	.
PENMAN9	0	.	.	.	.	.
PENMAN10	0	.	.	.	.	.
PENMAN11	0	.	.	.	.	.
PENMAN12	0	.	.	.	.	.
THORT1	14	61.5	4.0	55.1	69.7	1.1
THORT2	15	62.0	3.4	58.0	69.0	0.9
THORT3	15	61.9	3.2	56.8	67.8	0.8
THORT4	15	62.5	1.8	59.8	65.3	0.5
THORT5	15	60.4	2.4	56.8	65.3	0.6
THORT6	15	55.5	3.3	49.4	60.4	0.8
THORT7	15	53.0	3.5	47.7	58.0	0.9
THORT8	15	54.3	3.5	48.3	61.0	0.9
THORT9	14	58.4	2.4	53.9	62.8	0.7
THORT10	15	63.0	2.9	57.4	68.4	0.8
THORT11	14	64.9	2.9	61.6	71.6	0.8
THORT12	14	63.7	3.3	58.6	70.3	0.9
PRSTLY1	0	.	.	.	.	.
PRSTLY2	0	.	.	.	.	.
PRSTLY3	0	.	.	.	.	.
PRSTLY4	0	.	.	.	.	.
PRSTLY5	0	.	.	.	.	.
PRSTLY6	0	.	.	.	.	.
PRSTLY7	0	.	.	.	.	.
PRSTLY8	0	.	.	.	.	.
PRSTLY9	0	.	.	.	.	.
PRSTLY10	0	.	.	.	.	.
PRSTLY11	0	.	.	.	.	.
PRSTLY12	0	.	.	.	.	.
HARGRS1	0	.	.	.	.	.
HARGRS2	0	.	.	.	.	.
HARGRS3	0	.	.	.	.	.
HARGRS4	0	.	.	.	.	.
HARGRS5	0	.	.	.	.	.
HARGRS6	0	.	.	.	.	.
HARGRS7	0	.	.	.	.	.
HARGRS8	0	.	.	.	.	.
HARGRS9	0	.	.	.	.	.
HARGRS10	0	.	.	.	.	.
HARGRS11	0	.	.	.	.	.
HARGRS12	0	.	.	.	.	.

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=RIOBAMBA

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
P1	14	22.4	12.7	2.0	49.0	3.4
P2	15	42.1	24.8	9.0	99.0	6.4
P3	14	53.3	27.4	15.0	106.0	7.3
P4	15	56.4	29.2	9.0	119.0	7.5
P5	15	33.4	24.0	4.0	84.0	6.2
P6	15	38.5	20.7	6.0	74.0	5.4
P7	13	18.5	20.4	1.0	82.0	5.7
P8	13	17.2	12.7	2.0	50.0	3.5
P9	15	31.9	18.6	7.0	58.0	4.8
P10	14	43.8	30.8	11.0	103.0	8.2
P11	14	45.7	35.3	1.0	118.0	9.4
P12	14	26.7	9.4	9.0	40.0	2.5
T1	14	13.9	0.5	13.0	15.0	0.1
T2	15	13.9	0.7	13.0	15.0	0.2
T3	14	13.8	0.6	13.0	15.0	0.2
T4	15	13.7	1.1	10.0	15.0	0.3
T5	15	13.7	0.6	13.0	15.0	0.2
T6	15	12.7	0.6	12.0	14.0	0.2
T7	13	12.5	0.5	12.0	13.0	0.1
T8	13	12.5	0.5	12.0	13.0	0.1
T9	15	13.1	0.6	12.0	14.0	0.2
T10	14	13.9	0.4	13.0	14.0	0.1
T11	13	14.2	0.6	13.0	15.0	0.2
T12	13	14.1	0.8	13.0	15.0	0.2
E1	0	.	.	.	.	.
E2	0	.	.	.	.	.
E3	0	.	.	.	.	.
E4	0	.	.	.	.	.
E5	0	.	.	.	.	.
E6	0	.	.	.	.	.
E7	0	.	.	.	.	.
E8	0	.	.	.	.	.
E9	0	.	.	.	.	.
E10	0	.	.	.	.	.
E11	0	.	.	.	.	.
E12	0	.	.	.	.	.

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=RIOBAMBA

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
PENMAN1	11	129.6	8.4	114.6	141.1	2.5
PENMAN2	11	120.4	9.5	105.6	139.6	2.9
PENMAN3	12	121.6	4.8	110.1	128.7	1.4
PENMAN4	14	111.8	8.1	96.2	133.2	2.2
PENMAN5	13	115.8	9.0	100.7	132.3	2.5
PENMAN6	11	103.5	9.0	90.6	118.2	2.7
PENMAN7	8	111.3	14.5	78.7	123.8	5.1
PENMAN8	7	120.4	10.4	105.6	136.1	3.9
PENMAN9	11	120.6	8.5	109.0	134.0	2.6
PENMAN10	11	132.4	10.0	118.9	153.9	3.0
PENMAN11	10	125.4	10.4	105.2	145.0	3.3
PENMAN12	8	126.8	6.9	116.3	139.9	2.4
THORT1	14	57.1	2.6	52.0	63.0	0.7
THORT2	15	57.1	3.9	52.0	63.0	1.0
THORT3	14	56.3	3.2	52.0	63.0	0.8
THORT4	15	55.7	5.9	36.6	63.0	1.5
THORT5	15	56.0	3.2	52.0	63.0	0.8
THORT6	15	50.6	3.2	46.7	57.5	0.8
THORT7	13	49.2	2.7	46.7	52.0	0.8
THORT8	13	49.6	2.7	46.7	52.0	0.8
THORT9	15	52.4	3.2	46.7	57.5	0.8
THORT10	14	56.7	2.0	52.0	57.5	0.5
THORT11	13	58.3	3.1	52.0	63.0	0.9
THORT12	13	57.9	4.2	52.0	63.0	1.2
PRSTLY1	11	189.2	15.4	163.5	213.5	4.6
PRSTLY2	11	174.0	12.8	151.1	201.6	3.8
PRSTLY3	13	174.6	7.6	155.7	188.8	2.1
PRSTLY4	14	161.8	15.1	134.0	198.3	4.0
PRSTLY5	13	169.2	13.7	144.9	193.7	3.8
PRSTLY6	11	151.0	16.8	122.2	175.9	5.1
PRSTLY7	8	163.2	27.4	100.2	184.8	9.7
PRSTLY8	7	177.9	21.6	143.4	209.3	8.2
PRSTLY9	11	173.2	13.4	151.1	192.9	4.0
PRSTLY10	11	194.6	12.8	172.2	210.0	3.9
PRSTLY11	10	186.2	17.9	149.2	216.8	5.7
PRSTLY12	9	189.7	10.5	174.4	208.2	3.5
HARGRS1	11	113.3	9.4	97.9	127.9	2.8
HARGRS2	11	103.6	8.1	87.0	119.6	2.5
HARGRS3	13	102.8	5.6	89.5	111.9	1.6
HARGRS4	14	96.1	10.4	80.2	122.1	2.8
HARGRS5	13	102.4	9.1	85.7	118.0	2.5
HARGRS6	11	89.9	10.6	73.3	105.5	3.2
HARGRS7	8	96.0	16.3	59.9	110.4	5.8
HARGRS8	7	102.9	14.0	81.7	123.1	5.3
HARGRS9	11	100.7	8.3	87.8	112.2	2.5
HARGRS10	11	115.0	7.8	102.4	124.8	2.4
HARGRS11	10	111.4	11.6	89.2	133.3	3.7
HARGRS12	9	115.3	8.0	101.9	128.8	2.7

SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

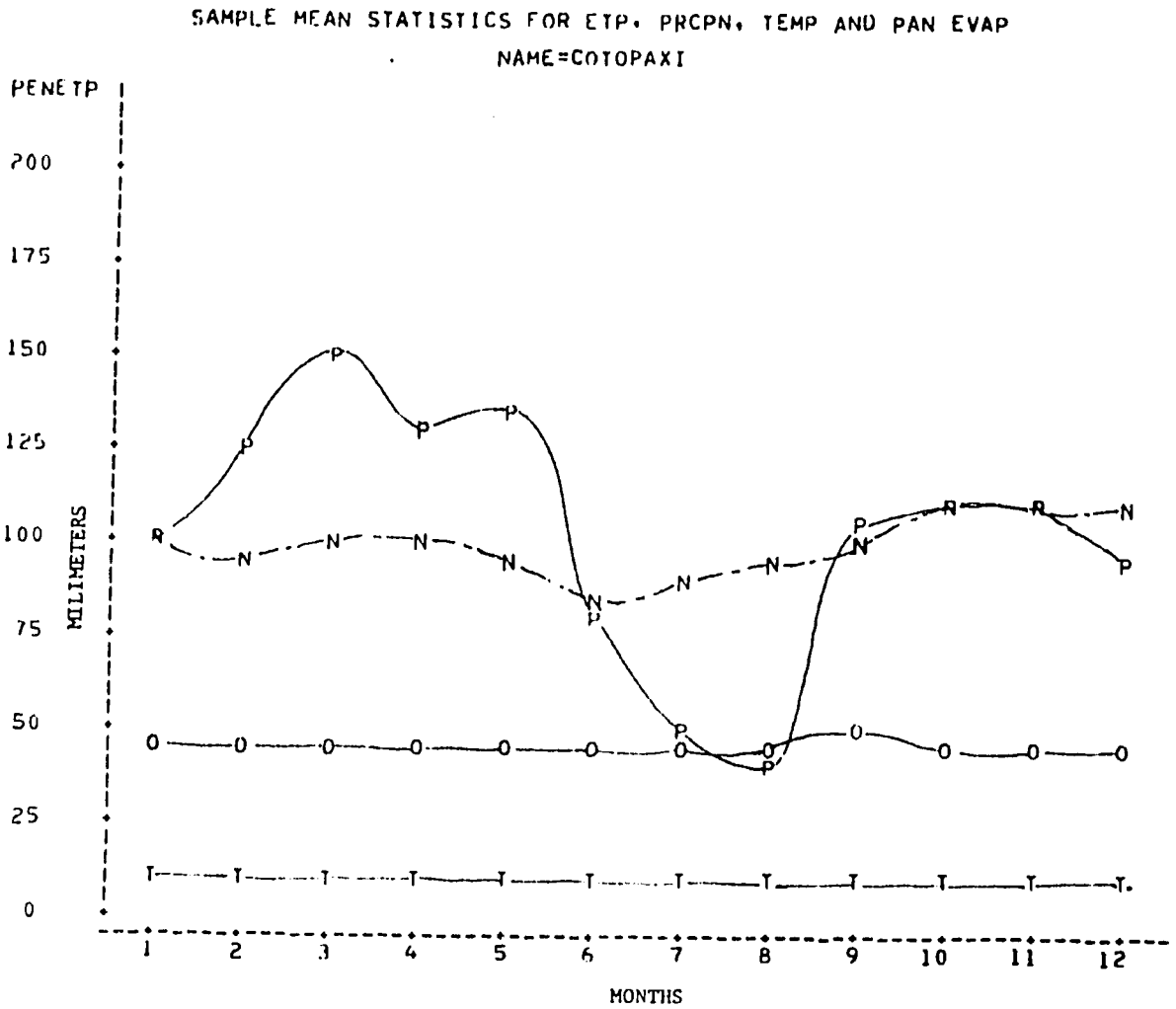
NAME=GUAMOTE

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
PENMAN1	0	.	.	.	.	.
PENMAN2	0	.	.	.	.	.
PENMAN3	0	.	.	.	.	.
PENMAN4	0	.	.	.	.	.
PENMAN5	0	.	.	.	.	.
PENMAN6	0	.	.	.	.	.
PENMAN7	0	.	.	.	.	.
PENMAN8	0	.	.	.	.	.
PENMAN9	0	.	.	.	.	.
PENMAN10	0	.	.	.	.	.
PENMAN11	0	.	.	.	.	.
PENMAN12	0	.	.	.	.	.
THORT1	14	55.9	3.4	49.5	60.9	0.9
THORT2	15	54.7	2.6	49.5	59.2	0.7
THORT3	15	54.4	4.0	47.4	62.0	1.0
THORT4	14	54.9	3.8	45.3	60.9	1.0
THORT5	14	56.0	3.6	47.4	61.4	0.9
THORT6	14	54.3	4.6	46.3	63.1	1.2
THORT7	14	53.3	4.8	46.3	61.4	1.3
THORT8	15	52.7	4.2	43.8	59.2	1.1
THORT9	15	53.2	3.6	45.8	59.8	0.9
THORT10	14	53.2	3.1	48.4	58.1	0.8
THORT11	14	55.2	3.4	48.4	59.2	0.9
THORT12	14	55.3	3.5	45.8	60.3	0.9
PRSTLY1	0	.	.	.	.	.
PRSTLY2	0	.	.	.	.	.
PRSTLY3	0	.	.	.	.	.
PRSTLY4	0	.	.	.	.	.
PRSTLY5	0	.	.	.	.	.
PRSTLY6	0	.	.	.	.	.
PRSTLY7	0	.	.	.	.	.
PRSTLY8	0	.	.	.	.	.
PRSTLY9	0	.	.	.	.	.
PRSTLY10	0	.	.	.	.	.
PRSTLY11	0	.	.	.	.	.
PRSTLY12	0	.	.	.	.	.
HARGRS1	0	.	.	.	.	.
HARGRS2	0	.	.	.	.	.
HARGRS3	0	.	.	.	.	.
HARGRS4	0	.	.	.	.	.
HARGRS5	0	.	.	.	.	.
HARGRS6	0	.	.	.	.	.
HARGRS7	0	.	.	.	.	.
HARGRS8	0	.	.	.	.	.
HARGRS9	0	.	.	.	.	.
HARGRS10	0	.	.	.	.	.
HARGRS11	0	.	.	.	.	.
HARGRS12	0	.	.	.	.	.

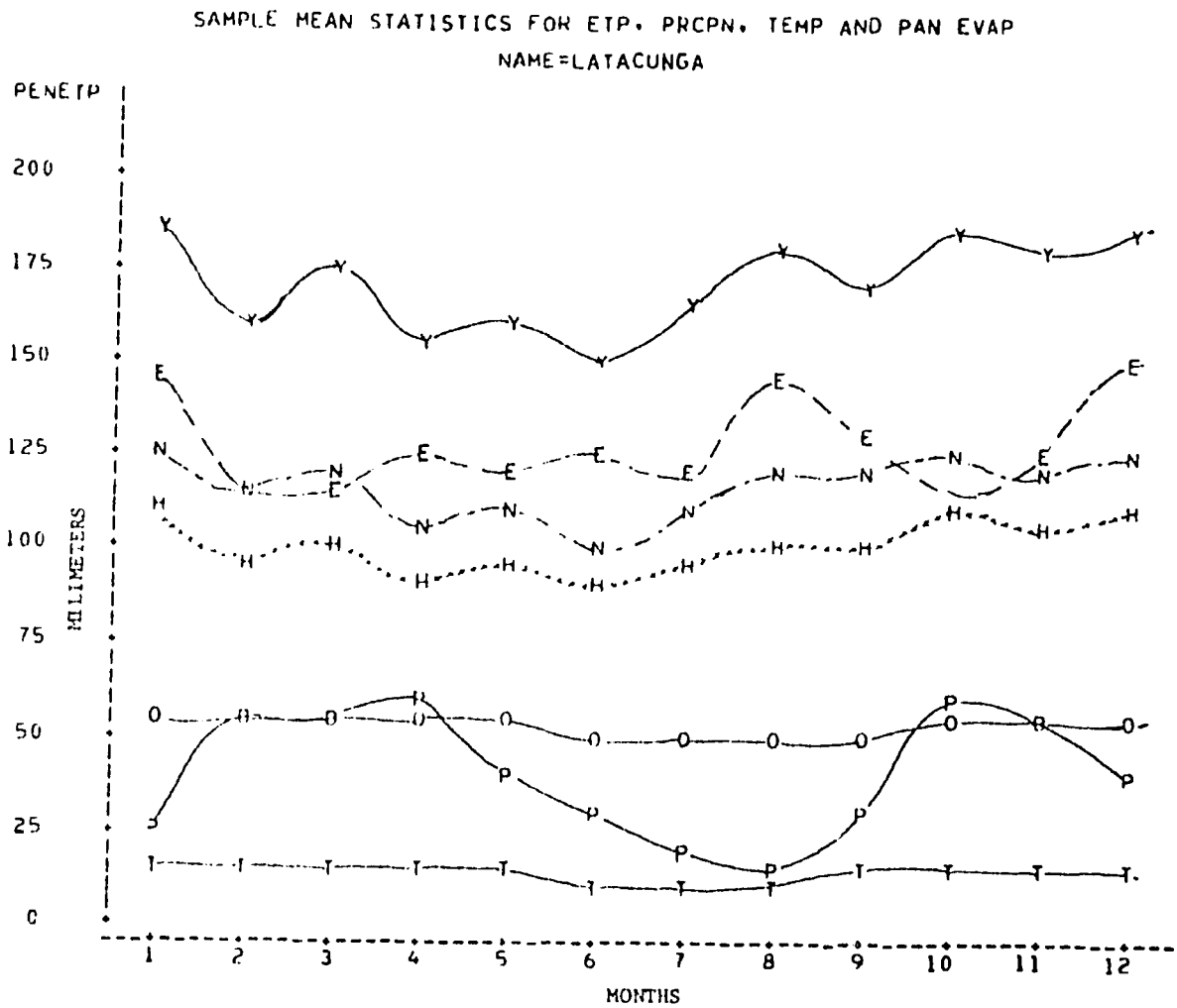
SIMPLE STATISTICS FOR ETP CALCULATIONS FOR CENTRAL SIERRA

NAME=GUAMOTE

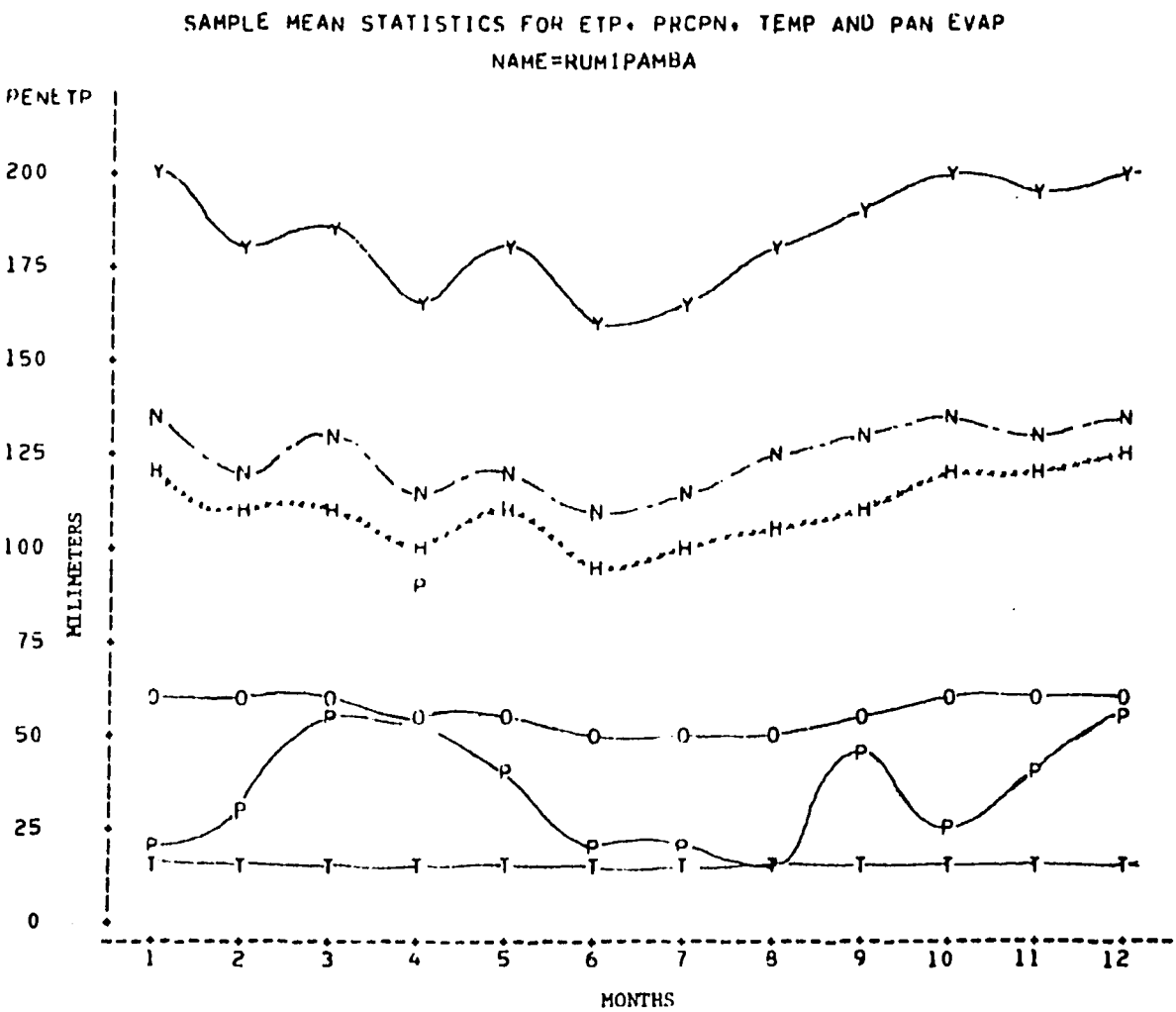
VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
P1	14	34.4	20.8	2.0	93.0	5.6
P2	15	66.6	32.2	12.0	127.0	8.3
P3	15	73.8	43.2	24.0	169.0	11.1
P4	14	59.3	37.8	17.0	156.0	10.1
P5	14	32.7	30.5	0.0	124.0	8.2
P6	14	32.4	19.1	2.0	66.0	5.1
P7	14	16.4	17.6	1.0	68.0	4.7
P8	15	19.2	31.1	0.0	129.0	8.0
P9	15	33.5	26.7	0.0	73.0	6.9
P10	14	61.9	35.3	8.0	108.0	9.4
P11	14	43.9	38.2	9.0	140.0	10.2
P12	14	34.8	32.5	1.0	125.0	8.7
T1	15	13.6	0.6	12.4	14.5	0.2
T2	15	13.4	0.5	12.4	14.2	0.1
T3	15	13.3	0.7	12.0	14.7	0.2
T4	14	13.4	0.7	11.6	14.5	0.2
T5	14	13.6	0.7	12.0	14.6	0.2
T6	14	13.3	0.8	11.8	14.9	0.2
T7	14	13.1	0.9	11.8	14.6	0.2
T8	15	13.0	0.8	11.3	14.2	0.2
T9	15	13.1	0.7	11.7	14.3	0.2
T10	14	13.1	0.6	12.2	14.0	0.2
T11	14	13.5	0.6	12.2	14.2	0.2
T12	14	13.5	0.7	11.7	14.4	0.2
E1	0	.	.	.	.	.
E2	0	.	.	.	.	.
E3	0	.	.	.	.	.
E4	0	.	.	.	.	.
E5	0	.	.	.	.	.
E6	0	.	.	.	.	.
E7	0	.	.	.	.	.
E8	0	.	.	.	.	.
E9	0	.	.	.	.	.
E10	0	.	.	.	.	.
E11	0	.	.	.	.	.
E12	0	.	.	.	.	.



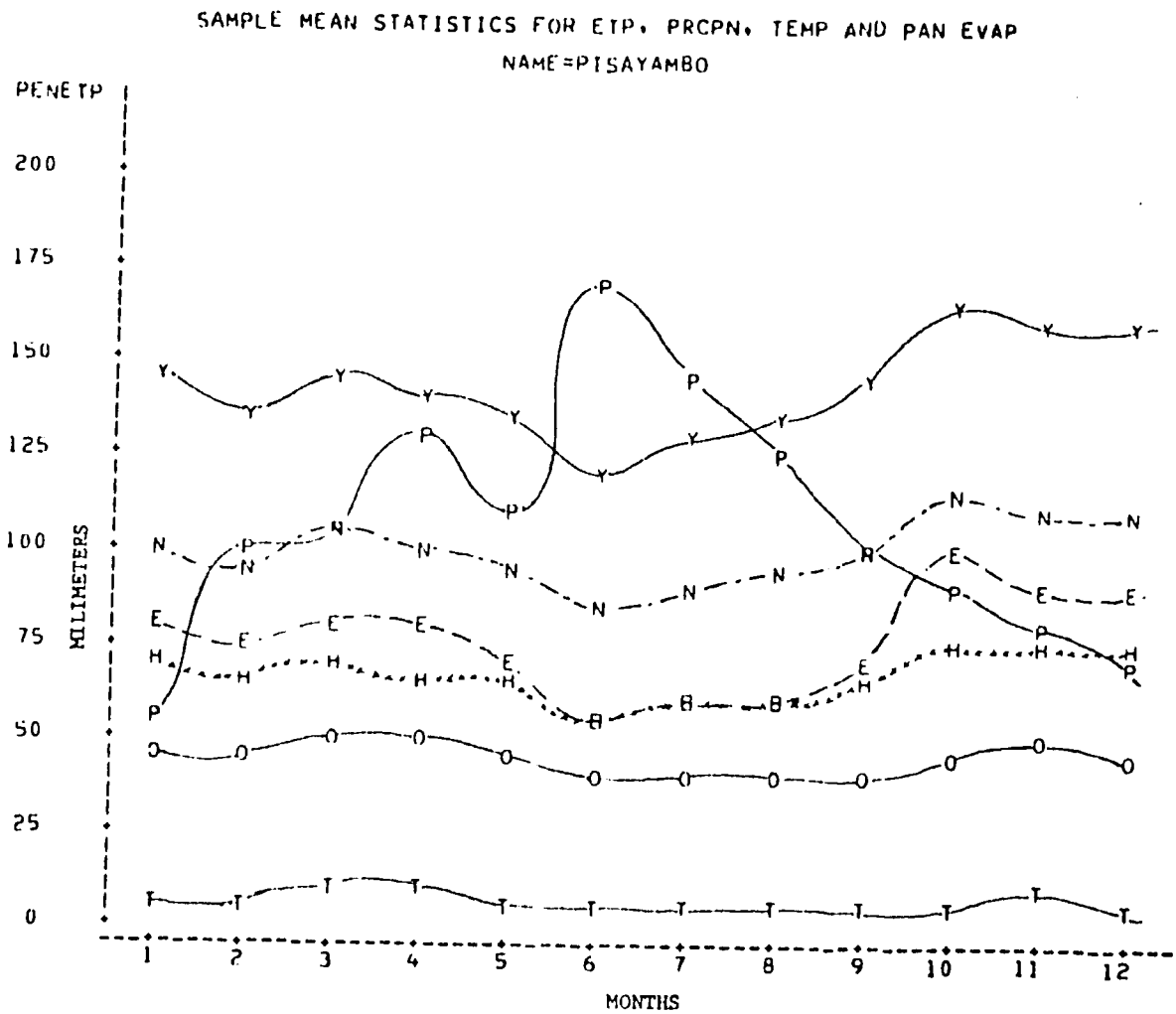
Comparisons of Mean Monthly Potential Evapotranspiration by Thornthwaite (O), Penman (N), Precipitation (P) and Temperature (T) at Cotopaxi.



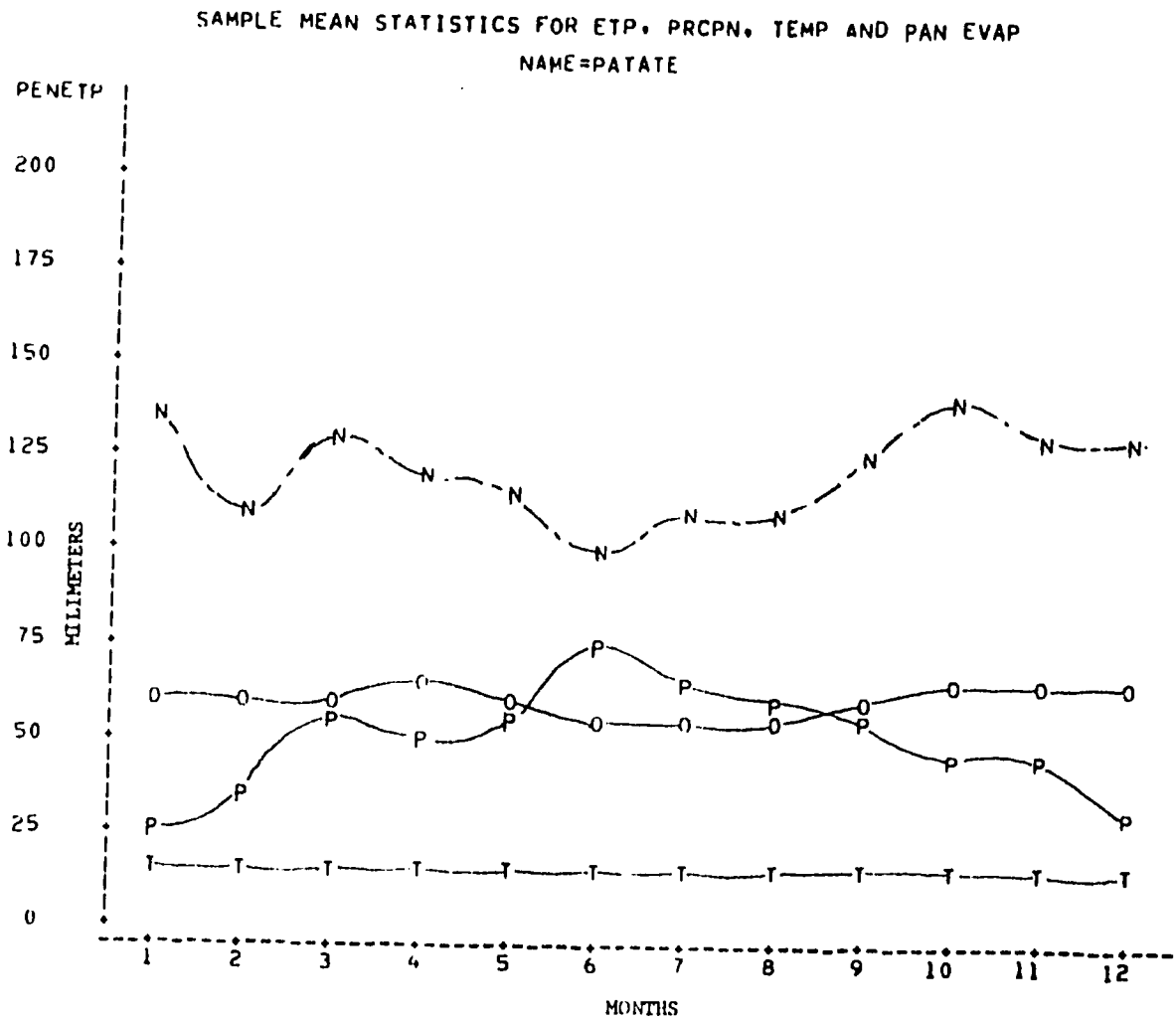
Comparisons of Mean Monthly Potential Evapotranspiration by Hargreaves (H), Thornthwaite (O), Penman (N), Priestley and Taylor (Y), Pan Evaporation (E), Precipitation (P) and Temperature (T) at Latacunga.



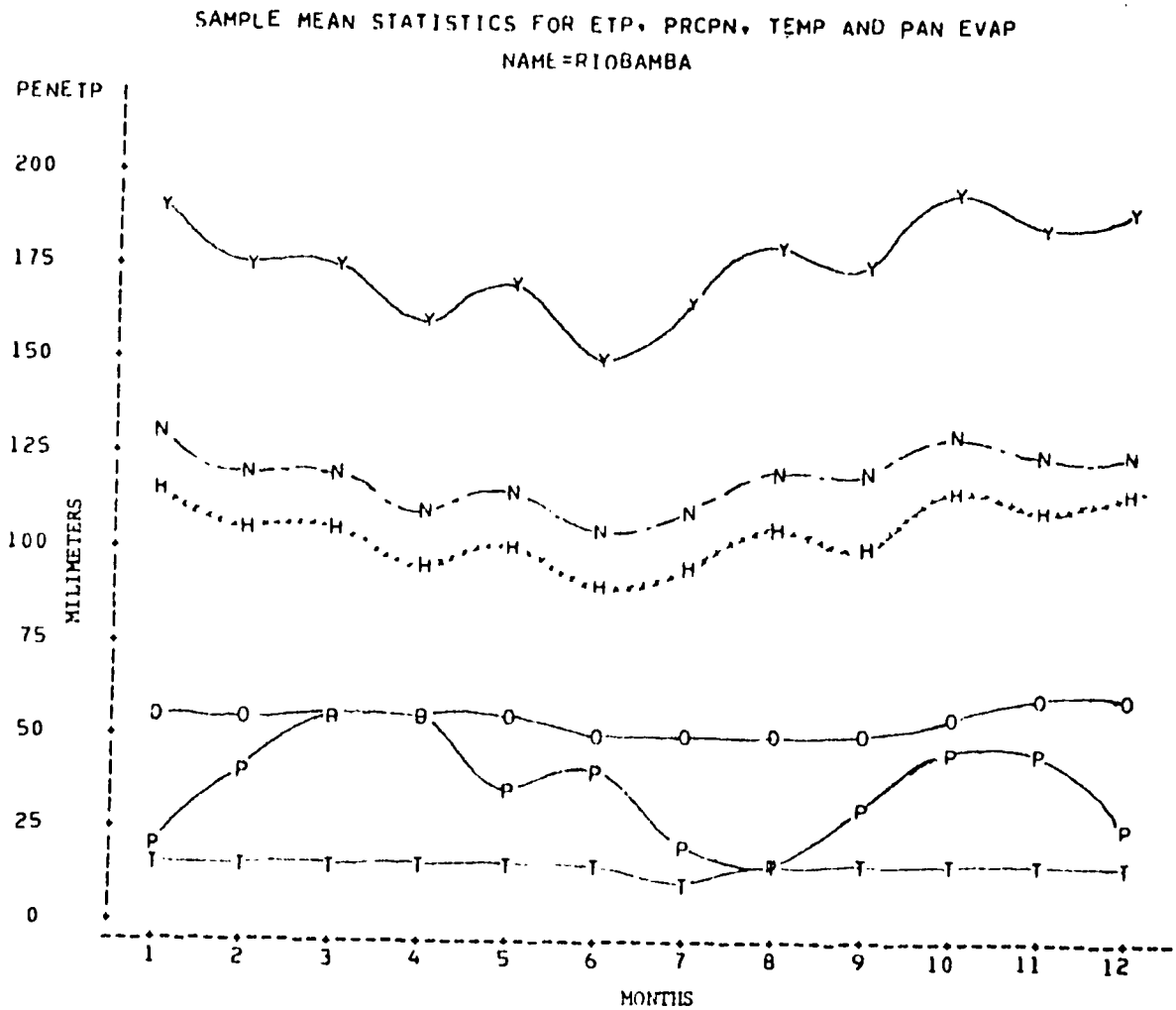
Comparisons of Mean Monthly Potential Evapotranspiration by Hargreaves (H), Thornthwaite (O), Penman (N), Priestley and Taylor (Y), Precipitation (P) and Temperature (T) at Rumipamba.



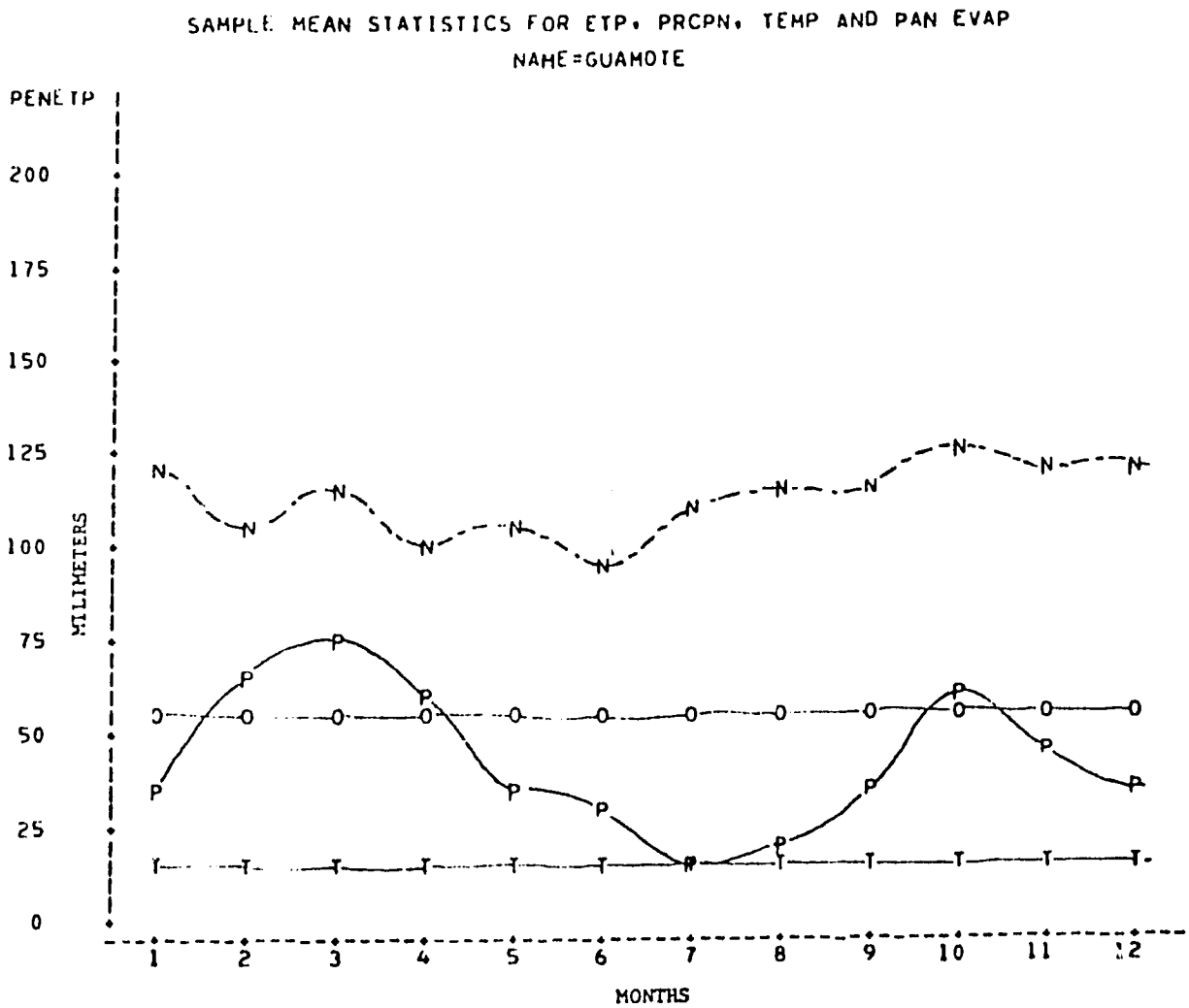
Comparisons of Mean Monthly Potential Evapotranspiration by Hargreaves (H), Thornthwaite (O), Penman (N), Priestley and Taylor (Y), Pan Evaporation (E), Precipitation (P) and Temperature (T) at Pisayambo.



Comparisons of Mean Monthly Potential Evapotranspiration by Thornthwaite (O), Penman (N), Precipitation (P) and Temperature (T) at Patate.



Comparisons of Mean Monthly Potential Evapotranspiration by Hargreaves (H), Thorthwaite (O), Penman (N), Priestley and Taylor (Y),Precipitation (P) and Temperature (T) at Rio -- bamba.



Comparisons of Mean Monthly Potential Evapotranspiration by Thornthwaite (O), Penman (N), Precipitation (P) and Temperature (T) at Guamote.

APPENDIX B[1/]

YIELD MOISTURE INDEX (YMI) EXPRESSED AS PERCENTILE RANKING

1/ Notes:

1) P is precipitation in millimeters

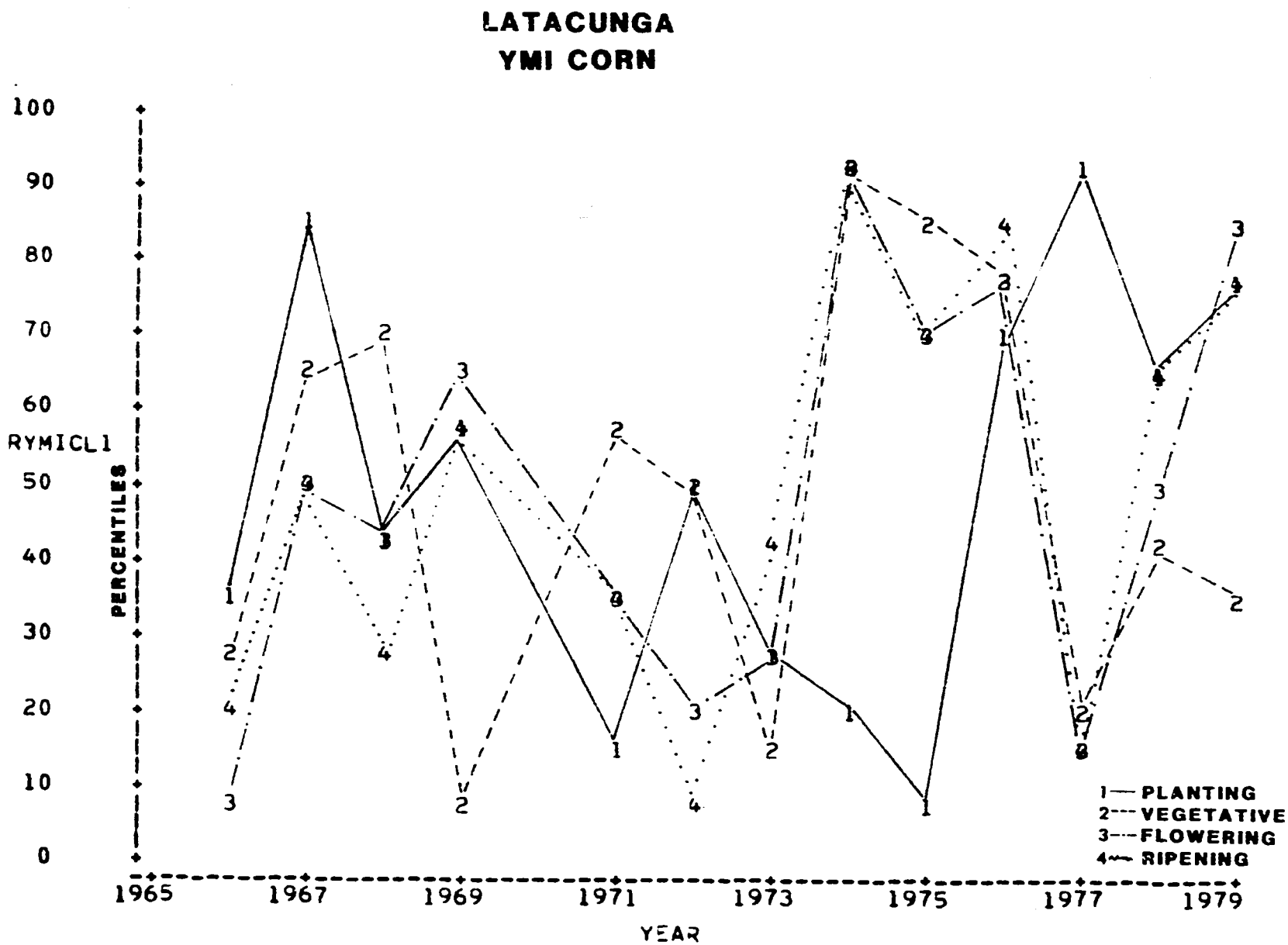
2) P1 = JAN, --- P12 = Dec.

3) LP10 = lagged Oct precipitation from previous year, etc.

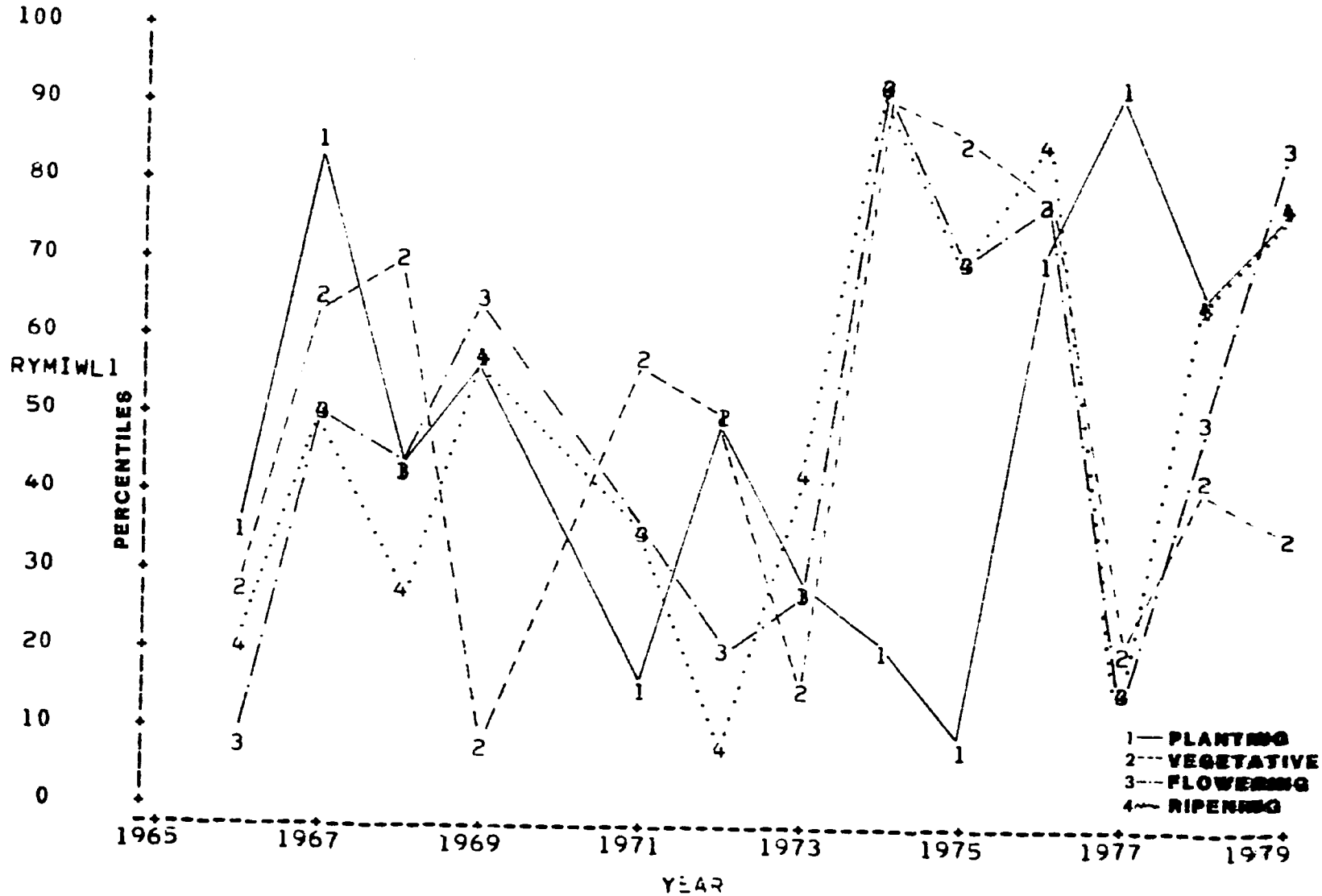
4) YMI = Yield Moisture Index; C = CORN, W = Wheat and Barley, P = Potatoes; L = Lowland, H = Highland.

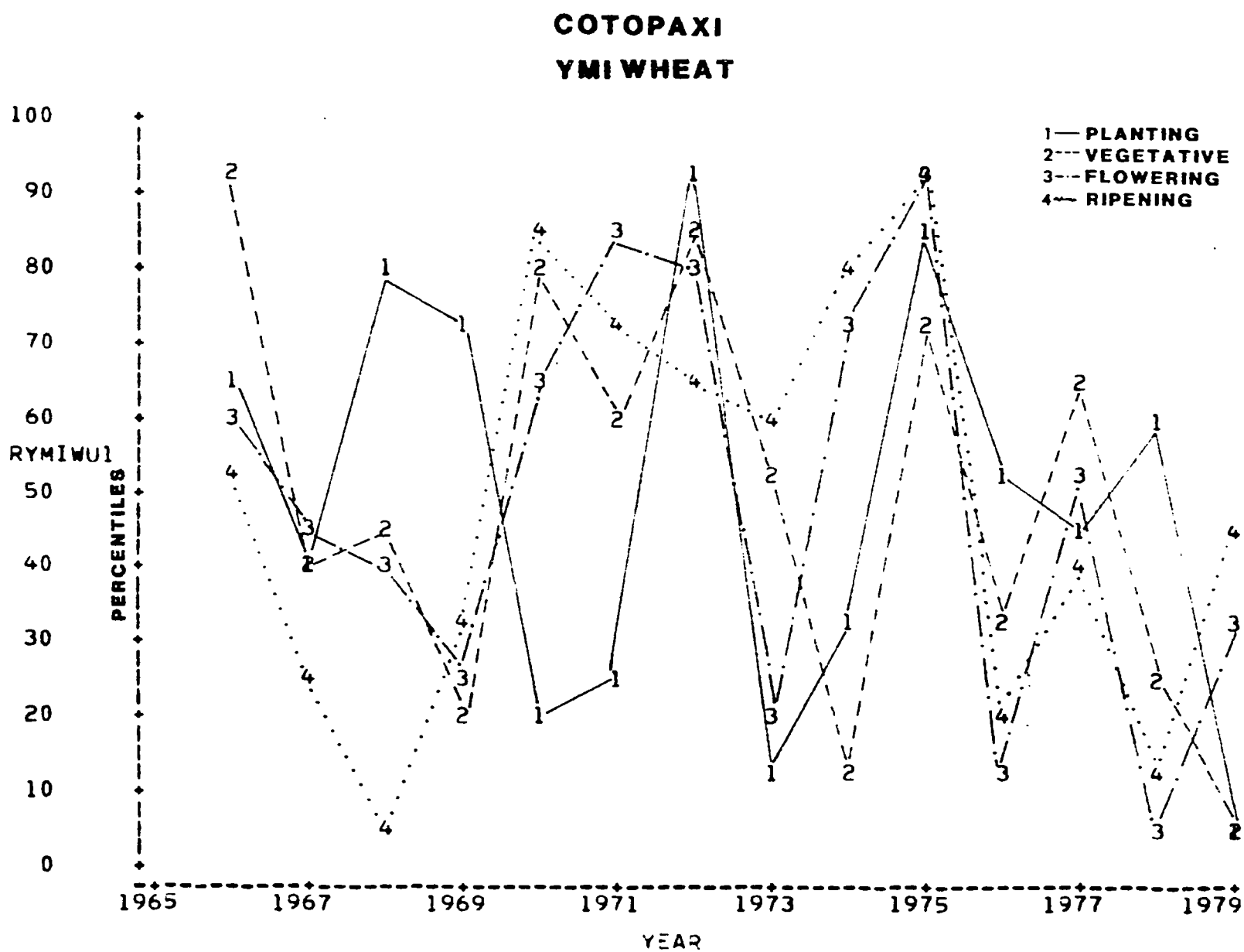
5) Subscript 1 = Planting crop stage, 2 = Vegetative, 3 = Flowering and 4 = Ripening.

6) Prefix "R" in RYMI --- Stands for percentile rank of associated YMI.

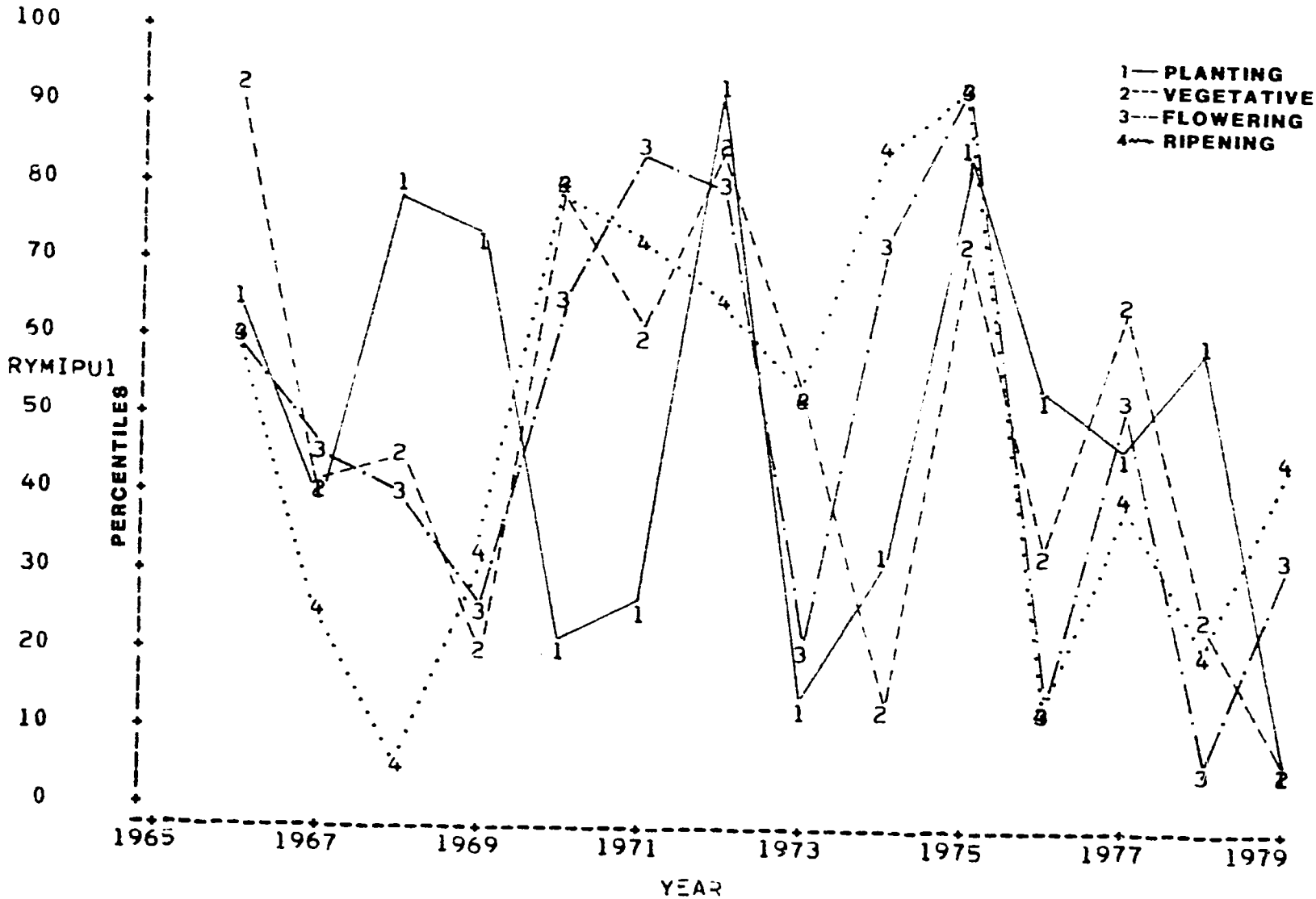

LATACUNGA
YMI CORN
RYMICL1
PERCENTILES
100
90
80
70
60
50
40
30
20
10
0
1965
1967
1969
1971
1973
1975
1977
1979
YEAR
1— PLANTING
2--- VEGETATIVE
3--- FLOWERING
4— RIPENING

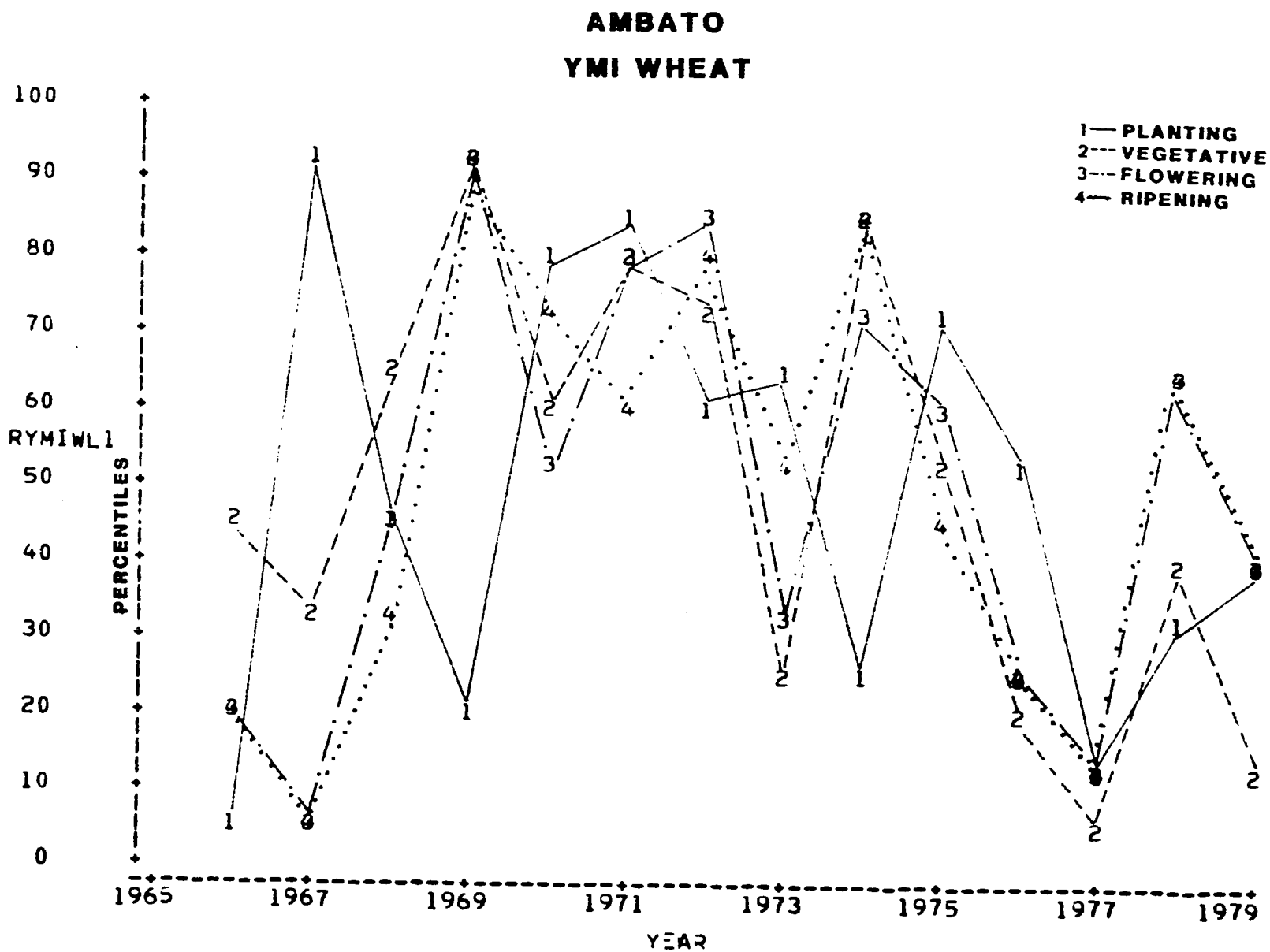
LATACUNGA
YMI WHEAT



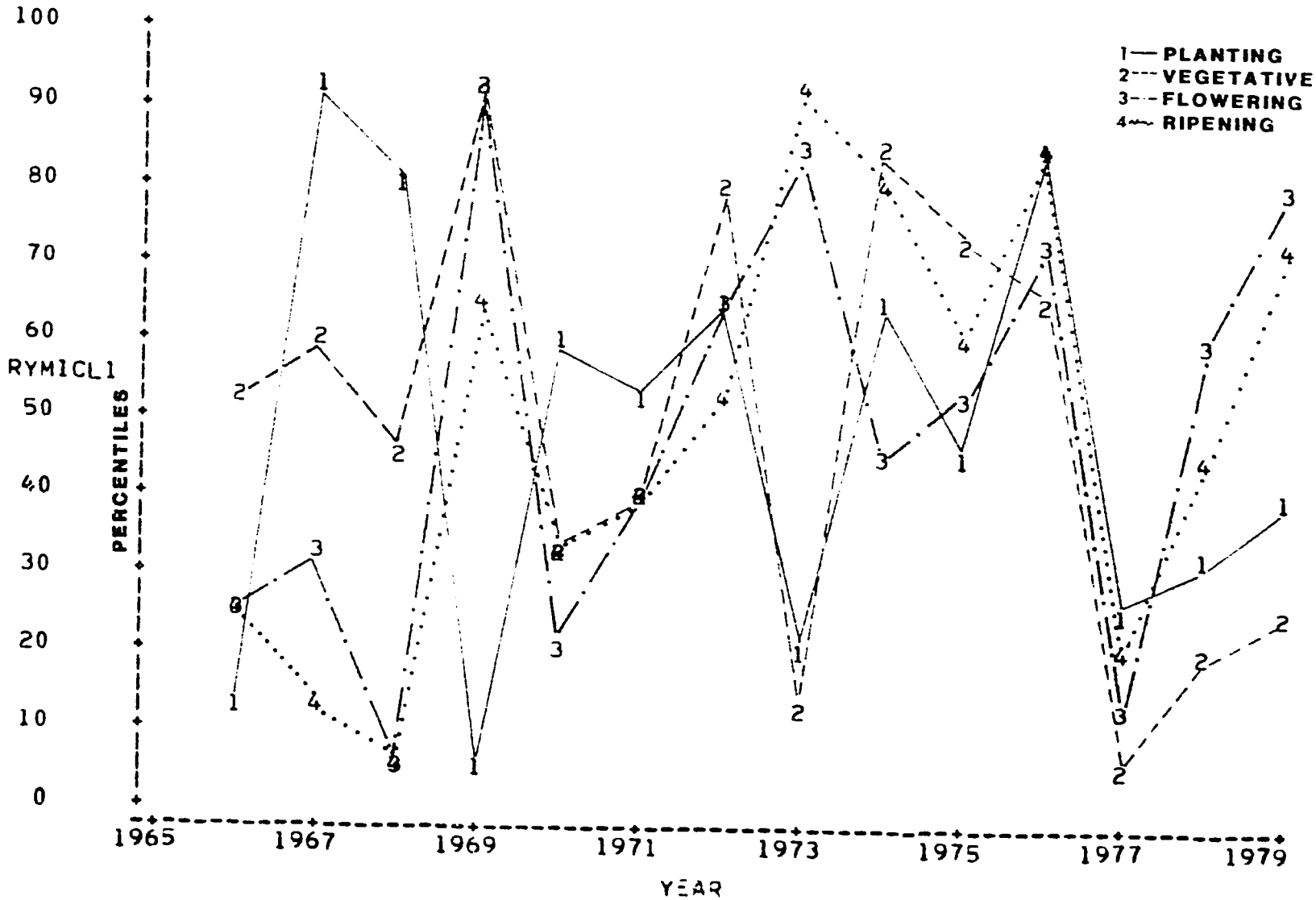

COTOPAXI
YMI WHEAT
1— PLANTING
2--- VEGETATIVE
3-·- FLOWERING
4··· RIPENING
RYMIWU1
PERCENTILES
YEAR
100
90
80
70
60
50
40
30
20
10
0
1965
1967
1969
1971
1973
1975
1977
1979

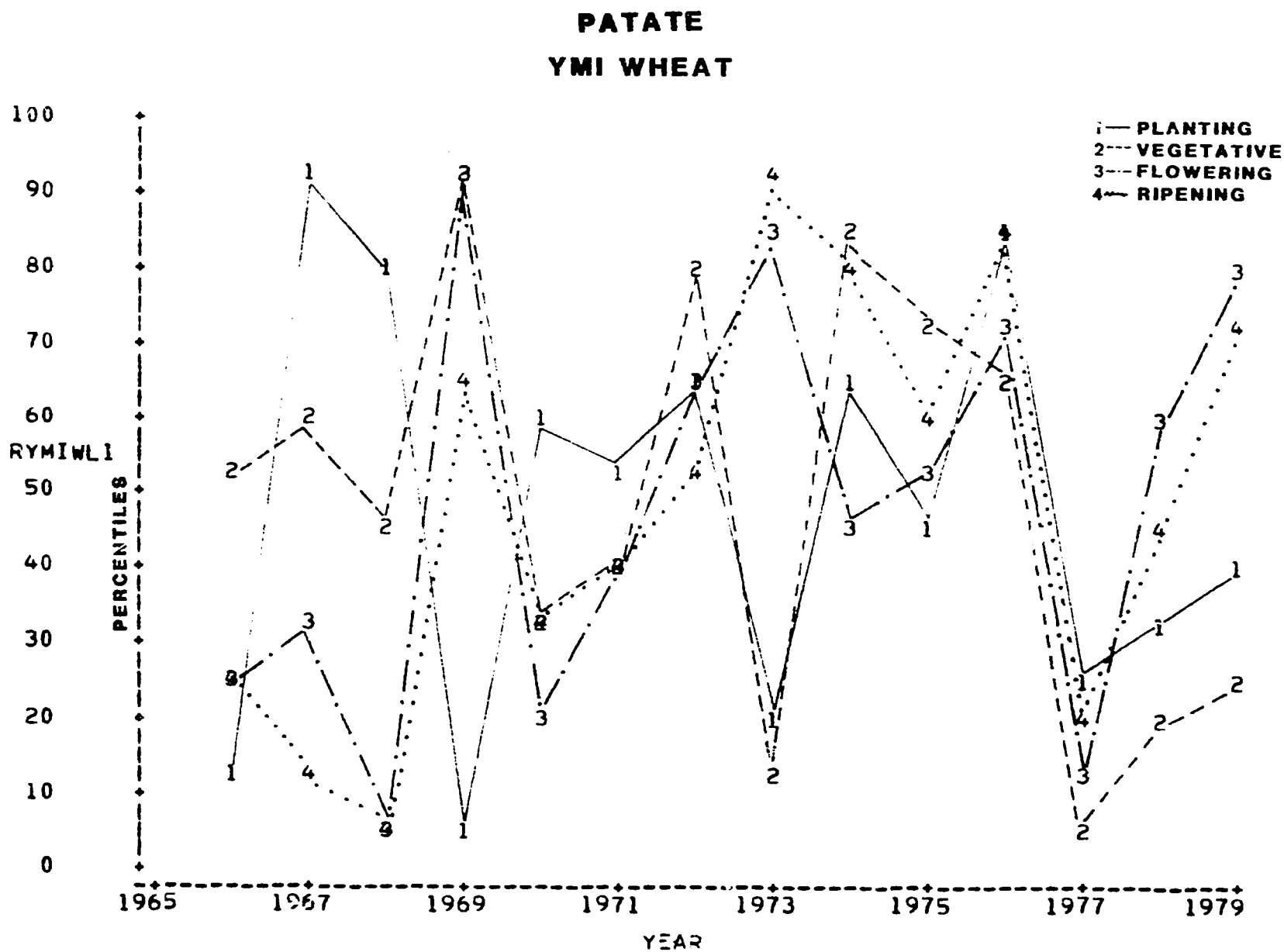
COTOPAXI
YMI POTATOES



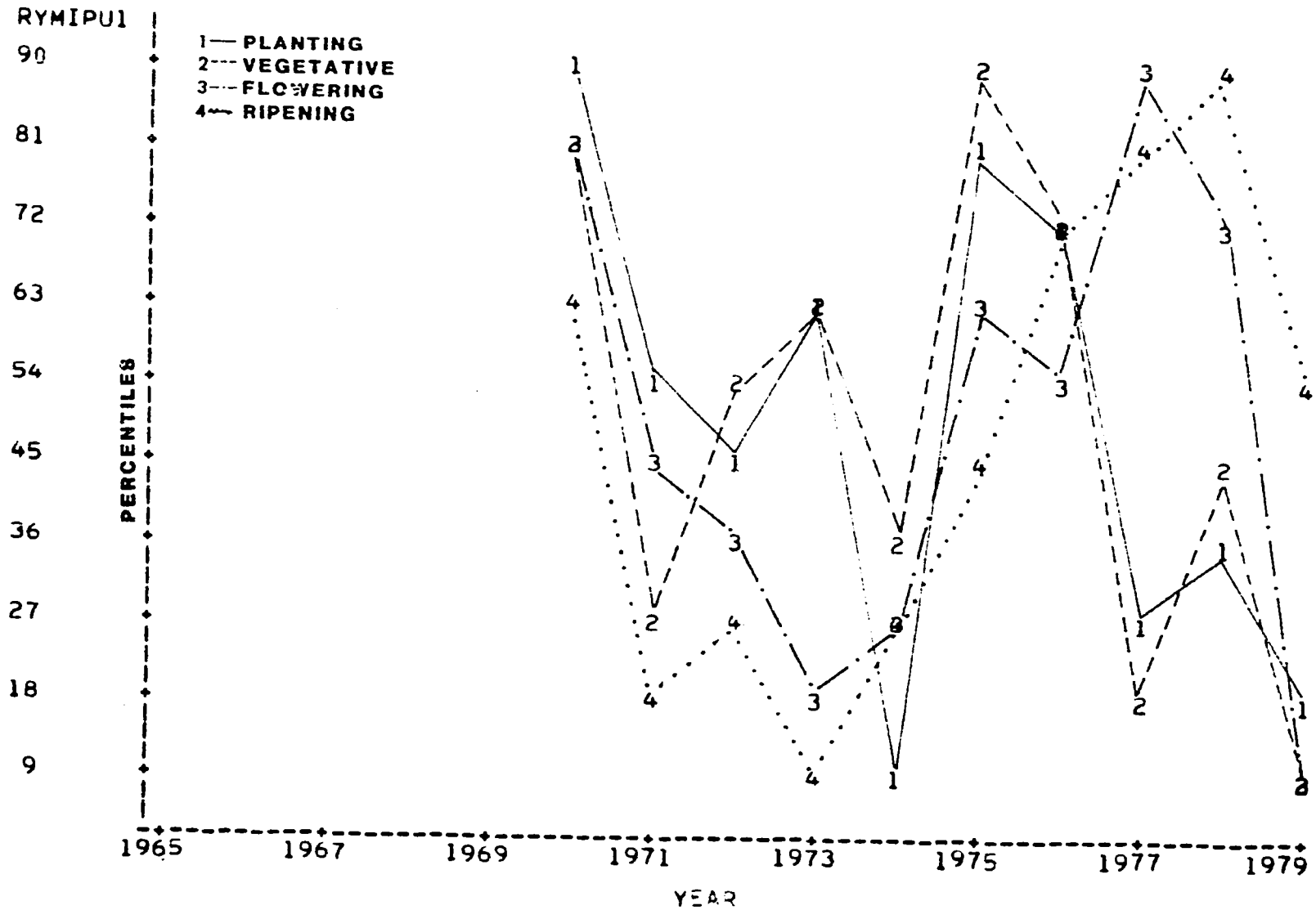

AMBATO
YMI WHEAT
1— PLANTING
2--- VEGETATIVE
3-·- FLOWERING
4-·- RIPENING
RYMIWL1
PERCENTILES
100
90
80
70
60
50
40
30
20
10
0
1965
1967
1969
1971
1973
1975
1977
1979
YEAR

PATATE
YMI CORN

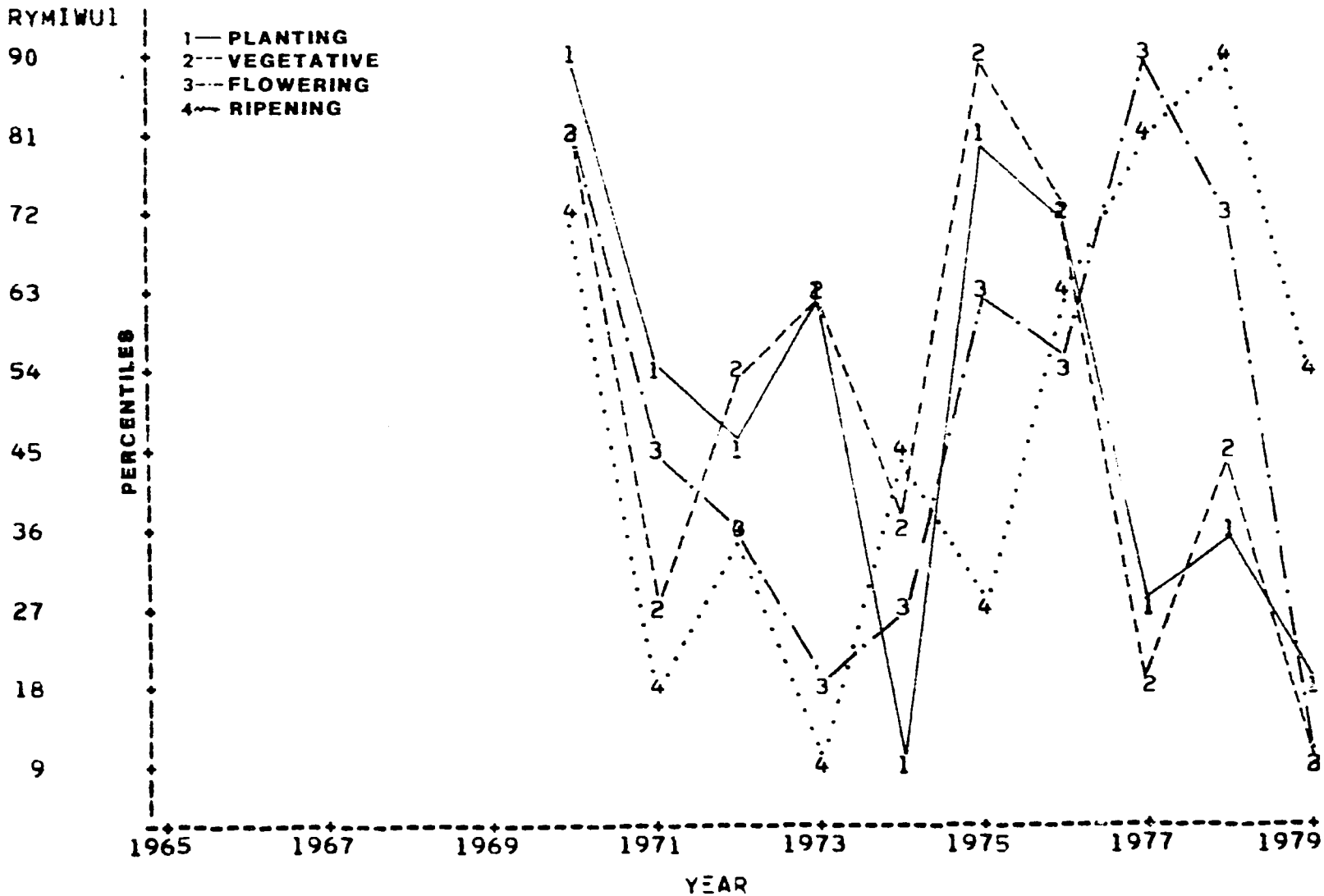



PATATE
YMI WHEAT
1— PLANTING
2--- VEGETATIVE
3-·- FLOWERING
4··· RIPENING
RYMIWL1
PERCENTILES
YEAR
100
90
80
70
60
50
40
30
20
10
0
1965
1967
1969
1971
1973
1975
1977
1979

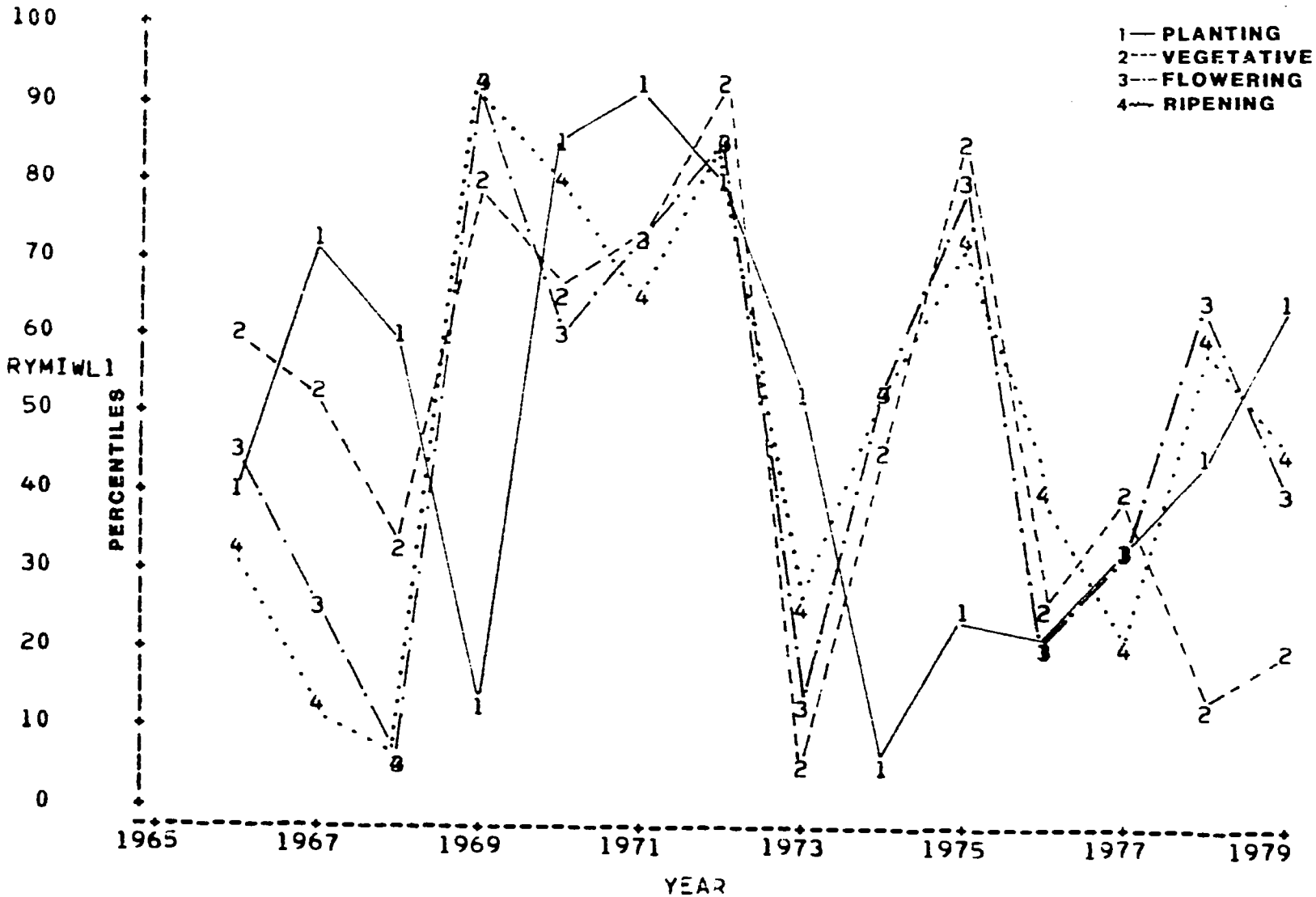
PISAYAMBO
YMI WHEAT



PISAYAMBO
YMI POTATOES

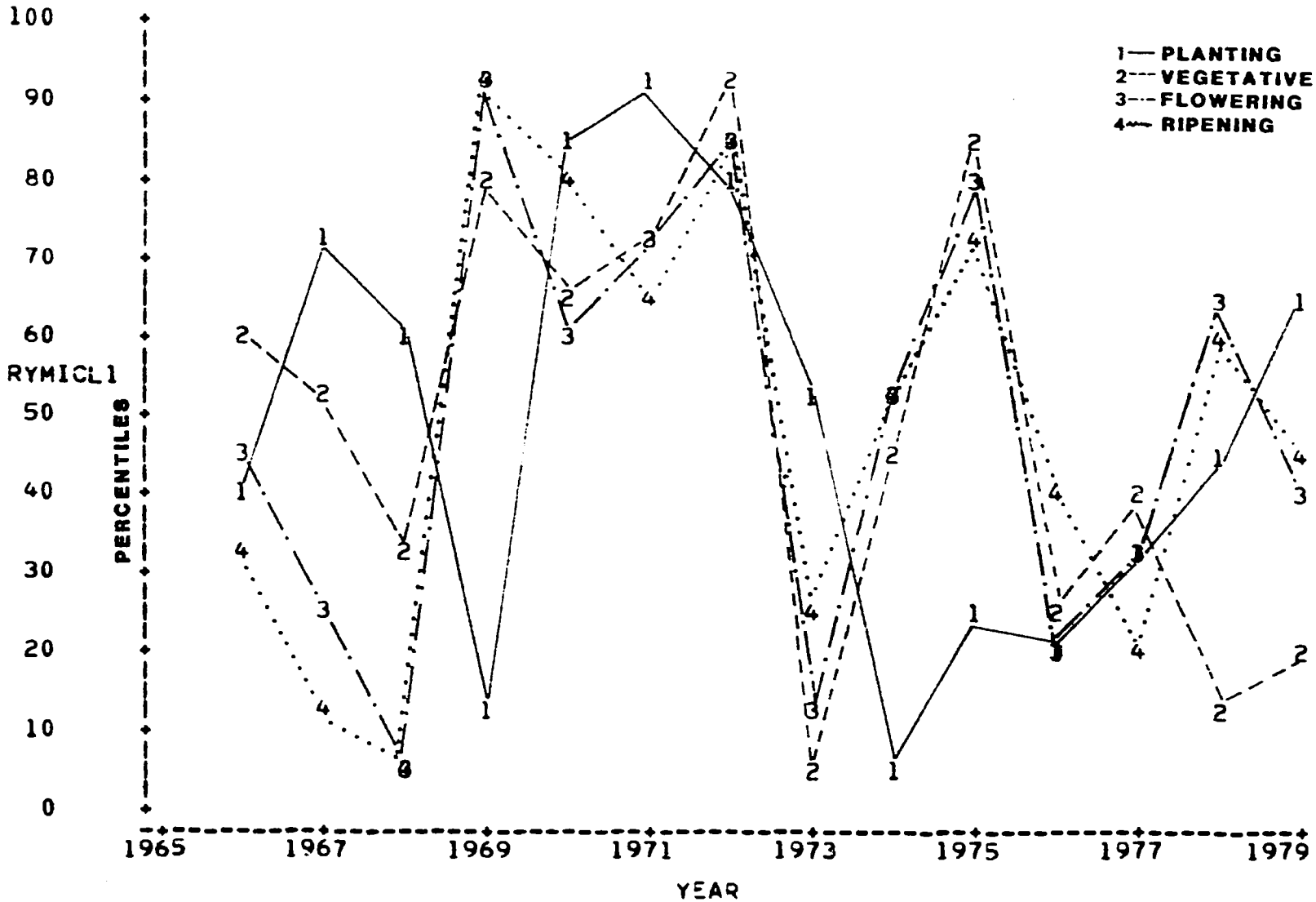


RIOBAMBA
YMI CORN

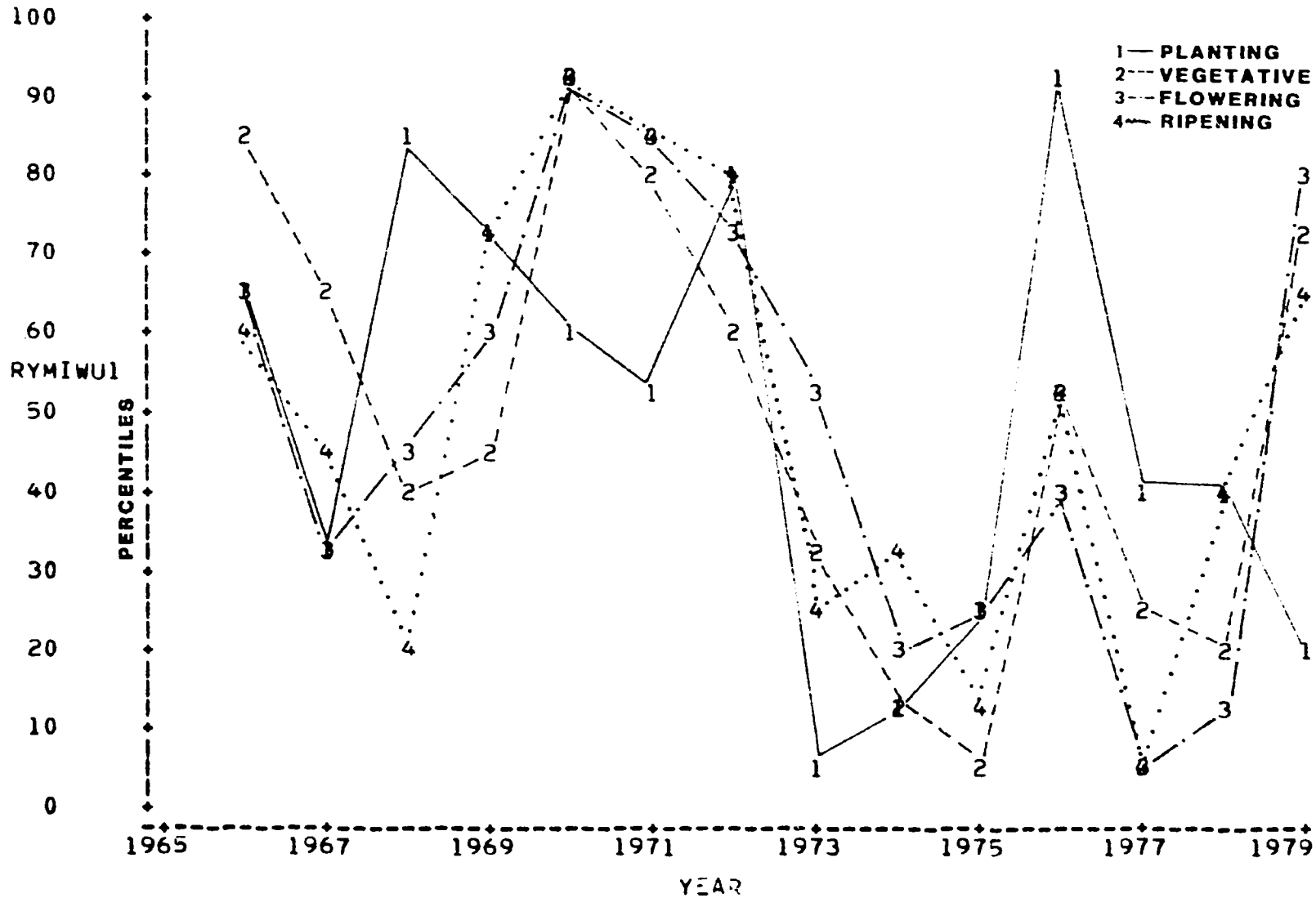


RIOBAMBA

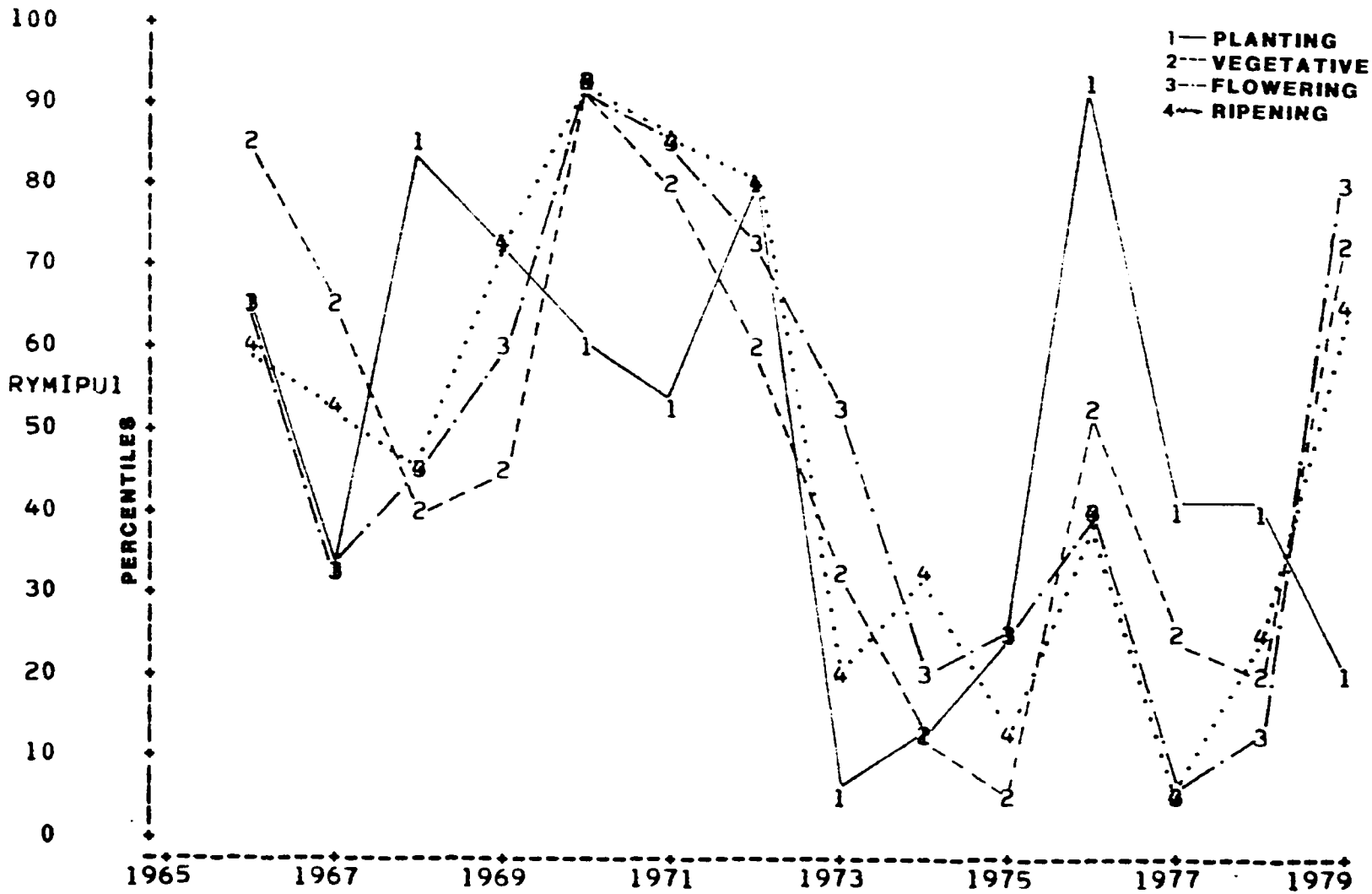
YMI WHEAT



GUAMOTE
YMI WHEAT



GUAMOTE
YMI POTATOES



S T A T I S T I C A L A N A L Y S I S S Y S T E M

---------- NAME=AMBATO ----------

OBS	CODE	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	LP10	LP11	LP12	YMICL1
1	P	1965	12	7	7	88	33	20	14	22	5	77	75	11	.	.	.	.
2	P	1966	13	52	50	14	31	47	34	28	37	24	40	79	77	75	11	18.1
3	P	1967	13	27	23	13	6	41	31	13	10	100	34	14	24	40	79	65.7
4	P	1968	48	46	68	28	15	64	22	9	18	44	17	8	100	34	14	48.2
5	P	1969	18	47	113	108	46	25	8	31	24	71	73	44	44	17	8	20.0
6	P	1970	34	56	46	44	94	55	26	22	23	62	52	40	71	73	44	58.0
7	P	1971	44	40	72	59	22	47	15	43	21	50	50	29	62	52	40	63.2
8	P	1972	38	42	72	85	32	72	29	20	22	20	20	67	50	50	29	50.7
9	P	1973	8	27	29	71	69	29	46	38	83	36	23	7	20	20	67	53.3
10	P	1974	20	65	90	55	69	33	42	10	76	57	65	52	36	23	7	20.9
11	P	1975	23	52	43	55	35	65	135	39	25	82	39	56	57	65	52	54.8
12	P	1976	13	32	26	45	50	47	34	20	25	18	52	19	82	39	56	49.6
13	P	1977	8	29	43	33	11	48	16	31	69	37	13	27	18	52	19	19.7
14	P	1978	10	31	60	100	39	46	10	20	47	6	2	27	37	13	27	26.9
15	P	1979	12	16	51	82	54	17	14	42	28	12	33	7	6	2	27	28.5

OBS	YMICL2	YMICL3	YMICL4	YMIWL1	YMIWL2	YMIWL3	YMIWL4	RYMICL1	RYMICL2	RYMICL3	RYMICL4	RYMIWL1	RYMIWL2	RYMIWL3	RYMIWL4
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	130.1	146.9	171.7	18.1	130.1	146.9	171.7	6	46	19	19	6	46	19	19
3	120.3	135.9	140.7	65.7	120.3	135.9	140.7	93	33	6	6	93	33	6	6
4	175.8	209.4	221.4	48.2	175.8	209.4	221.4	46	66	46	33	46	66	46	33
5	202.6	332.2	369.0	20.0	202.6	332.2	369.0	19	93	93	93	19	93	93	93
6	169.2	222.0	297.2	58.0	169.2	222.0	297.2	79	59	53	73	79	59	53	73
7	189.6	260.4	278.0	63.2	189.6	260.4	278.0	86	79	79	59	86	79	79	59
8	179.1	281.1	306.7	50.7	179.1	281.1	306.7	59	73	86	79	59	73	86	79
9	115.1	200.3	255.5	53.3	115.1	200.3	255.5	66	26	33	53	66	26	33	53
10	193.9	259.9	315.1	20.9	193.9	259.9	315.1	26	86	73	86	26	86	73	86
11	158.4	224.4	252.4	54.8	158.4	224.4	252.4	73	53	59	46	73	53	59	46
12	112.8	166.8	206.8	49.6	112.8	166.8	206.8	53	19	26	26	53	19	26	26
13	100.3	139.9	148.7	19.7	100.3	139.9	148.7	13	6	13	13	13	6	13	13
14	129.9	249.9	281.1	26.9	129.9	249.9	281.1	33	39	66	66	33	39	66	66
15	105.7	204.1	247.3	28.5	105.7	204.1	247.3	39	13	39	39	39	13	39	39

S T A T I S T I C A L A N A L Y S I S S Y S T E M

---------- NAME=COTOPAXI ----------

OBS	CODE	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	LP10	LP11	LP12	YMIPU1
1	P	1965	108	55	136	167	133	63	24	35	151	131	157	105	.	.	.	.
2	P	1966	168	77	138	106	123	86	44	25	103	101	79	90	131	157	105	52.4
3	P	1967	100	180	106	53	103	86	52	19	29	167	83	27	101	79	90	40.4
4	P	1968	135	89	118	99	30	46	44	35	102	133	53	67	167	83	27	66.8
5	P	1969	73	113	107	160	86	118	0	21	77	58	113	225	133	53	67	53.2
6	P	1970	116	151	110	202	201	70	39	41	101	61	114	102	58	113	225	23.2
7	P	1971	112	200	298	108	75	68	31	25	122	283	122	87	61	114	102	24.4
8	P	1972	126	154	245	72	148	42	21	75	32	33	181	96	283	122	87	113.2
9	P	1973	87	35	117	230	168	42	115	91	209	84	100	57	33	181	96	13.2
10	P	1974	69	259	168	140	235	205	75	15	209	189	163	159	84	100	57	33.6
11	P	1975	50	206	252	121	189	141	124	80	52	117	145	46	189	163	159	75.6
12	P	1976	81	82	82	103	148	40	24	19	50	105	139	82	117	145	46	46.8
13	P	1977	136	73	170	81	82	70	29	47	113	123	53	86	105	139	82	42.0
14	P	1978	64	74	78	151	123	59	68	38	84	13	41	88	123	53	86	49.2
15	P	1979	96	112	145	141	172	85	49	56	145	71	107	91	13	41	88	5.2

OBS	YMIPU2	YMIPU3	YMIPU4	YMIWU1	YMIWU2	YMIWU3	YMIWU4	RYMIPU1	RYMIPU2	RYMIPU3	RYMIPU4	RYMIWU1	RYMIWU2	RYMIWU3	RYMIWU4
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	338.8	581.4	850.0	52.4	338.8	581.4	807.0	66	93	59	59	66	93	59	53
3	222.9	530.1	71[illegible].1	40.4	222.9	530.1	676.1	39	39	46	26	39	39	46	26
4	235.2	465.8	631.6	66.8	235.2	465.8	608.6	79	46	39	6	79	46	39	6
5	185.0	426.4	746.2	53.2	185.0	426.4	687.2	73	19	26	33	73	19	26	33
6	330.0	613.0	1051.2	23.2	330.0	613.0	1016.2	19	79	66	79	19	79	66	86
7	242.4	800.0	1023.6	24.4	242.4	800.0	989.6	26	59	86	73	26	59	86	73
8	335.9	783.9	1009.7	113.2	335.9	783.9	988.7	93	86	79	66	93	86	79	66
9	240.5	415.9	847.3	13.2	240.5	415.9	826.3	13	53	19	53	13	53	19	59
10	178.7	639.3	1097.8	33.6	178.7	639.3	995.3	33	13	73	86	33	13	73	79
11	308.4	816.8	1183.7	75.6	308.4	816.8	1113.2	86	73	93	93	86	73	93	93
12	216.3	396.7	658.7	46.8	216.3	396.7	638.7	53	33	13	13	53	33	13	19
13	277.7	554.7	752.5	42.0	277.7	554.7	717.5	46	66	53	39	46	66	53	39
14	187.1	354.7	663.8	49.2	187.1	354.7	634.3	59	26	6	19	59	26	6	13
15	164.1	450.1	799.4	5.2	164.1	450.1	756.9	6	6	33	46	6	6	33	46

STATISTICAL ANALYSIS SYSTEM

NAME=GUAMOTE

OBS	CODE	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	LP10	LP11	LP12	YMIWU1
1	P	1965	32	24	25	102	45	9	3	9	18	96	140	46	.	.	.	.
2	P	1966	26	46	60	52	42	27	13	12	15	41	29	47	96	140	46	38.4
3	P	1967	49	69	44	44	23	66	34	3	9	106	19	1	41	29	47	16.4
4	P	1968	40	83	64	27	11	53	24	10	71	98	16	19	106	19	1	42.4
5	P	1969	37	83	78	156	10	36	5	9	39	81	83	125	98	16	19	39.2
6	P	1970	93	127	46	52	124	49	16	12	7	60	80	19	81	83	125	32.4
7	P	1971	41	54	169	75	14	42	3	17	42	102	26	18	60	80	19	24.0
8	P	1972	43	58	137	96	33	48	13	15	5	20	75	23	102	26	18	40.8
9	P	1973	18	65	90	18	21	15	22	21	59	31	14	37	20	75	23	8.0
10	P	1974	19	81	42	59	32	23	11	7	73	37	9	12	31	14	37	12.4
11	P	1975	2	113	61	17	13	47	68	4	26	108	58	2	37	9	12	14.8
12	P	1976	27	71	54	39	35	2	1	0	10	43	11	44	108	58	2	43.2
13	P	1977	23	12	24	38	0	22	3	22	59	43	23	22	43	11	44	17.2
14	P	1978	32	23	73	55	55	14	13	18	69	36	31	72	43	23	22	17.2
15	P	1979	32	90	140	58	32	33	16	129	0	8	43	36	36	31	72	14.4

OBS	YMIWU2	YMIWU3	YMIWU4	YMIPU1	YMIPU2	YMIPU3	YMIPU4	RYMIPU1	RYMIPU2	RYMIPU3	RYMIPU4	RYMIWU1	RYMIWU2	RYMIWU3	RYMIWU4
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	161.4	279.4	375.4	38.4	161.4	279.4	388.9	66	86	66	59	66	86	66	59
3	103.0	224.8	296.0	16.4	103.0	224.8	329.0	33	66	33	53	33	66	33	46
4	84.6	244.4	285.6	42.4	84.6	244.4	312.1	86	39	46	46	86	39	46	19
5	90.1	266.7	461.9	39.2	90.1	266.7	479.9	73	46	59	73	73	46	59	73
6	235.8	418.0	579.6	32.4	235.8	418.0	604.1	59	93	93	93	59	93	93	93
7	110.1	366.9	468.1	24.0	110.1	366.9	489.1	53	79	86	86	53	79	86	86
8	100.8	323.2	464.8	40.8	100.8	323.2	488.8	79	59	73	79	79	59	73	79
9	76.0	249.0	287.4	8.0	76.0	249.0	294.9	6	33	53	19	6	33	53	26
10	60.5	191.9	288.3	12.4	60.5	191.9	299.8	13	13	19	33	13	13	19	33
11	29.3	215.5	246.3	14.8	29.3	215.5	269.8	26	6	26	13	26	6	26	13
12	95.2	231.0	305.8	43.2	95.2	231.0	306.8	93	53	39	39	93	53	39	53
13	71.9	112.7	158.3	17.2	71.9	112.7	169.3	39	26	6	6	39	26	6	6
14	69.7	180.3	290.3	17.2	69.7	180.3	297.3	39	19	13	26	39	19	13	39
15	105.9	363.9	459.1	14.4	105.9	363.9	475.6	19	73	79	66	19	73	79	66

S T A T I S T I C A L A N A L Y S I S S Y S T E M

---------- NAME=LATACUNGA ----------

OBS	CODE	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	LP10	LP11	LP12	YMICL1
1	P	1965	28	17	24	69	35	2	5	3	27	45	108	36	.	.	.	.
2	P	1966	17	19	72	37	45	28	17	13	37	89	52	63	45	108	36	38.8
3	P	1967	31	89	34	40	29	32	22	9	6	88	56	15	89	52	63	68.9
4	P	1968	39	62	89	29	6	44	9	34	32	48	55	36	88	56	15	41.7
5	P	1969	25	34	19	132	34	51	0	13	16	58	67	.	48	55	36	45.2
6	P	1970	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7	P	1970	.	72	25	62	88	25	6	8	7	63	50	24	88	67	.	.
8	P	1971	21	49	94	38	24	46	14	0	11	98	62	5	63	50	24	33.6
9	P	1972	51	69	46	28	13	8	3	31	9	17	51	31	98	62	5	44.3
10	P	1973	19	51	33	89	44	17	15	15	68	32	26	30	17	51	31	36.9
11	P	1974	18	87	95	74	56	29	37	2	59	68	88	37	32	26	30	35.4
12	P	1975	7	133	58	32	43	44	83	53	27	89	68	58	68	88	37	31.3
13	P	1976	27	40	96	72	62	29	14	6	16	55	44	46	89	68	58	62.2
14	P	1977	64	31	23	46	31	39	5	43	53	59	5	73	55	44	46	83.4
15	P	1978	10	28	56	77	52	3	34	3	46	6	36	66	59	5	73	59.1
16	P	1979	28	23	52	133	42	9	0	36	59	11	52	42	6	36	66	68.6

OBS	YMICL2	YMICL3	YMICL4	YMIWL1	YMIWL2	YMIWL3	YMIWL4	RYMICL1	RYMICL2	RYMICL3	RYMICL4	RYMIWL1	RYMIWL2	RYMIWL3	RYMIWL4
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	144.2	188.6	224.6	38.8	144.2	188.6	224.6	35	28	7	21	35	28	7	21
3	198.7	246.7	269.9	68.9	198.7	246.7	269.9	85	64	49	49	85	64	49	49
4	210.5	245.3	250.1	41.7	210.5	245.3	250.1	42	71	42	28	42	71	42	28
5	102.0	260.4	287.6	45.2	102.0	260.4	287.6	57	7	64	57	57	7	64	57
6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
8	195.4	241.0	260.2	33.6	195.4	241.0	260.2	14	57	35	35	14	57	35	35
9	168.5	202.1	212.5	44.3	168.5	202.1	212.5	49	49	21	7	49	49	21	7
10	127.5	234.3	269.5	36.9	127.5	234.3	269.5	28	14	28	42	28	14	28	42
11	236.4	325.2	370.0	35.4	236.4	325.2	370.0	21	92	92	92	21	92	92	92
12	234.1	272.5	306.9	31.5	234.1	272.5	306.9	7	85	71	71	7	85	71	71
13	217.4	303.8	353.4	62.2	217.4	303.8	353.4	71	78	78	85	71	78	78	85
14	142.0	197.2	222.0	83.4	142.0	197.2	222.0	92	21	14	14	92	21	14	14
15	154.3	246.7	288.3	59.1	154.3	246.7	288.3	64	42	49	64	64	42	49	64
16	154.0	313.6	347.2	68.6	154.0	313.6	347.2	78	35	85	78	78	35	85	78

S T A T I S T I C A L A N A L Y S I S S Y S T E M

---------- NAME=PATATE ----------

OBS	CODE	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	LP10	LP11	LP12	YMIWL1
1	P	1965	24	5	22	55	34	43	34	69	25	93	38	11	.	.	.	.
2	P	1966	12	38	84	13	53	79	75	61	58	35	51	124	93	38	11	17.3
3	P	1967	23	25	22	15	11	107	76	60	.	85	24	24	35	51	124	105.2
4	P	1968	40	33	52	1	15	69	42	12	60	19	13	12	85	24	24	48.8
5	P	1969	8	34	118	67	35	40	11	59	38	33	80	22	19	13	12	14.8
6	P	1970	31	60	34	17	85	64	66	141	25	41	40	11	33	80	22	40.2
7	P	1971	37	37	58	63	25	92	45	76	33	27	52	30	41	40	11	37.3
8	P	1972	32	50	59	60	51	108	101	32	43	23	126	18	27	52	30	46.6
9	P	1973	14	29	54	109	113	46	71	79	93	51	21	30	23	126	18	23.8
10	P	1974	32	53	65	40	102	72	106	15	99	74	54	31	51	21	30	46.6
11	P	1975	18	61	57	57	66	125	127	71	52	101	31	45	74	54	31	36.1
12	P	1976	28	37	61	66	87	102	79	33	30	27	50	21	101	31	45	53.9
13	P	1977	14	43	36	40	35	121	34	66	121	59	17	24	27	50	21	25.9
14	P	1978	14	33	59	88	44	87	21	43	55	13	2	25	39	17	24	28.0
15	P	1979	22	12	74	92	66	34	61	84	49	20	42	29	13	2	25	35.1

OBS	YMIWL2	YMIWL3	YMIWL4	YMICL1	YMICL2	YMICL3	YMICL4	RYMICL1	RYMICL2	RYMICL3	RYMICL4	RYMIWL1	RYMIWL2	RYMIWL3	RYMIWL4
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	156.1	171.7	214.1	17.3	156.1	171.7	214.1	13	53	26	26	13	53	26	26
3	156.6	174.6	183.4	105.2	156.6	174.6	183.4	93	59	33	13	93	59	33	13
4	144.2	145.4	157.4	48.8	144.2	145.4	157.4	79	46	6	6	79	46	6	6
5	190.4	270.8	298.8	14.8	190.4	270.8	298.8	6	93	93	66	6	93	93	66
6	141.0	161.4	229.4	40.2	141.0	161.4	229.4	59	33	19	33	59	33	19	33
7	143.9	219.5	239.5	37.3	143.9	219.5	239.5	53	39	39	39	53	39	39	39
8	167.4	239.4	280.2	46.6	167.4	239.4	280.2	66	79	66	53	66	79	66	53
9	117.6	248.4	338.8	23.8	117.6	248.4	338.8	19	13	86	93	19	13	86	93
10	177.6	225.6	307.2	46.6	177.6	225.6	307.2	66	86	46	79	66	86	46	79
11	165.5	233.9	286.7	36.1	165.5	233.9	286.7	46	73	53	59	46	73	53	59
12	164.1	243.3	312.9	53.9	164.1	243.3	312.9	86	66	73	86	86	66	73	86
13	112.1	160.1	188.1	25.9	112.1	160.1	188.1	26	6	13	19	26	6	13	19
14	131.8	237.4	272.6	28.0	131.8	237.4	272.6	33	19	59	46	33	19	59	46
15	135.9	246.3	299.1	35.1	135.9	246.3	299.1	39	26	79	73	39	26	79	73

S T A T I S T I C A L A N A L Y S I S S Y S T E M

---------- NAME=PISAYAMBO ----------

OBS	CODE	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	LP10	LP11	LP12
1	P	1965	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	P	1967	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
3	P	1968	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4	P	1969	27	40	104	159	98	103	63	148	53	155	94	64	.	.	.
5	P	1970	79	125	132	85	149	130	213	103	89	87	96	40	155	94	64
6	P	1971	53	86	111	99	78	148	93	195	86	71	62	65	87	96	40
7	P	1972	90	68	102	116	94	141	150	40	76	93	135	61	71	62	65
8	P	1973	42	70	63	92	91	170	97	87	116	46	53	85	93	135	61
9	P	1974	70	110	78	102	131	122	154	58	156	143	92	116	46	53	85
10	P	1975	54	124	50	72	103	170	147	125	76	140	52	83	143	92	116
11	P	1976	72	85	79	128	175	320	293	241	97	67	121	64	140	52	83
12	P	1977	17	172	155	151	93	222	148	169	159	68	55	85	67	121	64
13	P	1978	58	126	172	189	100	244	142	133	107	56	41	32	68	55	85
14	P	1979	56	100	91	201	109	100	118	92	89	56	80	69	56	41	32

OBS	YMIWU1	YMIWU2	YMIWU3	YMIWU4	YMIPU1	YMIPU2	YMIPU3	YMIPU4	RYMIPU1	RYMIPU2	RYMIPU3	RYMIPU4	RYMIWU1	RYMIWU2	RYMIWU3	RYMIWU4
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5	62.0	217.0	500.4	721.6	62.0	217.0	500.4	786.6	90	81	81	63	90	81	81	72
6	34.8	153.2	372.4	553.6	34.8	153.2	372.4	627.6	54	27	45	18	54	27	45	18
7	28.4	176.9	367.3	581.7	28.4	176.9	367.3	652.2	45	54	36	27	45	54	36	36
8	37.2	181.0	326.6	509.8	37.2	181.0	326.6	594.8	63	63	18	9	63	63	18	9
9	18.4	160.4	364.0	591.2	18.4	160.4	364.0	652.2	9	36	27	27	9	36	27	45
10	57.2	227.6	411.6	580.4	57.2	227.6	411.6	665.4	81	90	63	45	81	90	63	27
11	56.0	197.7	377.5	671.1	56.0	197.7	377.5	831.1	72	72	54	72	72	72	54	63
12	26.8	145.7	503.7	759.3	26.8	145.7	503.7	870.3	27	18	90	81	27	18	90	81
13	27.2	160.6	493.0	799.8	27.2	160.6	493.0	921.8	36	45	72	90	36	45	72	90
14	22.4	110.1	319.3	647.7	22.4	110.1	319.3	697.7	18	9	9	54	18	9	9	54

S T A T I S T I C A L A N A L Y S I S S Y S T E M

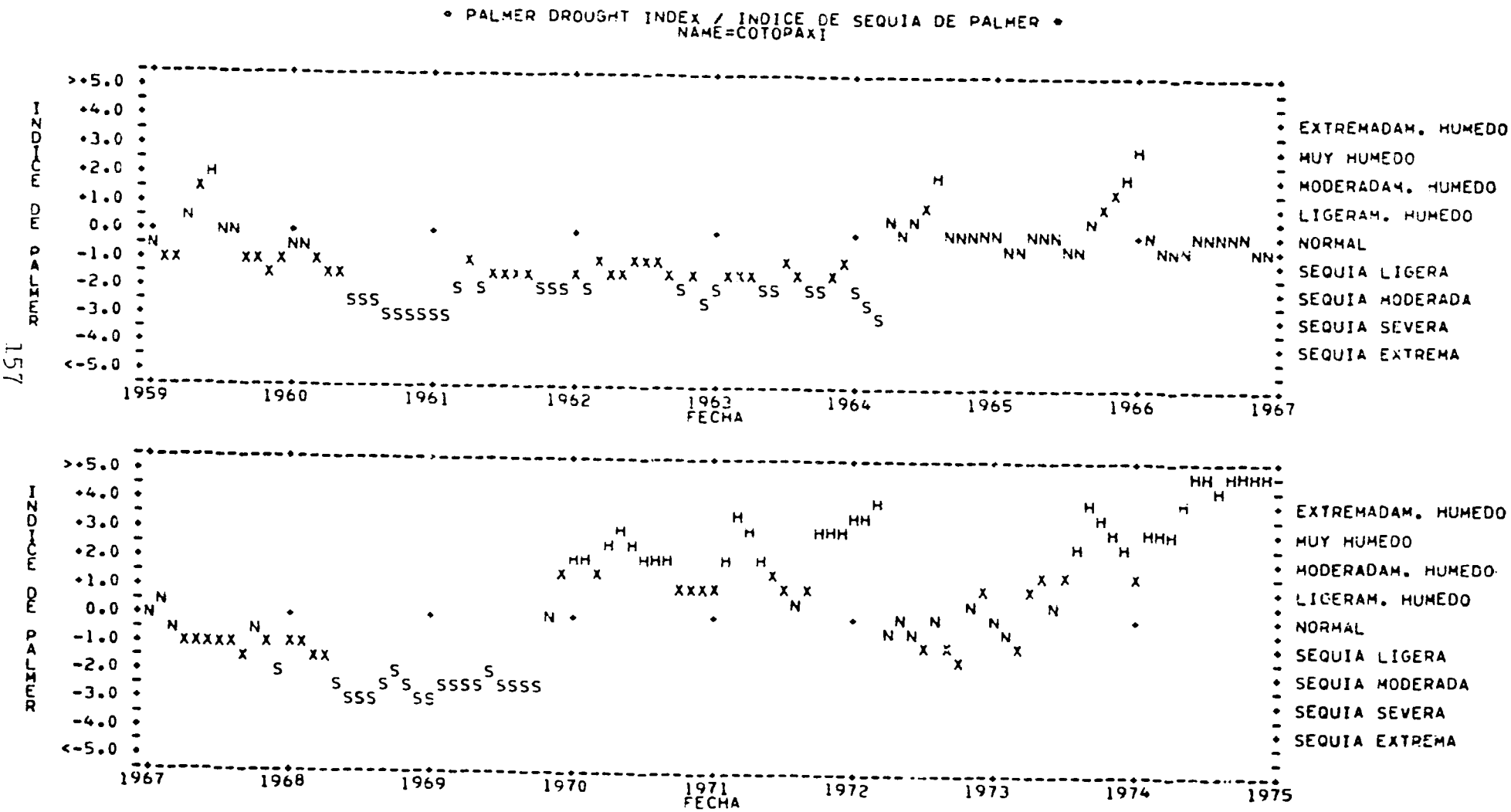
NAME=PIOBAMBA

OBS	CODE	YEAR	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	LP10	LP11	LP12	YMIN
1	P	1965	15	9	15	74	48	14	7	13	23	103	118	40	.	.	.	.
2	P	1966	6	37	79	21	17	45	21	8	17	35	45	40	103	118	40	32.8
3	P	1967	23	43	43	26	7	46	13	8	16	86	30	18	35	45	40	46.4
4	P	1968	29	36	40	9	4	55	14	2	42	11	1	9	86	30	18	35.8
5	P	1969	26	31	106	119	20	43	7	.	13	31	52	35	11	1	9	27.1
6	P	1970	39	87	28	46	84	62	.	.	17	50	110	30	31	52	35	55.7
7	P	1971	49	27	76	67	25	39	16	26	53	54	61	36	50	110	30	60.2
8	P	1972	36	70	81	69	23	67	23	12	7	11	47	29	54	61	36	54.0
9	P	1973	18	25	23	61	39	7	1	24	28	22	13	16	11	47	29	34.7
10	P	1974	2	29	82	56	31	35	21	10	37	77	29	24	22	13	16	32.8
11	P	1975	19	99	55	58	17	74	82	24	47	76	48	22	77	29	24	32.0
12	P	1976	16	40	41	39	73	29	11	24	8	23	65	22	76	48	22	28.2
13	P	1977	21	32	51	41	11	26	3	50	58	22	18	32	23	65	22	32.2
14	P	1978	14	47	25	105	44	29	22	5	47	12	3	21	22	18	32	33.6
15	P	1979	27	20	48	55	58	6	12	18	46	49	38	30	12	3	21	36.3

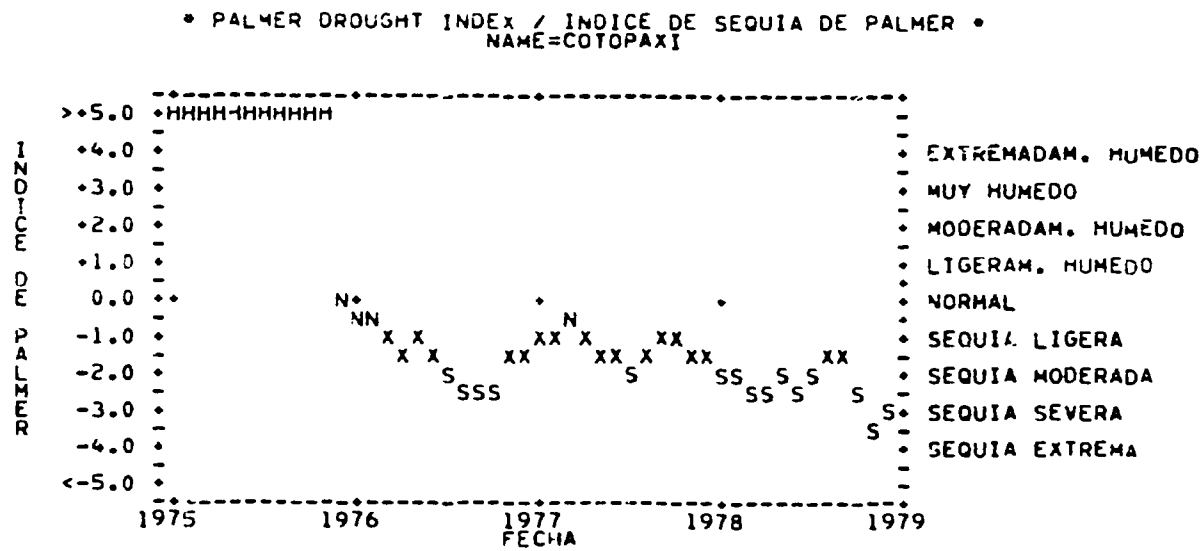
OBS	YMIWL2	YMIWL3	YMIWL4	YMICL1	YMICL2	YMICL3	YMICL4	RYMICL1	RYMICL2	RYMICL3	RYMICL4	RYMIWL1	RYMIWL2	RYMIWL3	RYMIWL4
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	164.6	189.8	203.4	32.8	164.6	189.8	203.4	39	59	46	33	39	59	46	33
3	141.0	172.2	177.8	46.4	141.0	172.2	177.8	73	53	26	13	73	53	26	13
4	119.8	130.6	133.8	35.8	119.8	130.6	133.8	59	33	6	6	59	33	6	6
5	185.3	328.1	344.1	27.1	185.3	328.1	344.1	13	79	93	93	13	79	93	93
6	176.3	231.5	298.7	55.7	176.3	231.5	298.7	86	66	59	79	86	66	59	79
7	178.4	258.8	278.8	60.2	178.4	258.8	278.8	93	73	73	66	93	73	73	66
8	221.2	304.0	322.4	54.0	221.2	304.0	322.4	79	93	86	86	79	93	86	86
9	87.3	160.5	191.7	34.7	87.3	160.5	191.7	53	6	13	26	53	6	13	26
10	140.2	207.4	232.2	12.8	140.2	207.4	232.2	6	46	53	53	6	46	53	53
11	197.0	266.6	280.2	32.0	197.0	266.6	280.2	26	86	79	73	26	86	79	73
12	117.4	164.2	222.6	28.2	117.4	164.2	222.6	19	26	19	39	19	26	19	39
13	125.4	174.6	183.4	32.2	125.4	174.6	183.4	33	39	33	19	33	39	33	19
14	110.6	236.6	271.8	33.6	110.6	236.6	271.8	46	13	66	59	46	13	66	59
15	113.9	179.9	226.3	36.3	113.9	179.9	226.3	66	19	39	46	66	19	39	46

APPENDIX C

PALMER DROUGHT INDEX (PDI)



Palmer Drought Index (PDI) for Cotopaxi

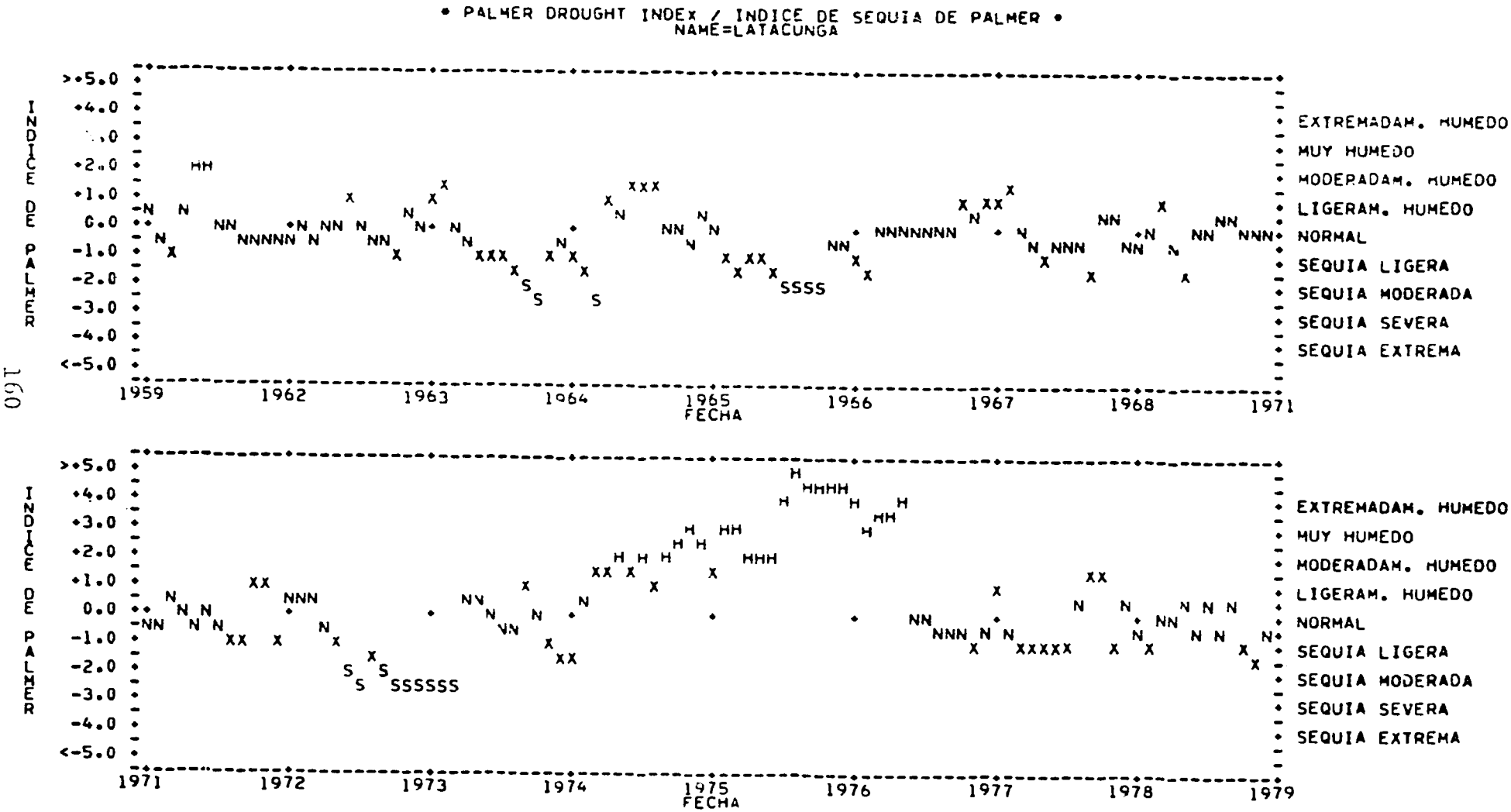


Palmer Drought Index (PDI) for Cotopaxi

```
* PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER *
                    NAME=COTOPAXI
                PERIODOS CON SEQUIA
+-----------------------------------------+
| SEQUIA EXTREMA                          |
|        SIN PERIODOS MAYORES DE 4 MESES  |
| SEQUIA SEVERA                           |
|   1  SEP 1960 HASTA FEB 1961   6 MESES  |
| SEQUIA MODERADA                         |
|   1  JUN 1960 HASTA MAR 1961  10 MESES  |
|   2  MAY 1968 HASTA OCT 1969  18 MESES  |
|   3  ENE 1978 HASTA JUL 1978   7 MESES  |
+-----------------------------------------+
```

```
* PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER *
                    NAME=COTOPAXI
                PERIODOS HUMEDOS
+-----------------------------------------+
| EXTREMADAM. HUMEDO                      |
|   1  MAY 1974 HASTA NOV 1975  19 MESES  |
| MUY HUMEDO                              |
|   1  OCT 1971 HASTA MAR 1972   6 MESES  |
|   2  FEB 1974 HASTA NOV 1975  22 MESES  |
| MODERADAM. HUMEDO                       |
|   1  ABR 1970 HASTA SEP 1970   6 MESES  |
|   2  OCT 1971 HASTA MAR 1972   6 MESES  |
|   3  AGO 1973 HASTA DIC 1973   5 MESES  |
|   4  FEB 1974 HASTA NOV 1975  22 MESES  |
+-----------------------------------------+
```

Palmer Drought Index (PDI) for Cotopaxi

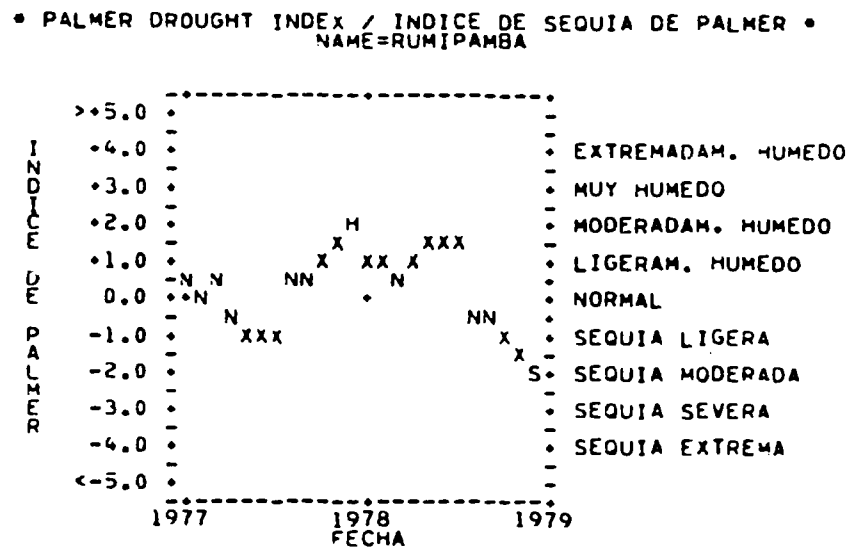


Palmer Drought Index (PDI) for Latacunga

```
* PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER *
                    NAME=LATACUNGA

                  PERIODOS CON SEQUIA

+-----------------------------------------+
| SEQUIA EXTREMA                          |
|         SIN PERIODOS MAYORES DE 4 MESES |
| SEQUIA SEVERA                           |
|         SIN PERIODOS MAYORES DE 4 MESES |
| SEQUIA MODERADA                         |
|    1  SEP 1972 HASTA MAR 1973   7 MESES |
+-----------------------------------------+
```

```
* PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER *
                    NAME=LATACUNGA

                  PERIODOS HUMEDOS

+-----------------------------------------+
| EXTREMADAM. HUMEDO                      |
|    1  JUL 1975 HASTA ENE 1976   7 MESES |
| MUY HUMEDO                              |
|    1  JUL 1975 HASTA MAY 1976  11 MESES |
| MODERADAM. HUMEDO                       |
|    1  FEB 1975 HASTA MAY 1976  16 MESES |
+-----------------------------------------+
```

Palmer Drought Index (PDI) for Latacunga

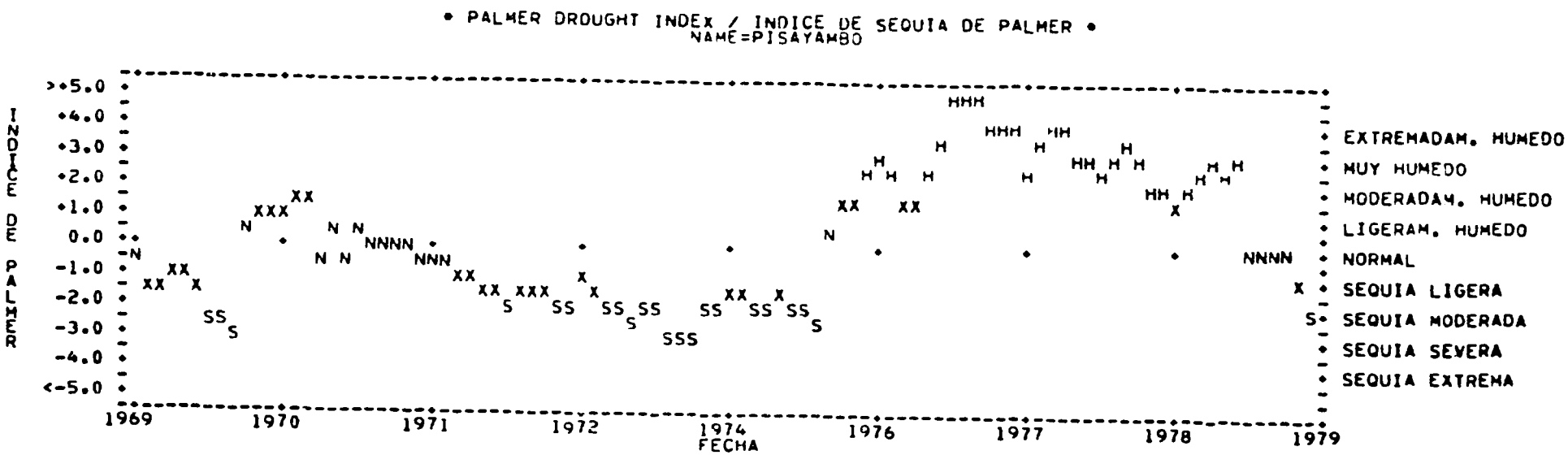


Palmer Drought Index (PDI) for Rumipamba

```
* PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER *
                    NAME=RUMIPAMBA

                  PERIODOS CON SEQUIA

 +-----------------------------------------+
 | SEQUIA EXTREMA                          |
 |         SIN PERIODOS MAYORES DE 4 MESES |
 | SEQUIA SEVERA                           |
 |         SIN PERIODOS MAYORES DE 4 MESES |
 | SEQUIA MODERADA                         |
 |         SIN PERIODOS MAYORES DE 4 MESES |
 +-----------------------------------------+
```

```
* PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER *
                    NAME=RUMIPAMBA

                  PERIODOS HUMEDOS

 +-----------------------------------------+
 | EXTREMADAM. HUMEDO                      |
 |         SIN PERIODOS MAYORES DE 4 MESES |
 | MUY HUMEDO                              |
 |         SIN PERIODOS MAYORES DE 4 MESES |
 | MODERADAM. HUMEDO                       |
 |         SIN PERIODOS MAYORES DE 4 MESES |
 +-----------------------------------------+
```

Palmer Drought Index (PDI) for Rumipamba

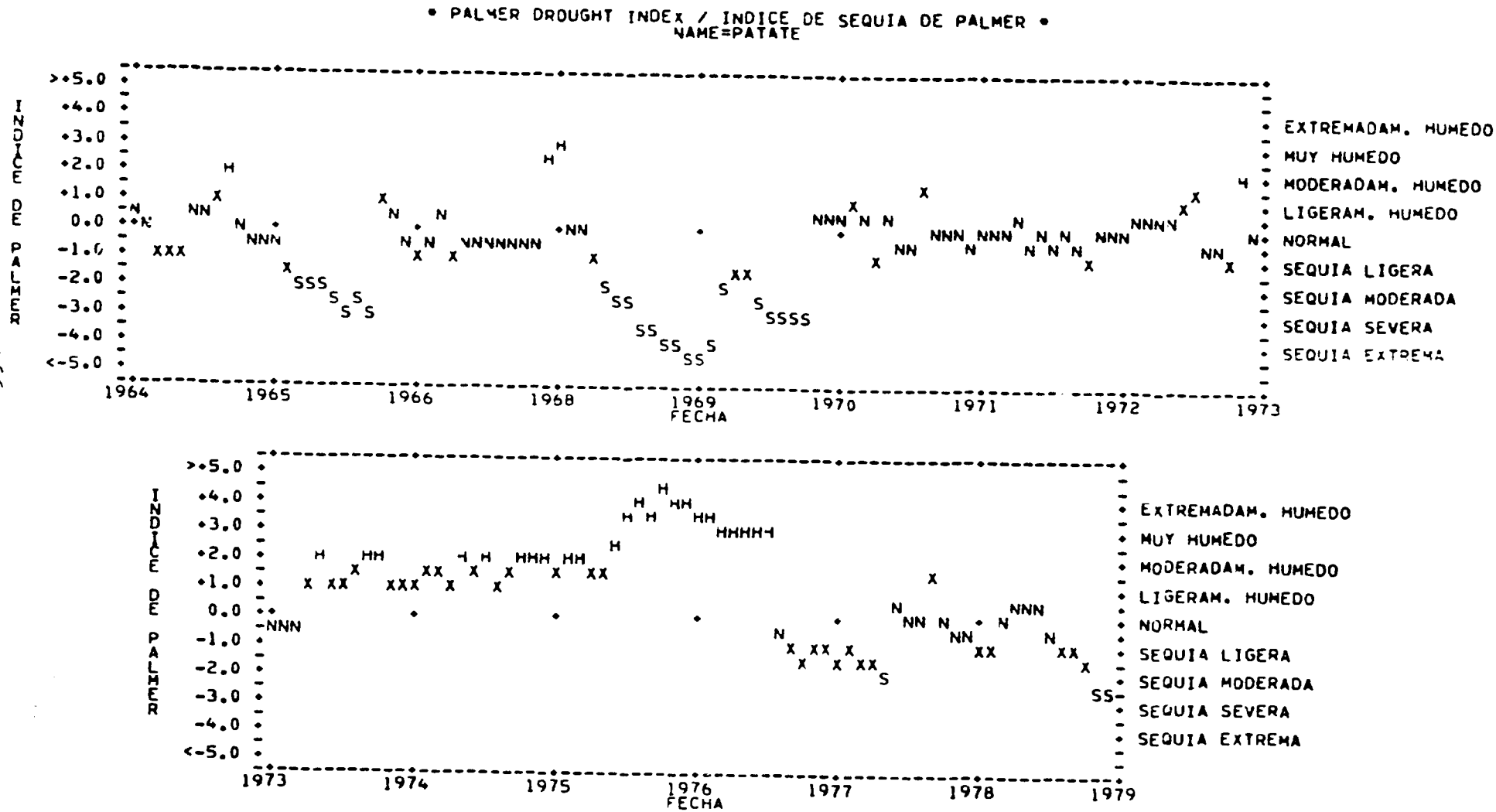


Palmer Drought Index (PDI) for Pisayambo

```
• PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER •
                    NAME=PISAYAMBO
                  PERIODOS CON SEQUIA
 ---------------------------------------------
 SEQUIA EXTREMA
          SIN PERIODOS MAYORES DE 4 MESES
 SEQUIA SEVERA
          SIN PERIODOS MAYORES DE 4 MESES
 SEQUIA MODERADA
    1  MAR 1972 HASTA DIC 1972  10 MESES
 ---------------------------------------------
```

```
• PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER •
                    NAME=PISAYAMBO
                  PERIODOS HUMEDOS
 ---------------------------------------------
 EXTREMADAM. HUMEDO
    1  JUL 1976 HASTA DIC 1976   6 MESES
 MUY HUMEDO
    1  JUN 1976 HASTA DIC 1976   7 MESES
    2  FEB 1977 HASTA JUN 1977   5 MESES
 MODERADAM. HUMEDO
    1  MAY 1976 HASTA DIC 1977  20 MESES
    2  FEB 1978 HASTA JUN 1978   5 MESES
 ---------------------------------------------
```

Palmer Drought Index (PDI) for Pisayambo



Palmer Drought Index (PDI) for Patate

• PALMER DROUGHT INDEx / INDICE DE SEQUIA DE PALMER •
NAME=PATATE

PERIODOS CON SEQUIA

SEQUIA EXTREMA

1 OCT 1968 HASTA FEB 1969 5 MESES

SEQUIA SEVERA

1 AGO 1968 HASTA FEB 1969 7 MESES

SEQUIA MODERADA

1 MAR 1965 HASTA SEP 1965 7 MESES
2 MAY 1966 HASTA MAR 1969 11 MESES
3 JUN 1969 HASTA OCT 1969 5 MESES

• PALMER DROUGHT INDEx / INDICE DE SEQUIA DE PALMER •
NAME=PATATE

PERIODOS HUMEDOS

EXTREMADAM. HUMEDO

SIN PERIODOS MAYORES DE 4 MESES

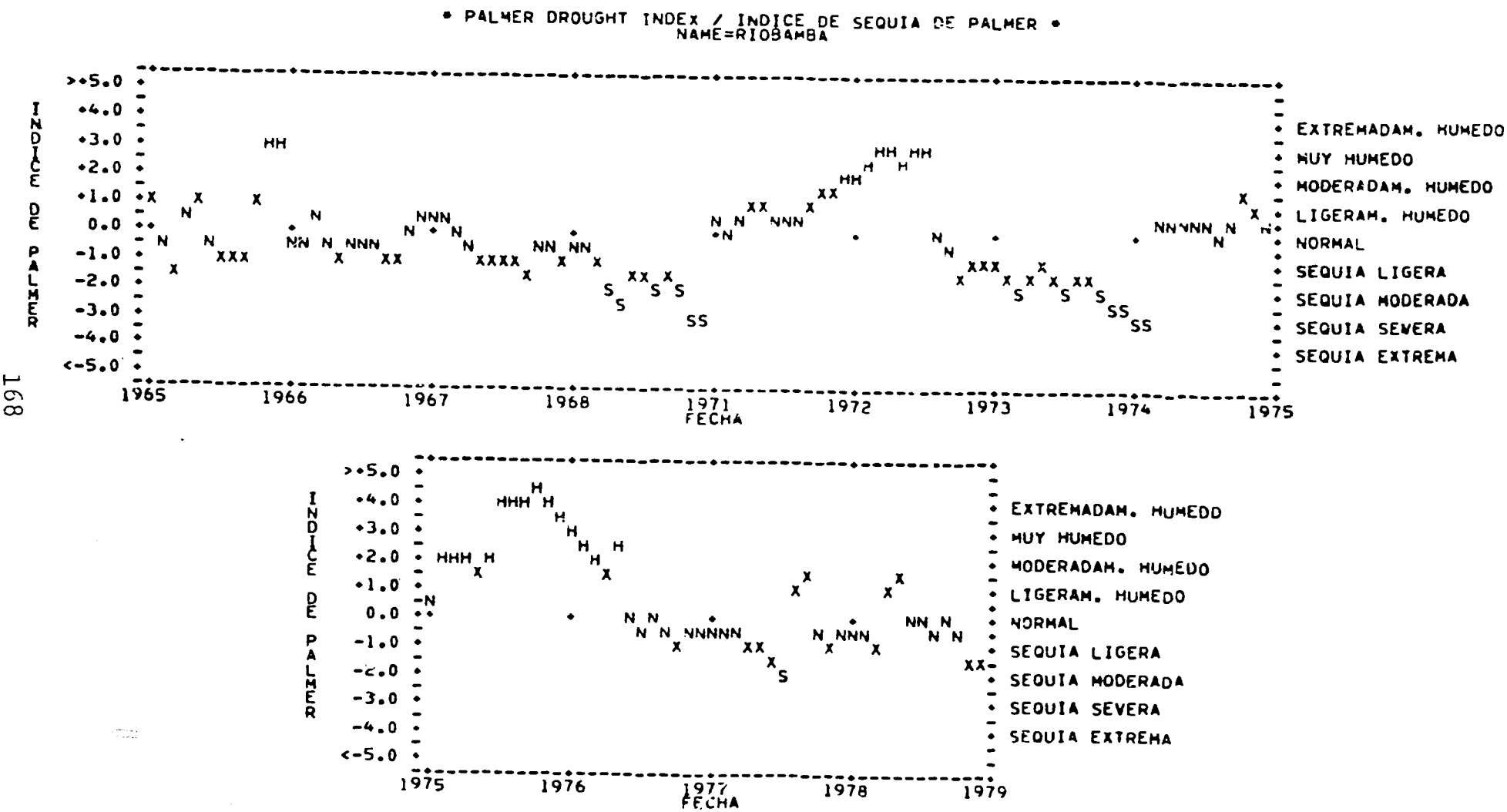
MUY HUMEDO

1 JUL 1975 HASTA JUL 1976 13 MESES

MODERADAM. HUMEDO

1 JUN 1975 HASTA JUL 1976 14 MESES

Palmer Drought Index (PDI) for Patate

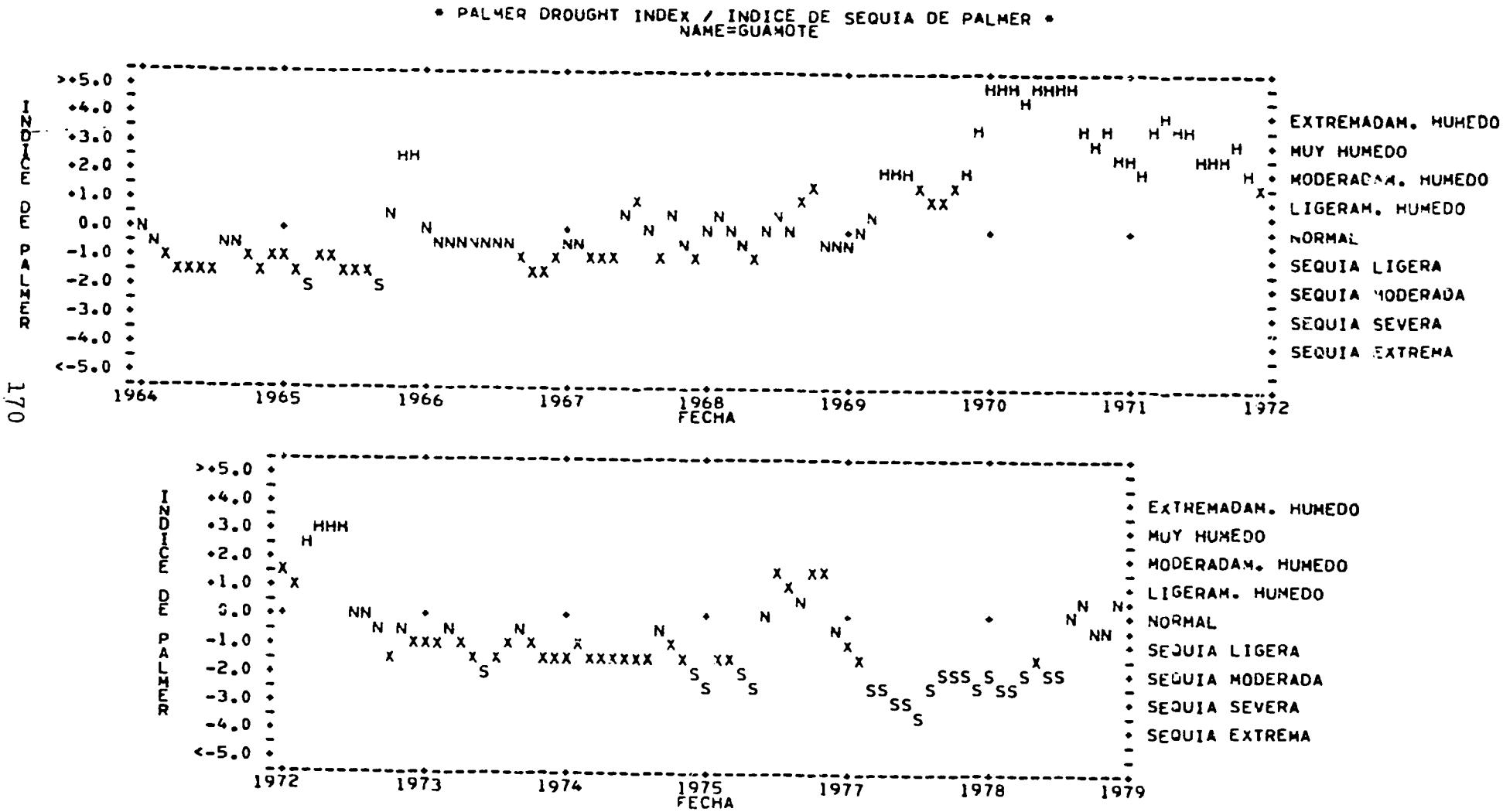


Palmer Drought Index (PDI) for Riobamba

```
* PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER *
                    NAME=RIOBAMBA
                PERIODOS CON SEQUIA
+-----------------------------------------+
| SEQUIA EXTREMA                          |
|         SIN PERIODOS MAYORES DE 4 MESES |
| SEQUIA SEVERA                           |
|         SIN PERIODOS MAYORES DE 4 MESES |
| SEQUIA MODERADA                         |
|    1  OCT 1973 HASTA FEB 1974   5 MESES |
+-----------------------------------------+
```

```
* PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER *
                    NAME=RIOBAMBA
                PERIODOS HUMEDOS
+-----------------------------------------+
| EXTREMADAM. HUMEDO                      |
|    1  JUL 1975 HASTA NOV 1975   5 MESES |
| MUY HUMEDO                              |
|    1  JUL 1975 HASTA ENE 1976   7 MESES |
| MODERADAM. HUMEDO                       |
|    1  DIC 1971 HASTA JUL 1972   8 MESES |
|    2  JUN 1975 HASTA MAR 1976  10 MESES |
+-----------------------------------------+
```

Palmer Drought Index (PDI) for Riobamba



Palmer Drought Index (PDI) for Guamote

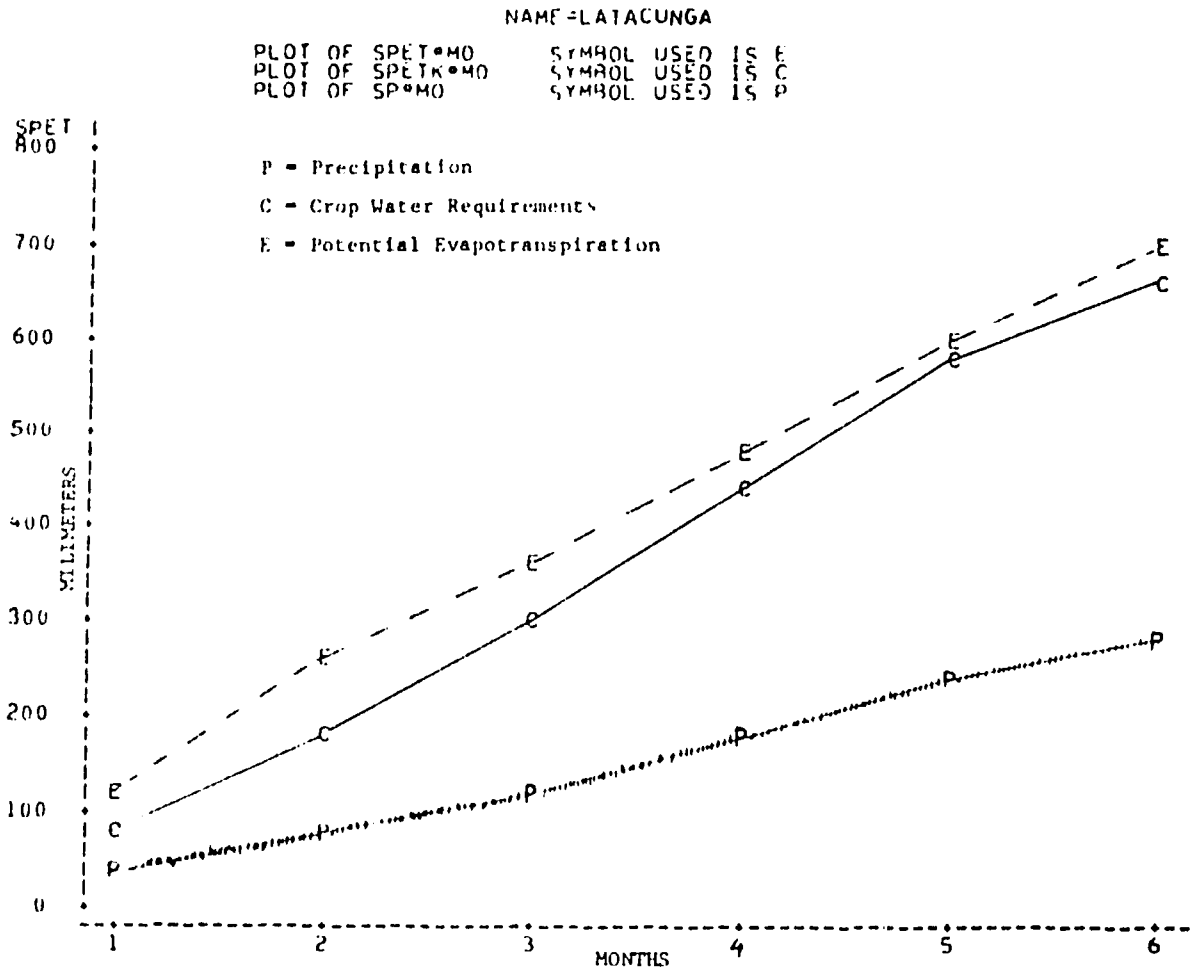
```
* PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER *
                    NAME=GUAMOTE
                PERIODOS CON SEQUIA
+-----------------------------------------+
| SEQUIA EXTREMA                          |
|        SIN PERIODOS MAYORES DE 4 MESES  |
| SEQUIA SEVERA                           |
|        SIN PERIODOS MAYORES DE 4 MESES  |
| SEQUIA MODERADA                         |
|   1  MAR 1977 HASTA ABR 1978  14 MESES  |
+-----------------------------------------+
```

```
* PALMER DROUGHT INDEX / INDICE DE SEQUIA DE PALMER *
                    NAME=GUAMOTE
                PERIODOS HUMEDOS
+-----------------------------------------+
| EXTREMADAM. HUMEDO                      |
|   1  ENE 1970 HASTA AGO 1970   8 MESES  |
| MUY HUMEDO                              |
|   1  DIC 1969 HASTA NOV 1970  12 MESES  |
| MODERADAM. HUMEDO                       |
|   1  NOV 1969 HASTA NOV 1971  25 MESES  |
+-----------------------------------------+
```

Palmer Drought Index (PDI) for Guamote

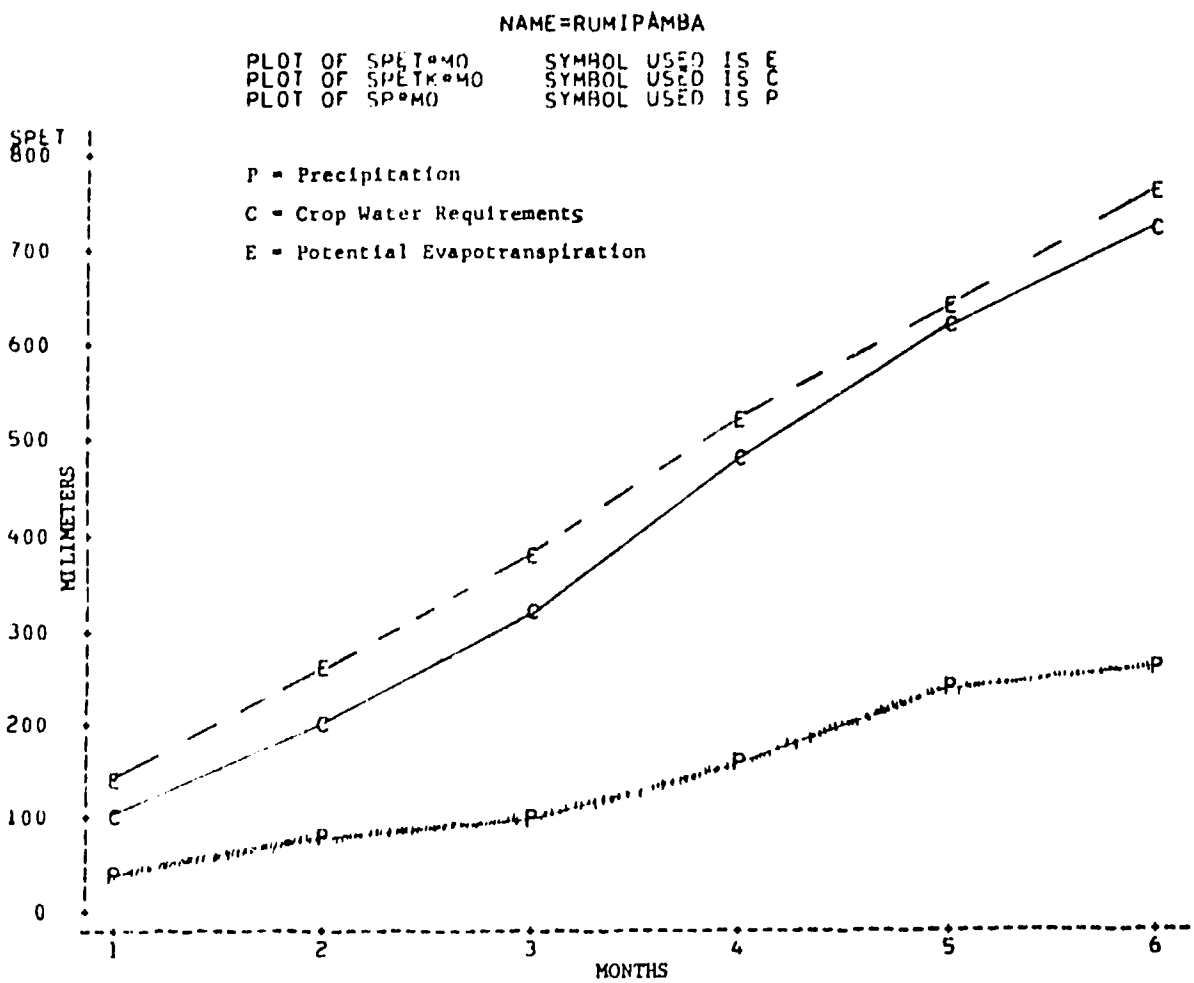
APPENDIX D

CROP WEATHER REQUIREMENT FOR WHEAT, BARLEY CORN, AND POTATOES GROWN IN CENTRAL SIERRA

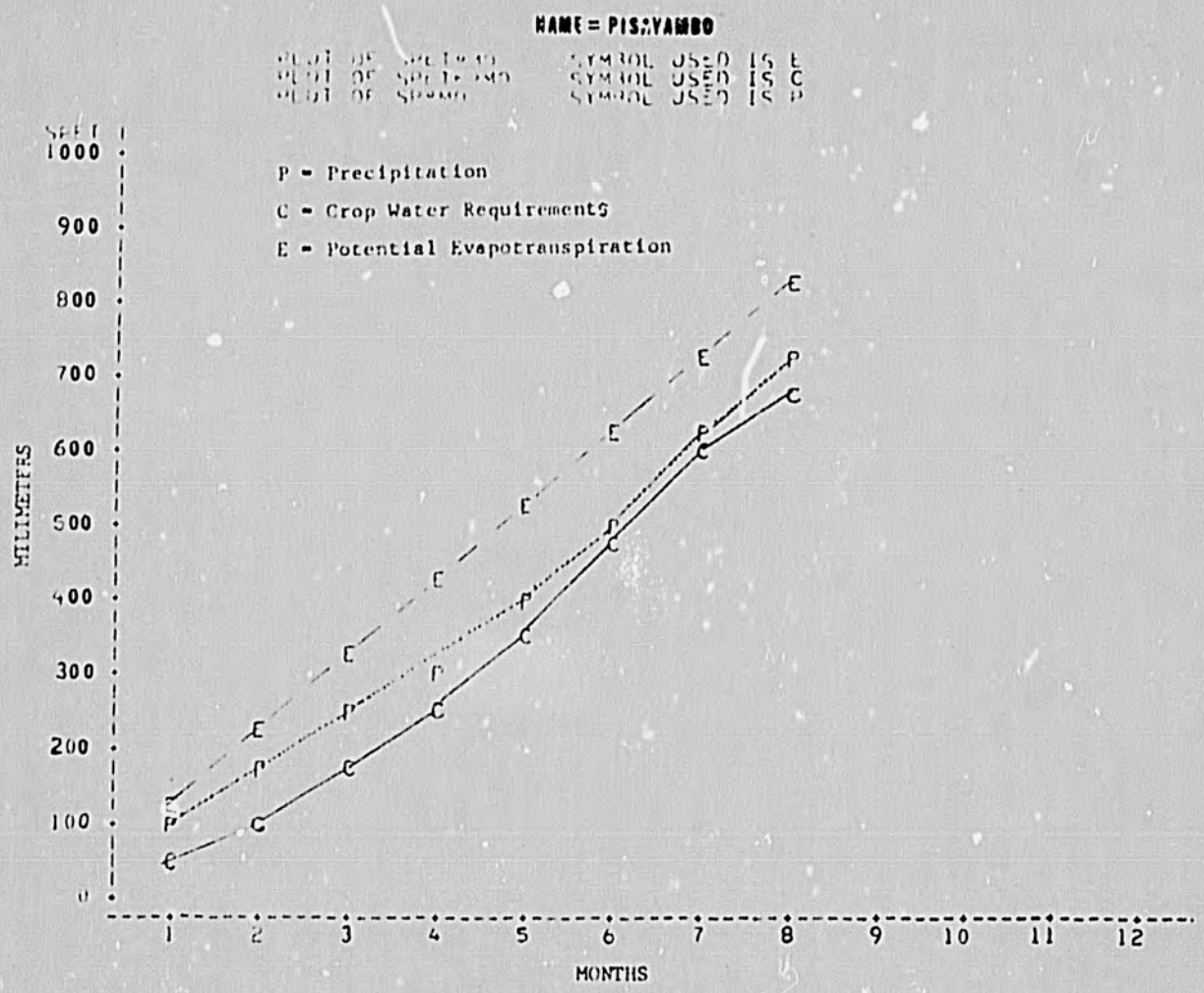


Crop Water Requirements for wheat, barley and corn grown in Latacunga

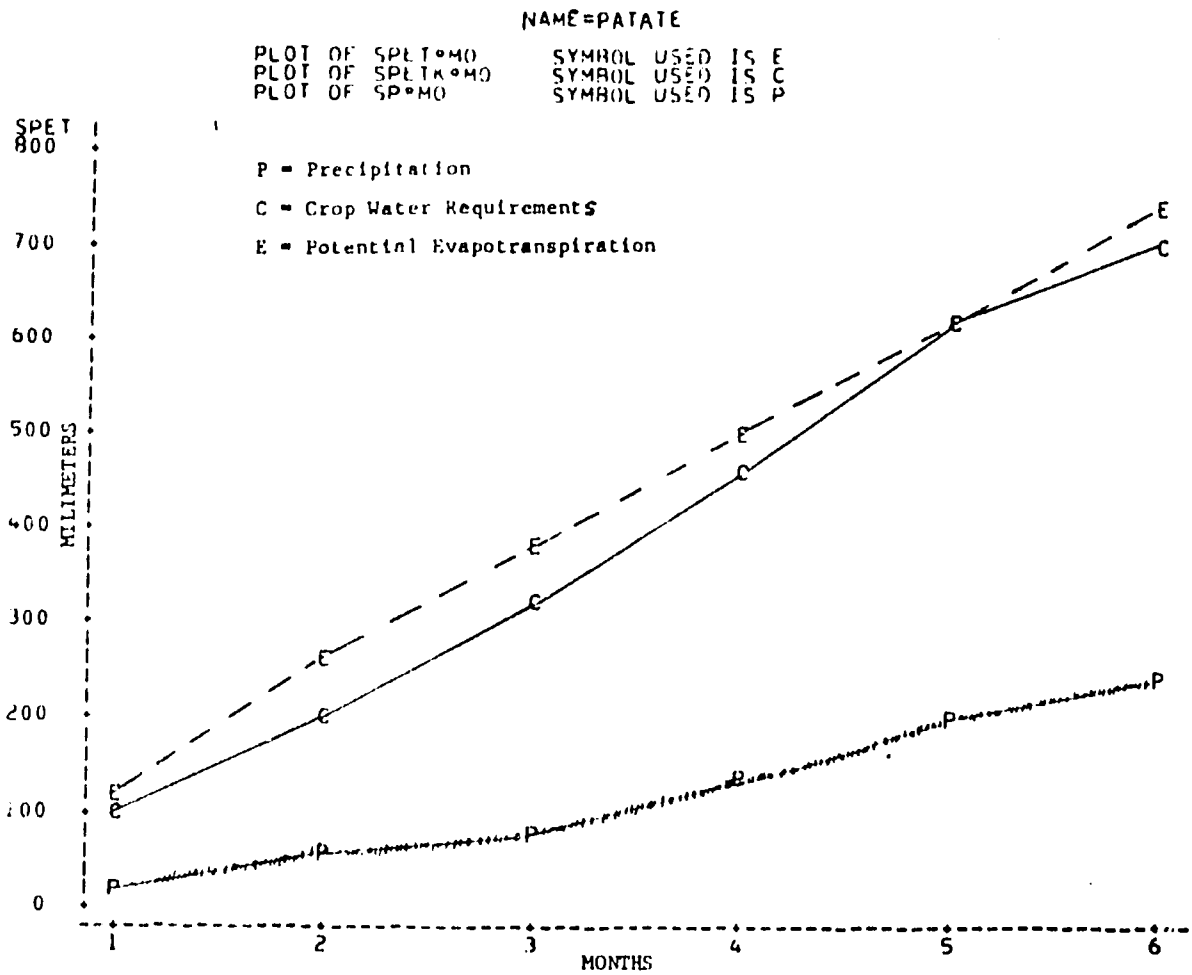
Note: Month begins with planting month



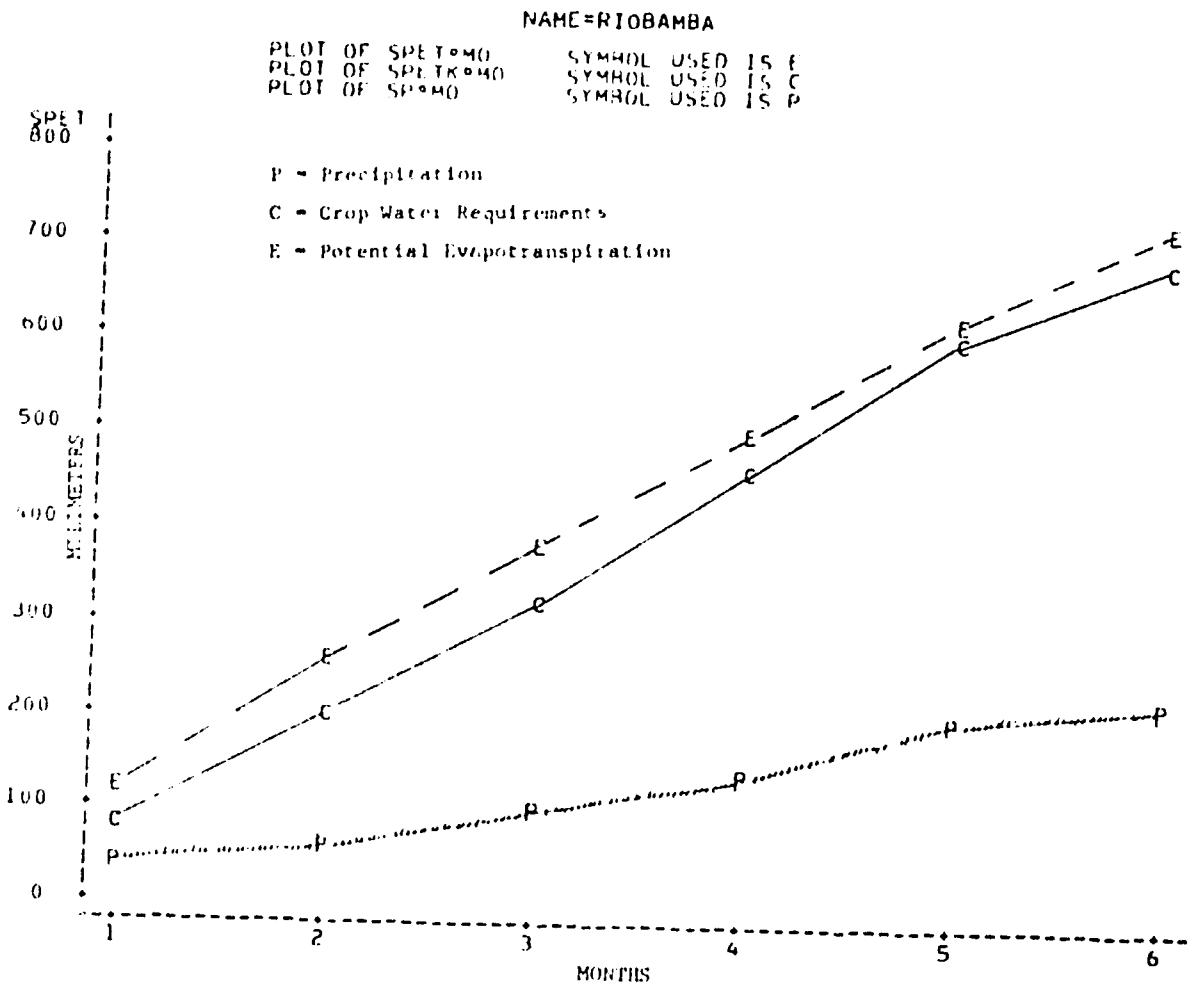
Crop Water Requirements for wheat, barley



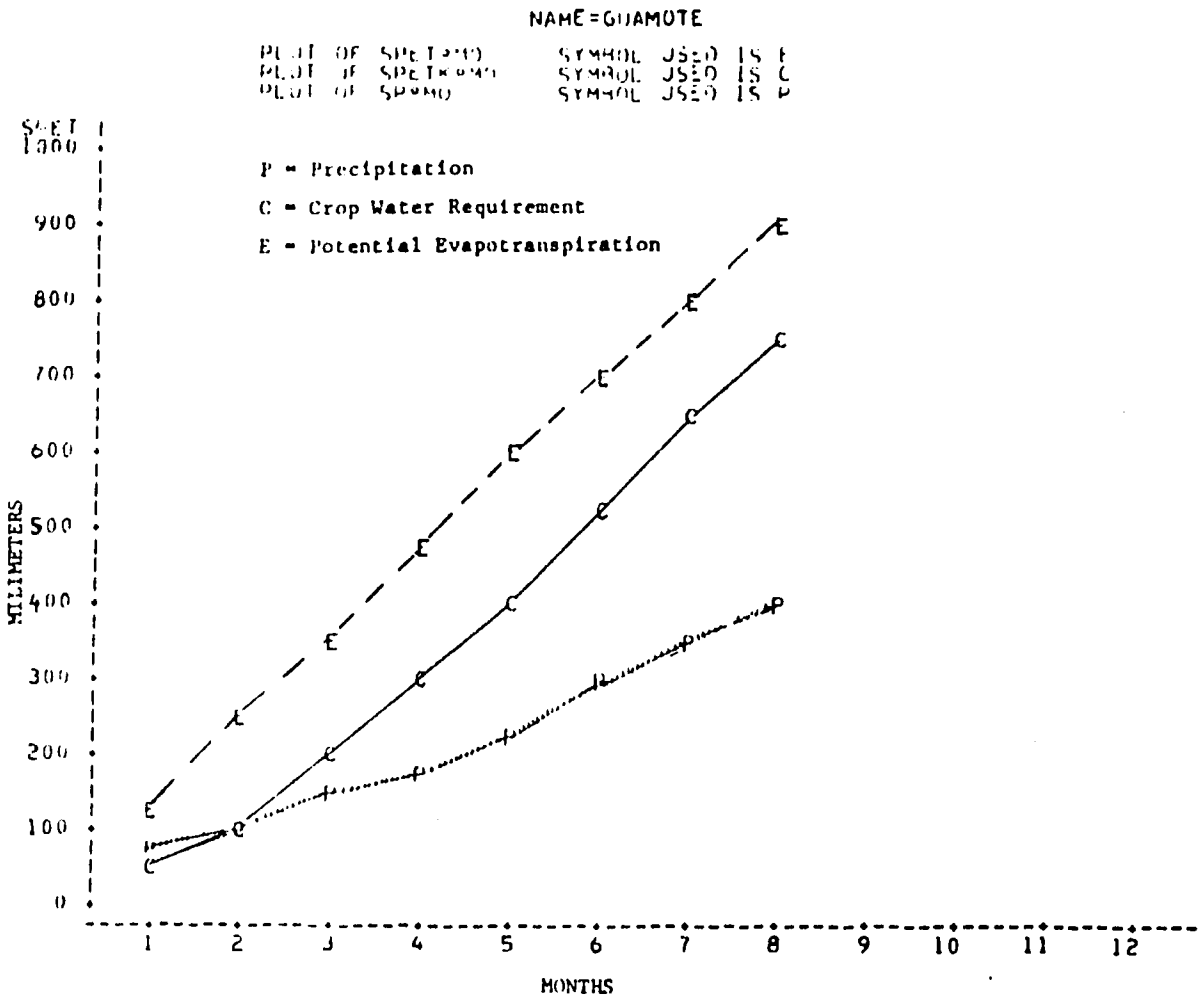
Crop Water Requirements for wheat, barley and potatoes grown in Pisayambo



Crop Water Requirements for wheat, barley and corn grown in Patate



Crop Water Rquirements for wheat, barley and corn grown in Riobamba



Crop Water Rquirements for wheat, barley and corn grown in Guamote

---------- NAME=AMBATO ----------

OBS	ALT	CODE	PET2	PET3	PET4	PET5	PET6	PET7	PET8	PET9	PET10	PET11	PET12
1	2540	PN	131	108	127	116	113	95	104	104	119	134	125
2	2540	PN	131	108	127	116	113	95	104	104	119	134	125
3	2540	PN	131	108	127	116	113	95	104	104	119	134	125
4	2540	PN	131	108	127	116	113	95	104	104	119	134	125
5	2540	PN	131	108	127	116	113	95	104	104	119	134	125
6	2540	PN	131	108	127	116	113	95	104	104	119	134	125

OBS	PET1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P1	I	SP	SPETK	SPET	MO	PETK
1	125	35	41	52	83	42	43	27	26	29	52	45	34	1	34	87.5	125	1	87.5
2	125	35	41	52	83	42	43	27	26	29	52	45	34	2	69	192.3	256	2	104.8
3	125	35	41	52	83	42	43	27	26	29	52	45	34	3	110	300.3	364	3	108.0
4	125	35	41	52	83	42	43	27	26	29	52	45	34	4	162	452.7	491	4	152.4
5	125	35	41	52	83	42	43	27	26	29	52	45	34	5	245	591.9	607	5	139.2
6	125	35	41	52	83	42	43	27	26	29	52	45	34	6	287	682.3	720	6	90.4

---------- NAME=LATACUNGA ----------

OBS	ALT	CODE	PET2	PET3	PET4	PET5	PET6	PET7	PET8	PET9	PET10	PET11	PET12
19	2809	PN	126	113	121	106	108	102	112	120	118	128	122
20	2809	PN	126	113	121	106	108	102	112	120	118	128	122
21	2809	PN	126	113	121	106	108	102	112	120	118	128	122
22	2809	PN	126	113	121	106	108	102	112	120	118	128	122
23	2809	PN	126	113	121	106	108	102	112	120	118	128	122
24	2809	PN	126	113	121	106	108	102	112	120	118	128	122

OBS	PET1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P1	I	SP	SPETK	SPET	MO	PETK
19	125	28	52	55	62	39	34	18	15	27	54	55	42	1	42	87.5	125	1	87.5
20	125	28	52	55	62	39	34	18	15	27	54	55	42	2	70	188.3	251	2	100.8
21	125	28	52	55	62	39	34	18	15	27	54	55	42	3	122	301.3	364	3	113.0
22	125	28	52	55	62	39	34	18	15	27	54	55	42	4	177	446.5	485	4	145.2
23	125	28	52	55	62	39	34	18	15	27	54	55	42	5	239	573.7	591	5	127.2
24	125	28	52	55	62	39	34	18	15	27	54	55	42	6	278	660.1	699	6	86.4

NAME=RIOBAMBA

OBS	ALT	CODE	PET2	PET3	PET4	PET5	PET6	PET7	PET8	PET9	PET10	PET11	PET12
37	2795	PN	130	120	122	112	116	103	111	120	121	134	125
38	2795	PN	130	120	122	112	116	103	111	120	121	134	125
39	2795	PN	130	120	122	112	116	103	111	120	121	134	125
40	2795	PN	130	120	122	112	116	103	111	120	121	134	125
41	2795	PN	130	120	122	112	116	103	111	120	121	134	125
42	2795	PN	130	120	122	112	116	103	111	120	121	134	125

OBS	PET1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P1	I	SP	SPETK	SPET	MO	PETK
37	127	27	39	48	53	32	34	12	14	23	49	38	30	1	30	88.9	127	1	88.9
38	127	27	39	48	53	32	34	12	14	23	49	38	30	2	57	192.9	257	2	104.0
39	127	27	39	48	53	32	34	12	14	23	49	38	30	3	96	312.9	377	3	120.0
40	127	27	39	48	53	32	34	12	14	23	49	38	30	4	144	459.3	499	4	146.4
41	127	27	39	48	53	32	34	12	14	23	49	38	30	5	197	593.7	611	5	134.4
42	127	27	39	48	53	32	34	12	14	23	49	38	30	6	229	686.5	727	6	92.8

NAME=RUMIPAMBA

OBS	ALT	CODE	PET2	PET3	PET4	PET5	PET6	PET7	PET8	PET9	PET10	PET11	PET12
43	2628	PN	134	122	130	116	120	109	114	113	129	135	131
44	2628	PN	134	122	130	116	120	109	114	113	129	135	131
45	2628	PN	134	122	130	116	120	109	114	113	129	135	131
46	2628	PN	134	122	130	116	120	109	114	113	129	135	131
47	2628	PN	134	122	130	116	120	109	114	113	129	135	131
48	2628	PN	134	122	130	116	120	109	114	113	129	135	131

OBS	PET1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P1	I	SP	SPETK	SPET	MO	PETK
43	132	30	24	68	74	20	16	21	28	52	22	30	43	1	43	92.4	132	1	92.4
44	132	30	24	68	74	20	16	21	28	52	22	30	43	2	73	199.6	266	2	107.2
45	132	30	24	68	74	20	16	21	28	52	22	30	43	3	97	321.6	388	3	122.0
46	132	30	24	68	74	20	16	21	28	52	22	30	43	4	165	477.6	518	4	156.0
47	132	30	24	68	74	20	16	21	28	52	22	30	43	5	239	616.8	634	5	139.2
48	132	30	24	68	74	20	16	21	28	52	22	30	43	6	259	712.8	754	6	96.0

NAME=PATATE

OBS	ALT	CODE	PET2	PET3	PET4	PET5	PET6	PET7	PET8	PET9	PET10	PET11	PET12
25	2360	PN	135	112	131	120	117	99	108	108	123	138	129
26	2360	PN	135	112	131	120	117	99	108	108	123	138	129
27	2360	PN	135	112	131	120	117	99	108	108	123	138	129
28	2360	PN	135	112	131	120	117	99	108	108	123	138	129
29	2360	PN	135	112	131	120	117	99	108	108	123	138	129
30	2360	PN	135	112	131	120	117	99	108	108	123	138	129

OBS	PET1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P1	I	SP	SPETK	SPET	MO	PETK
25	129	22	36	54	52	53	81	61	60	54	45	42	29	1	29	90.3	129	1	90.3
26	129	22	36	54	52	53	81	61	60	54	45	42	29	2	51	198.3	264	2	108.0
27	129	22	36	54	52	53	81	61	60	54	45	42	29	3	87	310.3	376	3	117.0
28	129	22	36	54	52	53	81	61	60	54	45	42	29	4	141	467.5	507	4	127.2
29	129	22	36	54	52	53	81	61	60	54	45	42	29	5	193	611.5	627	5	144.0
30	129	22	36	54	52	53	81	61	60	54	45	42	29	6	246	705.1	744	6	93.6

---------- NAME=COTOPAXI ----------

OBS	ALT	CODE	PET4	PET5	PET6	PET7	PET8	PET9	PET10	PET11	PET12	PET1	PET2	PET3
13	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
14	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
15	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
16	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
17	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
18	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
19	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
20	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
21	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
22	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
23	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110
24	3560	PN	100	93	102	98	94	83	89	94	100	112	109	110

OBS	P4	P5	P6	P7	P8	P9	P10	P11	P12	P1	P2	P3	I	SP	SPETK	SPET	MO	PETK
13	96	119	145	136	122	85	49	39	83	105	107	91	1	105	44.8	112	1	44.8
14	96	119	145	136	122	85	49	39	83	105	107	91	2	212	99.3	221	2	54.5
15	96	119	145	136	122	85	49	39	83	105	107	91	3	303	176.3	331	3	77.0
16	96	119	145	136	122	85	49	39	83	105	107	91	4	399	255.3	431	4	80.0
17	96	119	145	136	122	85	49	39	83	105	107	91	5	513	349.3	524	5	93.0
18	96	119	145	136	122	85	49	39	83	105	107	91	6	663	471.7	626	6	122.4
19	96	119	145	136	122	85	49	39	83	105	107	91	7	799	589.3	724	7	117.6
20	96	119	145	136	122	85	49	39	83	105	107	91	8	921	664.5	818	8	75.2
21	96	119	145	136	122	85	49	39	83	105	107	91	9	.	.	.	9	.
22	96	119	145	136	122	85	49	39	83	105	107	91	10	.	.	.	10	.
23	96	119	145	136	122	85	49	39	83	105	107	91	11	.	.	.	11	.
24	96	119	145	136	122	85	49	39	83	105	107	91	12	.	.	.	12	.

---------- NAME=PISAYAMBO ----------

OBS	ALT	CODE	PET4	PET5	PET6	PET7	PET8	PET9	PET10	PET11	PET12	PET1	PET2	PET3
61	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
62	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
63	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
64	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
65	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
66	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
67	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
68	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
69	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
70	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
71	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110
72	3615	PN	101	94	103	99	95	84	90	95	101	113	110	110

OBS	P4	P5	P6	P7	P8	P9	P10	P11	P12	P	P2	P3	I	SP	SPETK	SPET	MO	PETK
61	56	101	103	128	109	170	147	127	96	89	80	70	1	89	45.2	113	1	45.2
62	56	101	103	128	109	170	147	127	96	89	80	70	2	169	100.2	223	2	55.0
63	56	101	103	128	109	170	147	127	96	89	80	70	3	239	177.2	333	3	77.0
64	56	101	103	128	109	170	147	127	96	89	80	70	4	295	258.0	434	4	80.8
65	56	101	103	128	109	170	147	127	96	89	80	70	5	396	352.0	528	5	94.0
66	56	101	103	128	109	170	147	127	96	89	80	70	6	449	475.6	631	6	123.6
67	56	101	103	128	109	170	147	127	96	89	80	70	7	627	594.4	739	7	118.8
68	56	101	103	128	109	170	147	127	96	89	80	70	8	736	670.4	825	8	76.0
69	56	101	103	128	109	170	147	127	96	89	80	70	9	.	.	.	9	.
70	56	101	103	128	109	170	147	127	96	89	80	70	10	.	.	.	10	.
71	56	101	103	128	109	170	147	127	96	89	80	70	11	.	.	.	11	.
72	56	101	103	128	109	170	147	127	96	89	80	70	12	.	.	.	12	.

---------- NAME=GUAMOTE ----------

OBS	ALT	CODE	PET4	PET5	PET6	PET7	PET8	PET9	PET10	PET11	PET12	PET1	PET2
25	3020	PN	122	107	117	102	103	97	108	116	114	123	118
26	3020	PN	122	107	117	102	103	97	108	116	114	123	118
27	3020	PN	122	107	117	102	103	97	108	116	114	123	118
28	3020	PN	122	107	117	102	103	97	108	116	114	123	118
29	3020	PN	122	107	117	102	103	97	108	116	114	123	118
30	3020	PN	122	107	117	102	103	97	108	116	114	123	118
31	3020	PN	122	107	117	102	103	97	108	116	114	123	118
32	3020	PN	122	107	117	102	103	97	108	116	114	123	118
33	3020	PN	122	107	117	102	103	97	108	116	114	123	118
34	3020	PN	122	107	117	102	103	97	108	116	114	123	118
35	3020	PN	122	107	117	102	103	97	108	116	114	123	118
36	3020	PN	122	107	117	102	103	97	108	116	114	123	118

OBS	PET3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P1	P2	P3	I	SP	SPETK	SPET	MO	PETK
25	120	32	62	66	58	32	33	16	12	36	64	43	36	1	64	49.2	123	1	49.2
26	120	32	62	66	58	32	33	16	12	36	64	43	36	2	107	108.2	241	2	59.0
27	120	32	62	66	58	32	33	16	12	36	64	43	36	3	143	192.2	361	3	84.0
28	120	32	62	66	58	32	33	16	12	36	64	43	36	4	175	289.8	483	4	97.6
29	120	32	62	66	58	32	33	16	12	36	64	43	36	5	237	396.8	590	5	107.0
30	120	32	62	66	58	32	33	16	12	36	64	43	36	6	303	537.2	707	6	140.4
31	120	32	62	66	58	32	33	16	12	36	64	43	36	7	361	659.6	809	7	122.4
32	120	32	62	66	58	32	33	16	12	36	64	43	36	8	393	742.0	912	8	82.4
33	120	32	62	66	58	32	33	16	12	36	64	43	36	9	.	.	.	9	.
34	120	32	62	66	58	32	33	16	12	36	64	43	36	10	.	.	.	10	.
35	120	32	62	66	58	32	33	16	12	36	64	43	36	11	.	.	.	11	.
36	120	32	62	66	58	32	33	16	12	36	64	43	36	12	.	.	.	12	.