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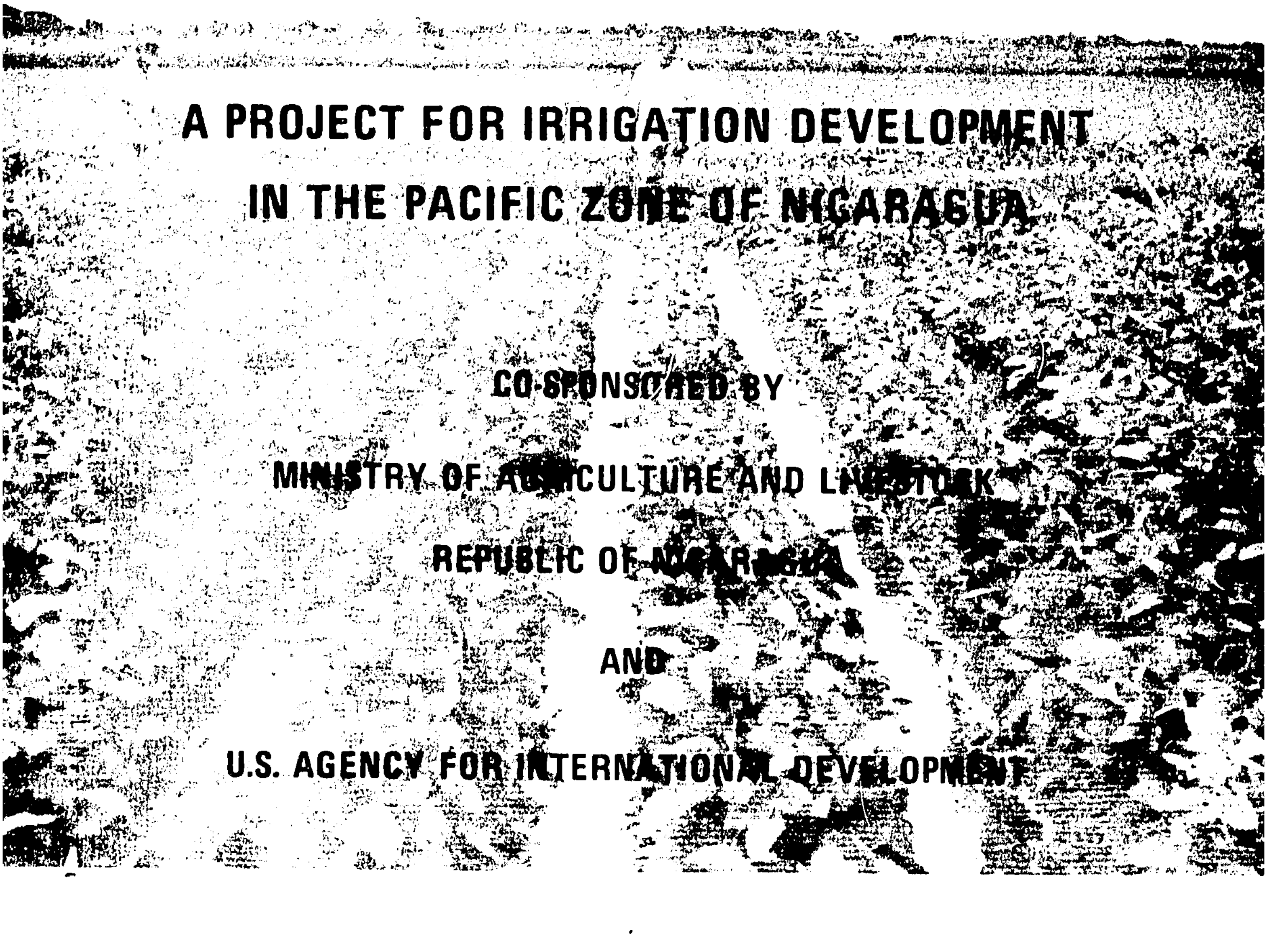
FINAL REPORT

PROJECT ADELANTE

NICARAGUA 1968-1970



A PROJECT FOR IRRIGATION DEVELOPMENT IN THE PACIFIC ZONE OF NICARAGUA

CO-SPONSORED BY

MINISTRY OF AGRICULTURE AND LIVESTOCK
REPUBLIC OF NICARAGUA

AND

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

AGRICULTURE INDUSTRIES, INC.
DAVIS, CALIFORNIA

NOVEMBER 1970

UNICONSULT, INC.
LAFAYETTE, CALIFORNIA

Final Report on

PROJECT ADELANTE, NICARAGUA 1968-70

A PROJECT FOR IRRIGATION DEVELOPMENT IN WESTERN NICARAGUA

Submitted to

MINISTRY OF AGRICULTURE AND LIVESTOCK

REPUBLIC OF NICARAGUA

Agriculture Industries, Inc.
Davis, California

Uniconsult, Inc.
Lafayette, California

November 1970

UNICONSULT, INC.

3513 MT. DIABLO BLVD., LAFAYETTE, CAL. 94549 • 415 284-4486

12 November 1970

Dr. Alfonso Lovo Cordero
Minister of Agriculture and Livestock
Republic of Nicaragua
Managua, D.N., Nicaragua

Dear Dr. Lovo:

Transmitted herewith is our report on the initiation and implementation of Project Adelante during the period January 1968 through May 1970. This project, cosponsored by your Ministry and the United States Agency for International Development, was identified as an irrigation demonstration project, but broader purposes were incorporated. The concept was to initiate irrigation of alternative new crops and some traditional crops; to develop technical and economic data under farmer conditions; to reduce the normal long delays between research and application; to begin the process of acceptance of irrigation by farmers; and to identify the physical, economic, and human factors which could be obstacles to widespread use of irrigation throughout the Pacific Zone.

We can report that many of the project objectives were achieved. Unfortunately, we cannot report that irrigation has been accepted as a profitable undertaking by the area farmers as a result of the project work during the first two years, but certainly a growing interest by them has been stimulated. Nevertheless, we believe that the principal obstacles to successful irrigated agriculture have been identified, and are pleased to report that there are no basic physical limitations to profitable irrigation. Several crops, both of the extensive and intensive types, can be produced, with reasonable returns to the farmer. We also are confident that the present limitations, which are in the areas of training of human resources, and logistical and organizational support, can be overcome, and we have included recommendations to accomplish this.

Your attention is invited to the photographs of project action in one of the first sections of this report. Aerial photographs of the demonstration parcels of the five full-cooperator farmers are contained in the first pages of Appendix II. Immediately following the project action scenes is an Executive Summary. Someone who does not have time to read the complete report can obtain an overall perspective of the project and Final Report in a short time by reading that summary. Chapter 9 of the report presents our conclusions, and our detailed recommendations for future actions.

We sincerely appreciate the opportunity to work on this pioneering project. We know that some day irrigation will become an integral part of the agriculture in the Pacific Zone, and that if the experiences and results, both good and bad, set forth in this report are used as a basis for further demonstration and development work, that both time and effort will be saved in attaining year-around crop production, for the benefit of all of Nicaragua.

Respectfully,

Frederick L Hotes

Frederick L. Hotes, President
Uniconsult, Inc.

Robert C. Harkens, Project Manager
Agriculture Industries, Inc.

LETTER OF TRANSMITTAL

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ACKNOWLEDGEMENTS

Justice can never be done fully when a listing is attempted of persons who, by their cooperation contributed materially to the work of Project Adelante. Recognizing that any such list is incomplete, the project staff and consultants gratefully acknowledge the contributions of time, knowledge, assistance, and in several instances, encouragement, provided by the following individuals, companies, and agencies.

Minister of Agriculture and Livestock, the Honorable Alfonso Lovo Cordero
Sr. Carl D. Koone of USAID/Nicaragua
Sr. M. H. McLendon of USAID/Nicaragua
Sr. Eldon D. Ford of USAID/Nicaragua
Servicio Geologico Nacional
ENALUF
Banco Central
Depto. Tecnico del Banco Nacional
Oficina de Catastro
Comision Nacional del Algodon
Centro Experimental de Posoltega
Centro Experimental Agropecuario "La Calero"
Sr. Enrique Sanchez
Sr. Rene Arguello
Monsanto Agricola
Compania de Fertilizantes Superior S.A.
Servicio Agricola Gurdian
Riegos de Nicaragua
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MADECA
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SEMECA
PRONICA
Sres. Jerome F. Besser and John W. De Grazio, of the Fish & Wildlife Service, U.S. Department of the Interior
Mr. George Hargreaves, specialist in consumptive use

Special acknowledgement is given to the AID Resources Inventory Center, Corps of Engineers, U.S.A., whose maps were used as bases for Plate I, Figure 1-2, and Figure 1-3, and to INFONAC, whose maps in "Investors Guide", May 1967, were the bases for Figures 1-4, 1-5, and 1-6.

Finally, very special thanks are extended to the Nicaraguan cooperators and associate cooperators and their employees, who by their willingness to invest some of their land, money, and efforts on behalf of the objectives of Project Adelante, have advanced the progress of irrigation and agricultural development in the Leon-Chinandega area of Nicaragua.

UNITS OF MEASURE

General

In Nicaragua a mixture of local, english, and metric weights and measures are used. In the report the units are those commonly used in the Project area. The listings on this page are intended to assist persons not familiar with the local useage, to convert to units with which they are more familiar. Abbreviations for these units are shown also, in several instances.

Money

1 United States dollar ($) = 7 Nicaragua cordobas (₵)
1 ₵ = $ 0.143

Length

1 inch (in., ") = 2.54 centimeters (cm) = 25.4 millimeters (mm)

1 foot (ft., ') = 12 in. = 30.5 cm = 305 mm

1 meter (m) = 100 cm = 1000 mm = 3.28'

Area

1 square foot (sq. ft., ft^2) = 144 square inches (sq. in., in^2) = 928 square centimeters (sq. cm.)
1 manzana (mz.) = 0.705 hectare (ha) = 1.74 acres (ac)

Volume

1 cubic foot (cu.ft., ft^3) = 7.48 gallons (gal., g) = 28.3 liters (1)

1 manzana-inch (mz-in) = 0.145 acre-feet (ac-ft) = 178.9 cubic meters (cu.m.) = 47,251 gallons (gal)
1 acre-foot (ac-ft) = 6.90 mz-in. = 325,872 gal. = 1,233.5 cu.m.

1 gallon (gal., g) = 3.78 liters (lit.)

Rates of Water Flow

448.86 gallons per minute (gpm) = 1 cubic foot per second (cfs) = 28.3 liters per second (lps)
100 gpm for one day (24 hours) gives 3.05 mz-in in one day

Weight

1 quintal (q) = 100 pounds (lbs.) = 1 hundredweight (cwt) = 45.4 kilograms (kg.)

20 quintals (qq) = one english ton (t.) = 2,000 lb.

22 qq = one metric ton (mt, MT) = 2,200 lb.

Yields & Applications

1 quintal per manzana (qq/mz) = 57.4 pounds per acre = 63.4 kilograms per hectare (kg/ha)
100 lbs/acre = 174 lbs/mz = 112.2 kg/ha

Power and Energy

one horsepower (hp) = 550 foot pounds per second = 0.746 kilowatts (kw)

one kilowatt-hour (kwh) = one kilowatt for one hour

GLOSSARY OF ABBREVIATIONS

AID & USAID - Agency for International Development
CACM - Central American Common Market
CATASTRO - Office of Inventory and Measurement of Natural Resources, Ministry of Economy, Industry and Commerce
ENALUF - National Electrical Organization
ENPL - National Milk Products Company
FAO - Food & Agriculture Organization of the United Nations
GDP - Gross Domestic Product
GON - Government of Nicaragua
IAN - Agrarian Institute of Nicaragua
IBRD - International Bank for Reconstruction & Development
INCEI - National Institute of Interior and Foreign Commerce
INFONAC - Institute for National Development
LSU - Louisiana State University
MAG - Ministry of Agriculture & Livestock
UNDP - United Nations Development Programme

Acre - Acre
Ha - Hectare
Mz - Manzana
Km or KM - Kilometer
cm - Centimeter
mm - Millimeter
in. - Inch
Sq. km. - Square kilometer
Sq. mi. - Square mile
KPH - Kilometers per hour
°C - Degrees Centigrade
°F - Degrees Fahrenheit
lbs.or Lbs. - Pounds
Cwt. - Hundred-weight or 100 pounds
QQ or qq - Quintal or Quintals
T - Ton
MT - Metric Ton
Kw - Kilowatts
Kwh, kwh - Kilowatt hour
hp - Horsepower
gpm - Gallons per minute
ac-ft - Acre-feet (volume measure)
Mz-in. - Manzana-inch (volume measure)
cms - Cubic meters per second

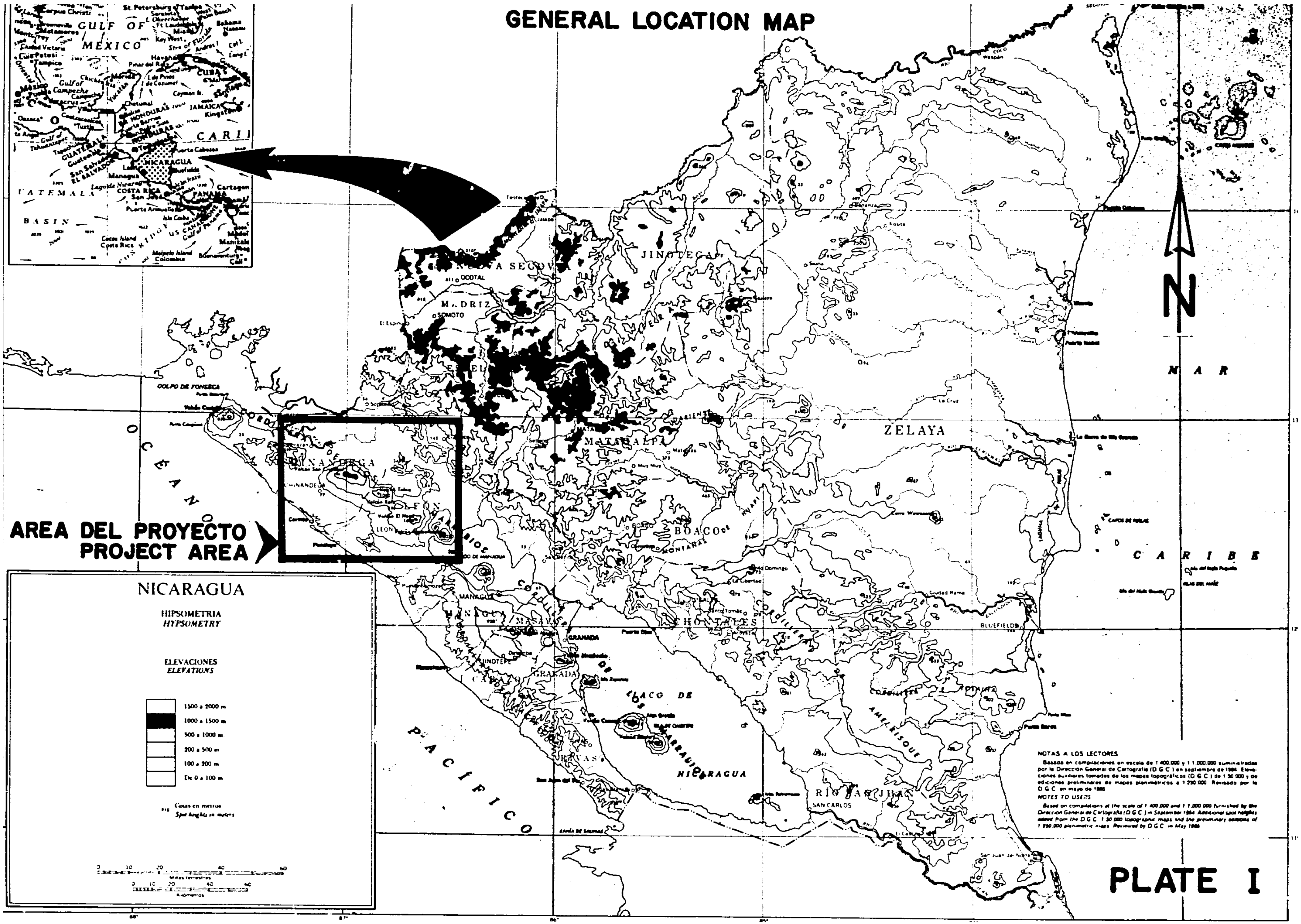
$ - U.S. Dollars

₵ - Nicaraguan Cordobas

a.u.m. - Animal Unit Month
rpm - Revolutions per minute
% - Percent
Yr - Year

PHOTOGRAPHS AND MAP (PLATE) I

GENERAL LOCATION MAP



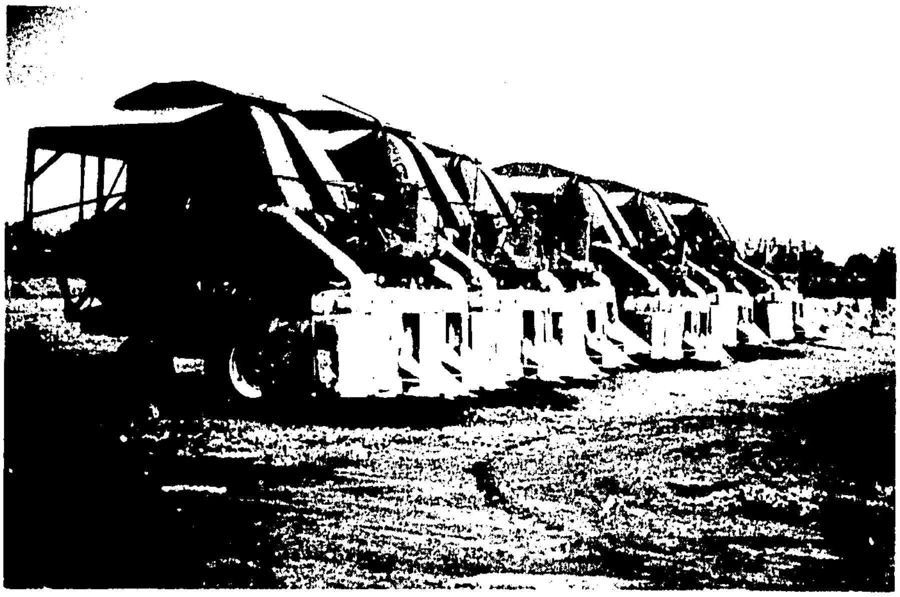
NOTAS A LOS LECTORES

Basada en compilaciones en escala de 1 400.000 y 1 1,000.000 suministradas por la Direccion General de Cartografía (D G C) en septiembre de 1984. Elevaciones auxiliares tomadas de los mapas topográficos (D G C) de 1 50 000 y de ediciones preliminares de mapas planimétricos a 1 250.000. Revisado por la D G C en mayo de 1986

NOTES TO USERS

Based on compilations at the scale of 1 400 000 and 1 1,000 000 furnished by the Direccion General de Cartografía (D G C) in September 1984. Additional spot heights added from the D G C 1 50.000 topographic maps and the preliminary editions of 1 250.000 planimetric maps. Reviewed by D G C in May 1986

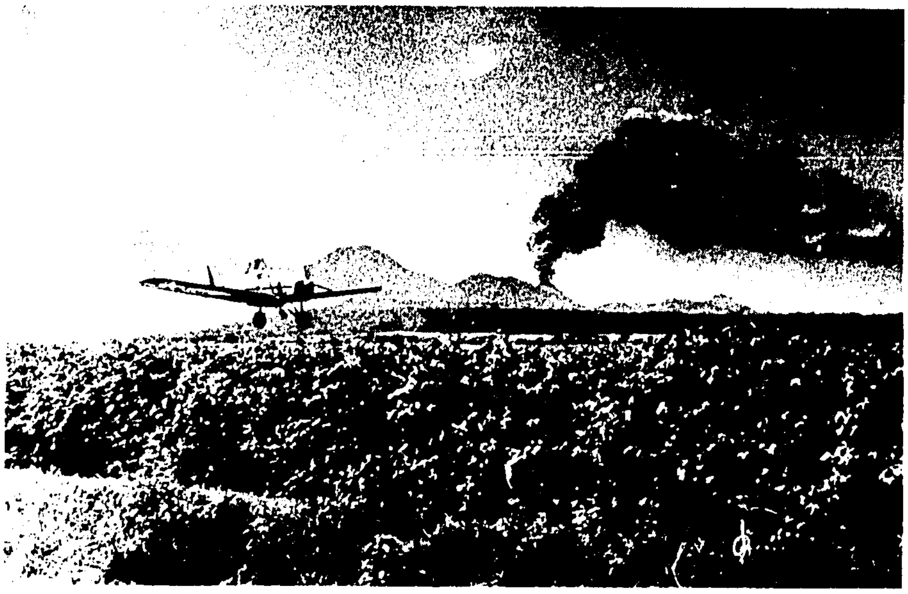
PLATE I



1. Cotton Harvesters, part of modern cotton production culture in Western (Pacific) Zone of Nicaragua.

2. Airplane spraying cotton in Project area. Volcano Cerro Negro erupts in the distance.

October-November 1968



3. Typical local fruit and vegetable market. R. M. Hoffman, Tropical Agriculturist on left, inspects with Ing. Armando Gonzales, USAID.

4. Moses, USAID, MAG Project Supervisor Ing. A. Tijerino, Farm Owner Sr. Fonseca, Project Resident Representative W.J. Schoenleber, at location of well at Fonseca farm, El Carmen, Site No. 50, during Site Selection Survey Work.

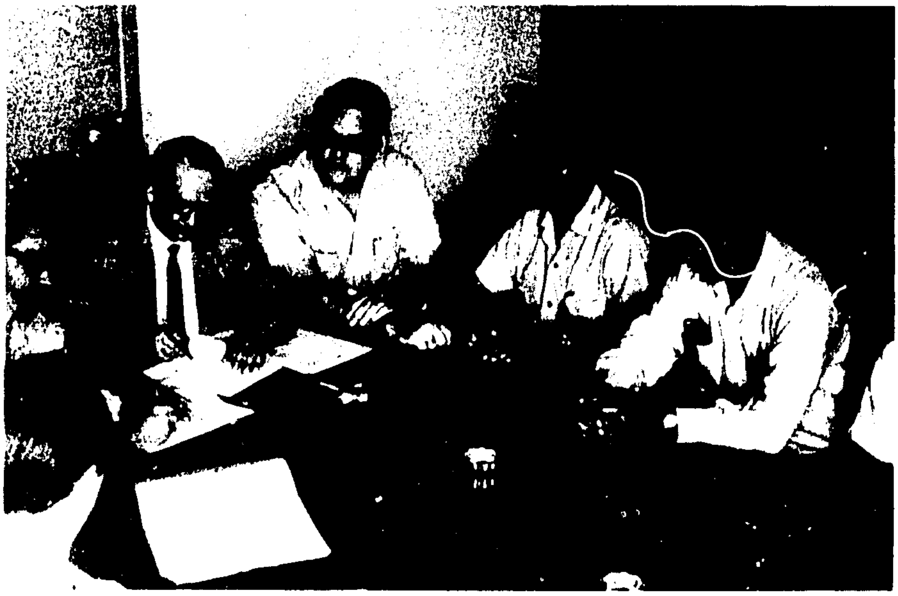
5. Project Agronomist Roy Edwards and Honorio Narvaez take soil sample. Part of Site Selection work.

6. Typical Profile of sosoquite soil in Project Area. This is a heavy clay soil, unsuited for most irrigated crops, except rice. Cooperator demonstration areas did not have any of this type of soil.

7. Srs. Espinosa (left) and Ortega (right) making a water-level measurement during soil infiltration tests at Las Palmeras near Malpaisillo.

8. Excess runoff and soil erosion on field adjacent to Leon-Chinandega Highway. This can be presented by proper soil conservation practices.

9. Soil removed from adjacent field by excess runoff. Soil conservation practices can prevent such occurrences.



10. Signing of Cooperator Agreements. The Minister of Agriculture and Livestock, Dr. Alfonso Lovo Cordero, signs. To his left is Governor Rene Arguello Sacasa, Department of Leon

11. Well drilling at Site 13 (Galo). Costs of well drilling, development, and pumps were borne by farm owners.

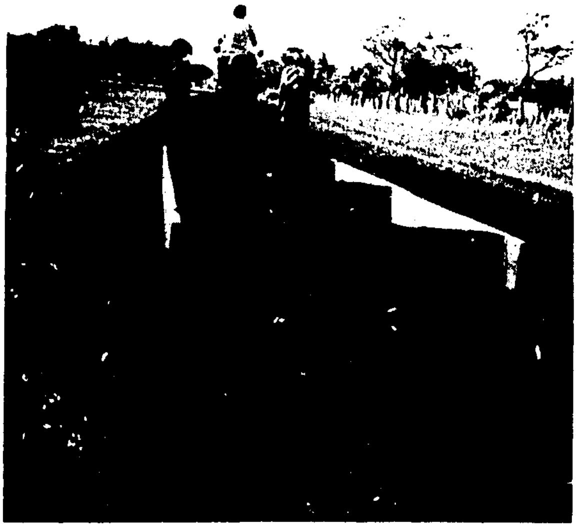
12. Test Pumping of Well at Site 13. Discharge = 330 gallons per minute with drawdown of 5 feet. Depth to static ground water level = 170 feet.

16. Concrete block division structure under construction at Site 50 (Fonseca).

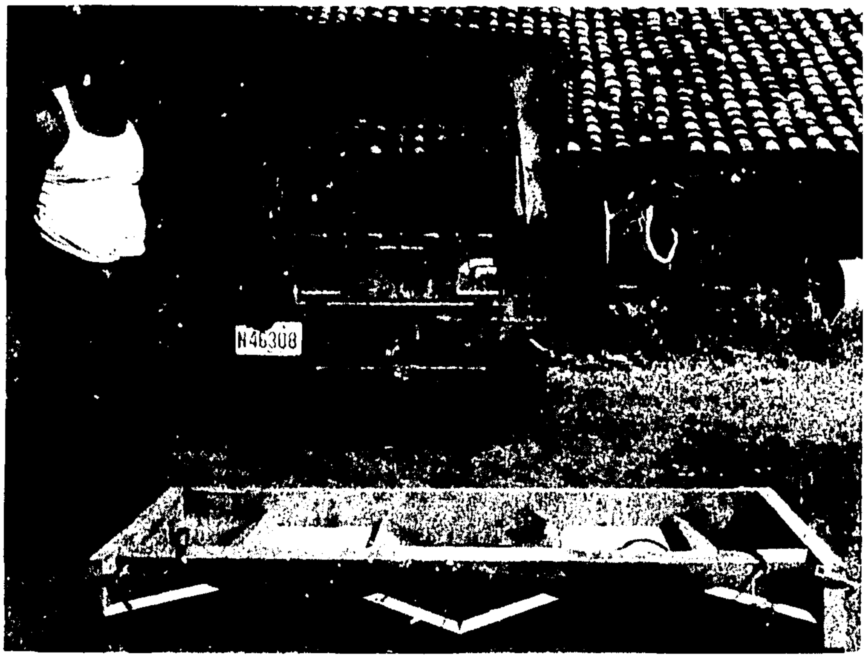
17. Completed concrete block division structure at Site 50. Pasture with surface irrigation in background.

18. Irrigators at Site 50 using 2-inch diameter siphon tubes.

19. Cattle in irrigated pasture, Site 50.

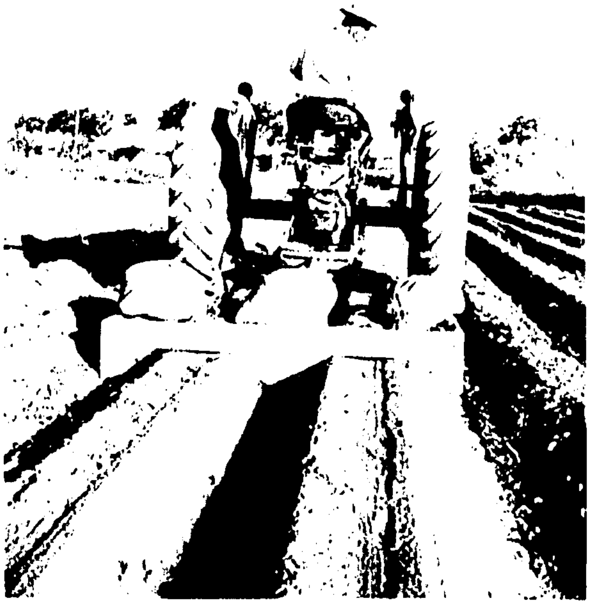


20. Project-designed wooden float preparing land for irrigation. Site 4 (Vaca).

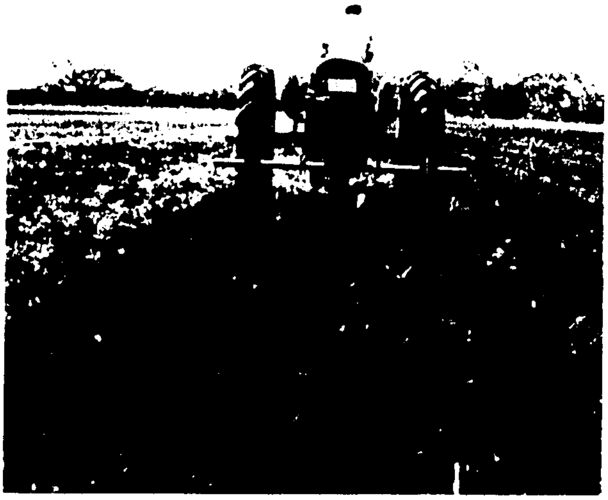


21. Project-designed wooden bed-shaper.

22. Sr. Roberto Vaca S., Site 4 co-operator, near diesel pump which lifts water from spring and delivers to gated pipe.

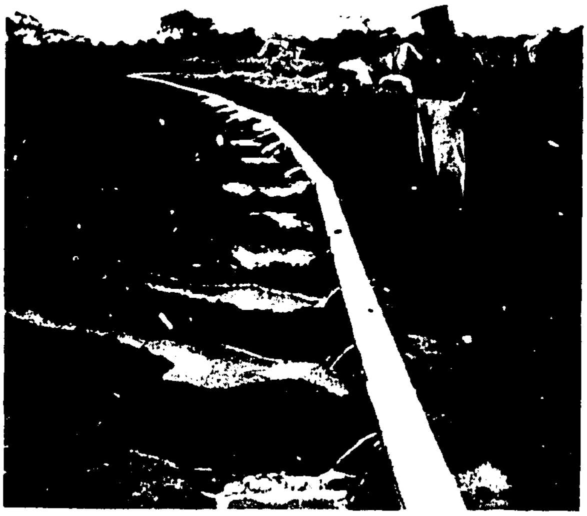


23. Shaping beds at Site 8 (Pineda) prior to planting quequisque.



24. Lister shovels "furrowing out" prior to bed shaping. Site 50.

25. Project Planet, Jr. Planter in operation.



26. Site 4 Mandador supervises furrow irrigation from gated pipe.

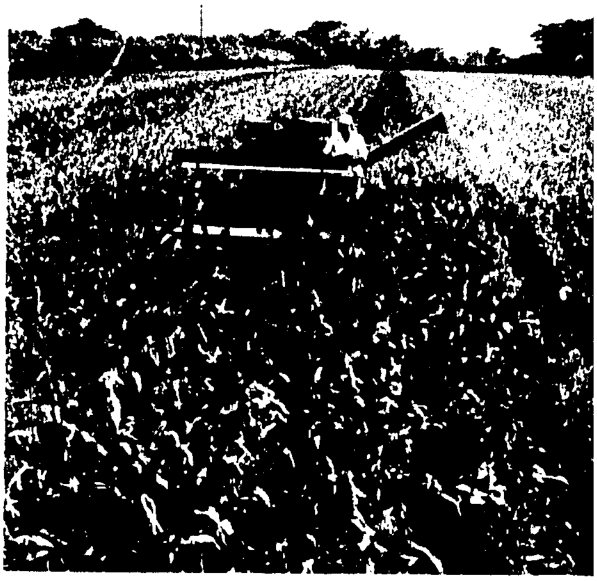
27. Site 4 Cowpeas planted on inside of bed, thus allowing alternate furrow irrigation.

28. Project Manager Robert C. Harkens and Ing. Tijerino discuss crops at Site 4.

29. Applying Dieldrin by hand to control soil insects in newly-planted corn, Site 50.

30. Minister Lovo and Ing. Tijerino inspect okra at Site 8.

31. Meloland sorghum at Site 13, 20 days after planting.



32. Combine harvesting of Meloland sorghum at Site 13, 105 days after planting.

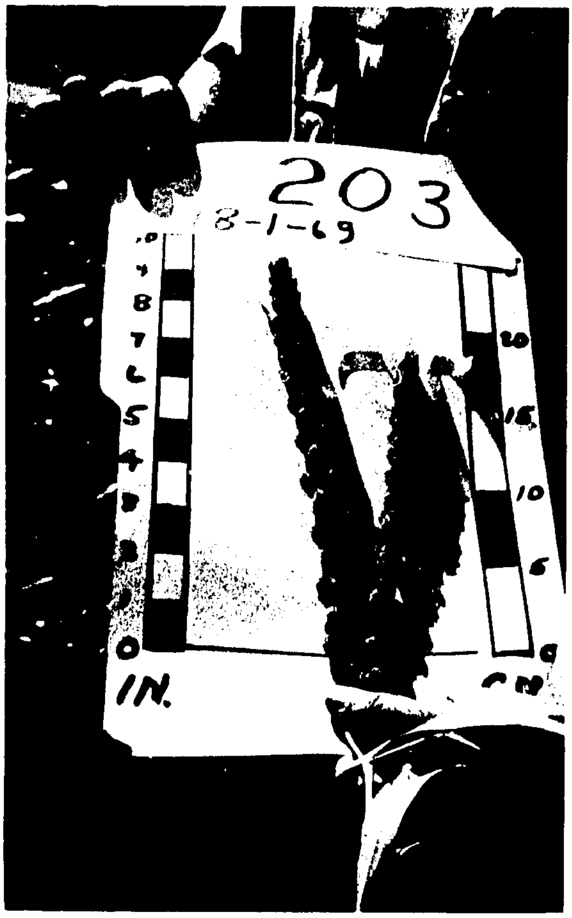
33. Excellent stand of AKS-614 grain sorghum at Site 62 (Quintanilla) 45 days after planting.

34. Sacking Meloland sorghum, Site 13.

35. Gahi hybrid pearl millet flowering and showing excellent growth after 38 days, Site 4.

36. Project Agronomist Edwards shows good seedheads of Gahi hybrid pearl millet at 48 days after planting at Site 4.

37. Excellent seedheads of Foxtail millet after 60 days. This plant shows potential for Nicaragua. Origin in Madras, India.



38. Also originating in Madras, India, this variety of Foxtail millet shows promise of adaption to Nicaragua conditions.

39. Agronomist Edwards instructs Project Technician Raul Gomez how to perform field plant tissue test on grain sorghum.

40. Yuca plot at Site 8.

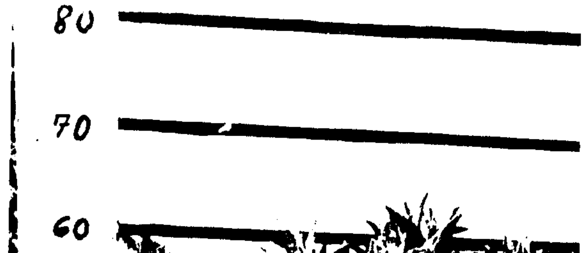
41. Irrigated yuca being harvested at Site 8, 7 months after planting.

42. Cowpeas at Site 4. Two rows of Mississippi Silvers on left; four rows of Whippoorwills on right.

43. Hybrid corn Rocamex H-507 after 49 days, Site 13. 10-12 feet tall at harvest 2 months later. This height causes serious irrigation difficulties.

44. White quequisque, on non-project farm near Coseguina.

45. Safflower at Site 84 (Reyes) after 48 days. Variety S-208.



46. Safflower Variety S-208 at Site 84, after 48 days.

47. Lynn (dwarf) castors setting seed capsules after 49 days, Site 13.

48. Special GON Project Evaluation Team viewing Lynn castors, Site 13, October 28, 1969. Mr. Carl Koone, USAID Rural Development Officer, second from left.

49. Sprinkler irrigation of Lynn castors at Site 13.

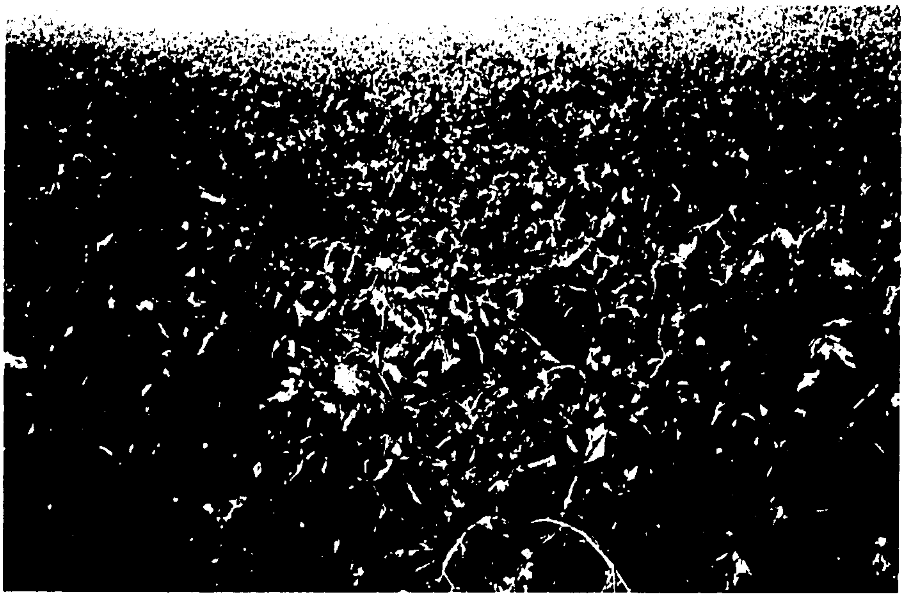
50. Checking Lynn castors at Site 13 for time of harvest.

51. Project Manager Harkens studies root development of Lynn castors, Site 13.

52. Cutting Lynn castors for ratoon crop, Site 13.

53. Lynn castor cut to 18-inch height to try for ratoon crop.

54. Ratooned Lynn castors, Site 86.

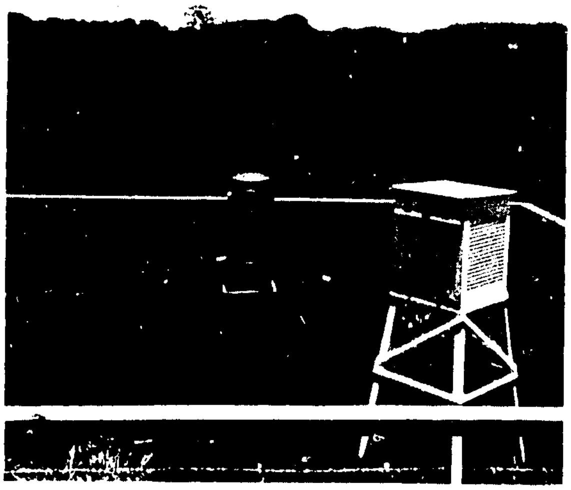


55. Cotton crop damaged by fallout from eruption of Volcano Cerro Negro, Oct-Nov 1968. See also Photo 2.

56. Field workers knocking volcanic debris from cotton plants downwind from Volcano Cerro Negro. See also Photos 2 and 55.

57. From left to right. Elton Ford, Assistant Rural Development Officer, USAID, Wm. Jallings, Controller, USAID, and Roy Edwards.

58. Cucumbers, Site 46, La Leona.



59. General view of Project Meteorological Station, Site 8.

60. Maximum-minimum thermometer, wet and dry bulb thermometers, and recording hygrothermograph, installed in shelter at Meteorological Station.

61. W. J. Schoenleber checks daily precipitation at Project Meteorological Station, Site 8. Evaporation pan at right.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Final Report on

PROJECT ADELANTE, NICARAGUA 1968-70

A PROJECT FOR IRRIGATION DEVELOPMENT IN WESTERN NICARAGUA

I. BACKGROUND

A. General Agricultural Situation in Western Nicaragua

Over the past twenty years technical teams from several organizations such as the Food and Agriculture Organization of the United Nations, the International Bank for Reconstruction and Development, and the U.S. Agency for International Development, have suggested the potential feasibility of irrigation in the Pacific Zone of Nicaragua. This zone is the most intensively cropped in Nicaragua, with large areas of deep, well-drained soils, characterized by nearly-level to gently-sloping relief, and a six-month rainy season from May through October, followed by a six-month dry season from November through April. While the area has been, and still is, highly productive, the long dry season, four months of which receive less than one millimeter of rain per month, have placed definite limitations on the crops which can be produced under natural conditions.

Some irrigation exists, but primarily for specialty crops such as sugar cane and bananas, with some rice and pasture irrigation beginning. The total area irrigated in 1968 was less than three percent of the more than 1,200,000 manzanas farmed in the zone. Lack of good surface water supplies, despite an annual rainfall in the Pacific Zone ranging from 1500 to 2500 millimeters (60 to 100 inches) annually, is one of the principal reasons why irrigation was not adopted many years ago as a standard practice during the dry season. Another reason has been the apparent acceptance by the farmers of the yields and returns from the crops which could be grown under naturally existing conditions. This is especially true in the case of cotton, which increased almost tenfold in area planted from 1951 to 1968. In that year approximately 204,000 acres of cotton were cultivated in the Pacific Zone. 70 percent of this amount was located in the Leon-Chinandega area, in the northwest portion.

B. Importance of Cotton

Cotton truly became the "King of Crops" during the 1960's in Western Nicaragua. It utilized the soil and climate more effectively than any other crop, growing during the rainy season, and being harvested and ginned during the long dry period. Several varieties from other areas in the world were well-adapted to the local climate, and fertilizer practices and insect control procedures were successfully transplanted to the area without expensive modifications. Large numbers of tractors and cotton equipment were brought into the country, and the zone soon reflected an advanced mechanized production system, involving fertilization, insect and weed control, with ample use of aircraft. The entire system of production was far ahead of that used for corn, sesame, and other existing crops, but, by the mid-60's, very few, if any, innovations had been developed locally for cotton production. The same standard practices which had been adopted initially continued to be duplicated as cotton plantings expanded even beyond the outstanding soils onto the less-adapted soils.

The economics of the cotton situation were good in the early 1960's. Cotton yields under the soil and climatic conditions were very good, and the prices were right. The situation was so good that cotton farmers could not justify the addition of irrigation systems to provide supplemental moisture. But it was apparent that the economy was linked closely to a single crop, and that no alternative crops were available to these growers should the economics of cotton production change.

Cotton exports reached an all-time high in 1965 of $66,131,900, representing 44.4 percent of all exports. But then the situation began to change. By 1968 cotton exports decreased in value to $59,675,400, with the greatest portion of the decrease resulting from lower prices. Production, however, decreased by about 20 percent, but export volume was essentially maintained by sale of carry-over stocks. Export volume has been decreasing each year since 1965. Another 25 percent reduction in crop production is estimated to have occurred in 1969. The decrease in export value in 1969 and 1970 may be as much as $12,000,000 each year. Some of the losses in export value has been, and will continue to be, offset by increased export earnings from beef, coffee, and seafood, but the problems of the cotton industry have adversely affected the total economy of the nation.

The inherent dangers in the flourishing cotton monoculture were recognized prior to the unfortunate decline in the fortunes of Nicaraguan cotton, and in addition the previously mentioned studies had pointed out the potential benefits of developing year-round cropping programs in the zone. Furthermore, there was growing evidence of the existence of a large reservoir of underground water in the northwestern area which could supply good quality irrigation water at reasonable pumping lifts. Also, even with cotton there were perhaps four to five months a year when the land was not fully productive due to lack of water. A definite need existed for alternative crops to cotton, and to develop a year-around cropping program. This also meant a need for irrigation.

II. THE PROJECT ADELANTE CONCEPT

A. Basic Concepts

Project Adelante was conceived as an initial effort to demonstrate the benefits of improved and diversified cropping systems under irrigation in the Pacific Zone. (The Spanish word "Adelante" means "Forward".) Wells would be developed to supply irrigation water to the demonstration farm tracts. The program was designed to develop technical and economic data under farmer conditions; to reduce the normal long delays between research and application of results; to begin the process of acceptance by farmers; and to identify the physical, economic, and human factors which could be obstacles to widespread use of irrigation throughout the Pacific Zone. Another principal objective was to identify alternative crops for the development of year-around cropping programs.

B. Organization and Personnel

Project Adelante was initiated in February 1968 as an arm of the Ministry of Agriculture and Livestock, in implementation of an agreement with the U.S.Agency for International Development which provided substantial support funds for technical assistance and equipment. Project Headquarters were established at Leon, the second largest city in Nicaragua, located approximately 60 miles northwest of Managua, the capitol city.

Two resident U.S. technicians, an irrigation engineer and an agronomist were provided by the Project Consultant, and were stationed and lived in Leon. They were supported by other part-time U.S. Specialists, including an agricultural economist. The Ministry of Agriculture and Livestock provided a Nicaraguan engineer to serve as Project Supervisor for MAG and to work with the irrigation engineer, an agronomist to work with the consultant resident agriculturist, and an agricultural economist to work with the consultant ag-economist. MAG also provided office space and equipment, a field technician, and two bilingual secretaries.

C. Farmer Cooperators

The demonstration farms were located within a fairly short radius of the Leon-Chinandega area in order to provide proper management. More than 90 potential locations for cooperator farms were examined. Most of these are shown on Figure 1-1, page 1-7.

After a detailed evaluation and selection process, five farmers signed formal agreements with MAG to serve as full-time cooperators, and three others agreed to act as associate cooperators. (Technical advice was provided also to many other area farmers over the project period, as requested.) The cooperator was expected to devote 20 to 30 manzanas (35 to 50 acres) of their land to project purposes, to provide a suitable water supply, to provide the necessary farm inputs, machinery, and labor, to make his own capital and credit arrangements, to do his own marketing, and to keep prescribed records. The Project was to supply on-site technical guidance on a continuous basis (but not management), and the necessary irrigation equipment (a combined total of $30,000), except for the water supply. At the end of the Project life, approximately 5 years, the equipment was to become the property of the cooperator. A copy of a typical cooperator contract is included as Appendix IV to this report.

In addition to the equipment incentive, the Project provided that there would be assistance in the acquisition of credit for both wells and pumps and for production through Nicaraguan agencies. A sum of 40,000 cordobas (U.S. $5,700) was supplied by ENALUF, the National Electrical Organization, as an additional government incentive. Limited contributions were made to the cooperators in the form of imported seeds, some insecticides, and even some payment for labor costs and equipment operations.

Aerial photographs of each full-cooperator demonstration plot may be found at the beginning of Appendix II. Field and irrigation system layouts are presented in Chapter 6, together with a detailed record of the cropping experiences at each site.

III. IRRIGATION SYSTEMS

A. Sprinkler vs. Surface Irrigation

Project plans took into consideration the lack of experience of the farmers in water handling. The culture did not include an appreciation of water application, nor of the intensive improved practices that are required with irrigated farming to realize benefits from the extra investment and work involved. It was recognized that surface irrigation would be important in the area, and it was hoped that demonstration sites could be developed for surface irrigation. Surface irrigation would have the advantages of reduced costs of pumping, slightly less capital investment requirements under proper circumstances, and would be unaffected by the winds which sometimes blow strongly during the dry season.

However, there were no trained land-levelers or land-leveling equipment in the country. To bring in such equipment for the small initial areas would cost much more than for installing sprinkler irrigation equipment, and require additional time for training the equipment operators. In these circumstances, portable sprinkler systems provided important advantages.

Orders were placed through AID and it was possible, through the cooperation of a United States sprinkler company, W. R. Ames Company, to purchase six systems; five using sprinklers, and one using gated pipe, for the money allocated the program. Each of these systems was to irrigate approximately 20 manzanas of land, (about 35 acres). Orders for this equipment were placed as early as possible so that the equipment would be on hand by the time the wells had been drilled, developed, and the pumps installed.

B. Water Supplies

One of the cooperators had an existing well but no pump was installed. Another had a spring which could be utilized by the installation of a pump and motor. The other full-cooperators had wells drilled, power lines built, and pumps installed at their demonstration plots. Except for the contribution by ENALUF to the power line construction, these water supply development costs were born by the land owner. One farmer who had signed as a cooperator installed a well and pump, but then had to resign from the program for business reasons. The principal features and costs of the water supply sources are summarized in Table 5-1 on the next page. Well logs and a discussion of each source are presented in Chapter 5.

All of the supplies are of suitable quality for irrigation, but at two sites the salinity is sufficiently high as to preclude use on salt-sensitive crops, such as cucumbers.

C. Irrigation Systems

Performance characteristics of the basic sprinkler irrigation systems for the demonstration parcels are as follows:

Basic Sprinkler Irrigation Systems

Sprinkler-head spacing along laterals = 30'
Spacing between lateral sets = 50'
Lateral Diameter, aluminum pipe = 3"
Mainline Diameter, aluminum pipe = 4"
Sprinkler-head flow, 5/32" nozzle = 5.2 gpm @ 55 psi
Gross application rate = 0.335 inches/hour
11-hour application = 3.7"
22-hour application = 7.4"
Estimated Efficiency = 70 to 75 percent
Total Cost for 20-manzana farm = $27,200 ($3,900)
Total Capital Cost: per manzana = $1,360/mz.
per acre = $112/acre

The one gated pipe system installed was of 8" and 6" diameter aluminum pipe, with gates spaced every 40" (1 meter). Cost was $36,390.

Because both 20' and 30' lengths of mainline pipe were provided, a 30'x 60' sprinkler was used by some operators instead of the basic 30'x 50'. This reduces the application rate more than 15 percent, which is permissible as long as high lateral pressures are maintained, the irrigation frequencies increased, and winds are not blowing. However, the greater spacing is not recommended because of the danger of under irrigation near the area mid-point between lateral sets, and reduced irrigation efficiency.

D. Irrigation Costs

Complete cost analyses are presented in Chapter 7 of the various elements making up irrigation costs, including a useful Table 7-7 on page 7-10 which gives the cost of pumping irrigation water under the ENALUF power schedule existing in 1968-70, for various total pumping lifts and quantities of water pumped.

Table 5-1

PRINCIPAL FEATURES OF COOPERATOR WATER SUPPLY SOURCES

Site No.	Owner	Supply Source	Total Depth	Well Diameter		Depth to Water Level		Drawdown	Yield gpm	Specific Capacity gpm/ft	Total Dynamic Head	Horsepower	Cost in Cordobas			
				Hole	Casing	Static	Pumping						Well	Pump	Electrical Connection (2	Total
4	R. Vaca S.	Spring	5'	N.A.	10"	5'	5'	0	300 to 750(1	N.A.	50' (3	13	-	-	Diesel	9,500
8	R. Pineda F.	Well	160'	18"	12"	10'	30'	20'	300	15	204'	20	20,000	21,350	8,220	49,570
13	O. Galo	Well(5	248'	10"	10"	170'	175'	5'	330	66	340'	40	16,500	38,500	15,000	70,000
50	J. Fonseca L.	Well(3	258'	16"	12"	25'	57'	32'	1370	43	90'	40	28,400 (4	22,850	16,000	67,250
		(Booster)	-	-	-	-	-	-	300	N.A.	150'	15	-	5,960	-	5,960
62	G.Quintanilla	Well	200'	16"	8 1/2"	34'	76'	42'	300	7	250'	25	20,000	26,000	15,630	61,630
86	R. Escobar L.	Well	240'	20"	12"	127'	152'	25'	600	24	320'	60	24,600	43,900	13,590	82,090

Notes:
1. Spring Yield varies from 300 to 1500 gpm, depending upon time of year.
2. All power, except for Site No. 4, is 220 volt, 3 phase, 60-cycle A.C.
3. Site No. 50, Fonseca, well does not provide total head required for sprinkler irrigation, since major portion of land is gravity-irrigated. All Site No. 4, Vaca, gravity-irrigated.
4. Well of Site No. 50, Fonseca, dug pre-project by Civic Action Program of G.O.N. National Guard. Cost shown is estimated 1968-69 cost.
5. All wells except that at Site No. 13, Galo, have gravel-packs.

For a total pumping lift of about 245', including the 125'-130' needed for sprinkler head pressure, a 20-manzana farm pumping about 1500 manzana-inches per year would pay power costs about $7.5 for each mz-in. pumped. (This is equivalent to $7.40/acre-foot of water pumped.) Omitting the requirement for sprinkler head pressure the cost drops to about 4.5 cordobas/mz-in., a significant reduction.

However, power costs are only one portion of irrigation costs. Other significant costs are depreciation, interest, and labor. The examples detailed on pp. 7-16 through 7-18 illustrate this important point.

Well drilling costs are summarized on p. 5-15.

E. Water Requirements

Accurate determination of crop water requirements by soil-water measurements or lysimeter studies was beyond the scope of the initial phase. Estimates were made of these requirements using available climatic data, and are summarized in Table 5-10, p. 5-23. With a 70 percent irrigation efficiency requirements ranged from a high of 82 inches for a year-around crop such as Pangola grass, down to 20 inches for a 90-day crop such as Pearl Millet.

The Project did expand climatic data collection in the area so that better estimates can be made in the future, to aid farmers in proper irrigation. Rain gages were installed at 7 sites, and in addition at one site an evaporation pan, a hygrothermograph, and wet and dry bulb thermometers were placed.

IV. CROPS

A. General

In Chapter 4, Agronomics, and Chapter 6, Farm Planning and Development, crops and varieties, farming practices, weeds, diseases, insects and other pests, and the actual on-farm experiences on all demonstration plots are presented in considerable detail. Chapter 7, from page 7-18 onward, contains sample cost studies on many of the crops grown.

B. Crops Grown

The crops grown at one time or another during the two-year period on the demonstration parcels include the following. Several varieties of some crops were tried.

Beans, dry
Castorbeans
Cowpeas
Corn, Field & Sweet
Cucumbers
Grain sorghum
Melons
Millet
Okra
Papaya
Peanuts
Pineapple
Quequisque
Safflower
Sesame
Soybeans
Squash
Tomatoes
Yuca
Pangola grass
Alfalfa

Those identified as having potential as irrigated crops in the Project area are as shown in Table E-1

Table E-1

POTENTIAL IRRIGATED CROPS IDENTIFIED

1968-70

	Extensive Crops (For large area plantings)	Intensive Crops (For limited area plantings)	
Probably Profitable	Grain sorghum (harvest limited to dry season) Peanuts (harvest limited to dry season) Safflower (dry season only) Castorbeans, dwarf (dry season only)	Cucumbers Melons Okra Sweet corn	Tomatoes Quequisque Squash Yuca, fresh *Citrus
Profitability not established	Pasture Yuca, starch Millet, Pearl & Foxtail	Cowpeas (not a cash crop)	

*Not grown on project

Proso millet, beans, and soybeans are not acceptable as crops for the area, at present.

If irrigation is to come into the Pacific Zone on a significant scale, the big need will be for extensive crops which can be grown on large acreages. Intensive crops such as citrus, melons, cucumbers, tomatoes, sweet corn, and similar crops are higher income-crops, but the existing markets will support only a very small acreage of these crops. In the examination of crops in these categories, sugar cane, tobacco, rice, and bananas were omitted because of their special nature. Quequisque and 300-day yuca are promising crops under irrigation, but since they are for the fresh market, the acreage grown must be fairly small.

C. Yields, Costs, and Prices

Low yields and low profits from the crops grown on the demonstration farms were major problems in developing farmer enthusiasm. Crop losses were not unusual, but actually such losses are an expected part of a completely new experience. At times these losses were due to lack of equipment, poor timing, or breakdown of communications. It was understandable that at times farmers and Project personnel were disappointed and discouraged.

At the same time the majority of the reasons for less-than-expected results were identifiable, and avoidable. More important, despite these difficulties many crops produced in a manner that it was possible to predict with assurance based on crop characteristics that their yields could be increased with proper management.

In preparing the sample cost studies of Chapter 7, costs were estimated on a liberal basis, that is to say, on the high side. These costs included charges for depreciation, land rent, and a return to management equal to five percent of the gross income. Since these are all non-cash expenses to a land owner, many farmers do not understand their magnitude or significance. A correct analysis must include these items. In the discussion on costs and estimated return in

Chapter 7 it is pointed out that only a few of these are subject to any appreciable degree of reduction. Irrigation water costs are one of those subject to change. Sprinkler irrigation with higher pumping and investment costs were used. Surface irrigation costs would be lower.

The cost of production per unit produced is very high at present, because of low yields. In order to lower unit costs, it is necessary to increase some input costs such as fertilizer, insecticide or others, as the needs are identified. These added inputs will increase the yields and thus lower the cost per unit.

Revenues are the product of both yield and price. Yields in several instances can be improved. Prices depend upon a market, and the timing of sales. In some cases, for example castorbeans and peanuts, the local prices for the tiny project quantities were well below normally-expected prices.

In reviewing the Summary of Yields, Prices, and Costs in Table 7-9 on page 7-22, therefore, it should be borne in mind that:

a) Costs would be reduced for surface irrigation, where applicable.
b) Yield figures can be revised to reflect new experience, and in most cases good management can bring greater yields than those shown.
c) Changes in prices can make crops profitable that are listed as having negative income in the Table, or increase the profitability of others. Obviously decreased prices could reduce or eliminate profitability.

In judging the feasibility of growing a particular crop, a proper procedure would be to ascertain the applicable price and yields, and compare their product with the estimated costs. If Gross Income is near or exceeds Total Cost, a more detailed study of the crop is probably justified. The tentative conclusions shown in Table E-1 were made in this manner.

D. Diseases and Pests

Many plants on project plots were attacked by diseases of the roots, leafs, or other plant parts. In some instances corrective action could not be, or was not, taken in time, and loss of yields, or of the entire crop, resulted. Those encountered have been noted in Chapters 4 and 6.

The most destructive insects in Project Adelante were the worm-type insects, both the soil types, such as the lesser cornstalk borer and the seedcorn maggot, which succeeded in destroying a complete stand of young corn, and the worms which attack the aerial portions of corn, beans, castorbeans, etc., shortly after plant emergence. There were additional insects, such as the white fly, which caused no visible economic damage to the crop; the leaf hopper which transmits the corn stunt disease, but otherwise is of no economic significance on Project crops, and others which caused minor damage such as ants, mole-crickets, white grubs, etc.

Included as pests are rats, which caused losses in Project Adelante in Yuca stands, and Garrobo (Iguanas). These are two of the more exotic of the pest-insect problems that faced the Project, though not the most serious.

Birds, both of the migratory type and local parakeets, caused appreciable damage to sorghum and millet stands, in some cases removing the entire crop. Specialists from the U.S. Fish and Wildlife Service investigated this problem, but no completely satisfactory solution was found. The intensity of the attacks on any one field may be diminished when large areas of such crops are growing at the same time.

E. Improved Cultural Methods

During the 2-year period, project operations permitted introduction and preliminary evaluation of several improved cultural methods, as noted by the following:

The Project ----

-demonstrated that use of a rotary tiller for seedbed preparation for irrigated crops greatly reduces the time for this operation compared to the use of a plow and a disk and eliminates four or more conventional operations,

-used 4-row tractor equipment to make furrows and to cover hand-planted crops of yuca and quequisque,

-demonstrated the use of bedshaping equipment after furrowing-out as an important practice for non-irrigated and irrigated crops. Built and demonstrated a wooden float for preplant smoothing,

-made use of fertilizer attachment on 4-row planters to apply soil insecticide in a narrow band overseed row, thus reducing cost and improving insect control,

-demonstrated advantage of a spike-tooth harrow as proper equipment for final seedbed preparation, and its use for effective weed control when crop plants are too small for cultivating,

-had local certified corn seed graded to uniform seed size to show that this crop can be easily planted with precision, thus eliminating the need for thinning or hand-seeding to obtain desired plant population,

-discouraged standard practice in the area of applying a potash fertilizer on fields not deficient (most fields in area are high in potash),

-demonstrated the importance of ground spray rigs and the proper nozzle size during the windy period of the dry season.

F. Crop Rotations and Cropping Programs

From the experience gained from Project Adelante it has been possible to identify the factors which must be considered in developing year-around cropping programs and alternatives. These factors are:

1. Weather
   a. dry season
   b. wet season
   c. period of very heavy rains
   d. Canícula (dry period in the wet season)

2. Bird Seasons
   a. migratory birds (Rice birds)
   b. local birds (Parakeets)

3. Crops
   a. length of growing season
   b. tolerance to wet weather

4. Prices
   a. normal trends and yearly fluctuations
   b. period of highs and lows

Except for the last point on prices, these are all physical factors. It is possible to develop an annual calendar which shows how these factors fit. With this the crops, with their different lengths of seasons and requirements, can be superimposed. The dates used are close enough to be guides but are likely to shift from year to year.

A Guide for Use in Establishing Cropping Programs is given as Figure 4-1, p. 4-25, and examples of its application are given on pp. 4-24 through 4-26.

Adelante experience proved that a two-week variance in rainfall periods, either earlier or later, is not a unique event. Furthermore, the amount and intensity of rainfall which occurs during the Canícula varies widely. In some years supplemental irrigation during the Canícula may help sustain or improve yields of wet season crops. In other years farming operations may be difficult to accomplish when planned because of excess soil moisture. The general regularity of the rainy and dry seasons is, however, a valid concept.

G. Farm Management Training

Farm management training, "on-the-job", was given where possible to the farm owner, his mandador, and farm workers, including these important aspects:

-Operation of irrigation equipment, and proper irrigation practices.

-Timing of crops for best markets, prevention of bird damage, avoiding harvest during rainy periods, etc.

-Keeping good farm records for economic analysis.

-Locating markets.

-Scheduling of farm operations with irrigated crops.

-Training in proper adjustment of equipment.

-Demonstration of efficient use and operation of equipment.

-Techniques for evaluating varieties and cultural practices using regular farm equipment.

-On-the-farm methods of determining soil moisture and estimating water requirements.

-Training in determining need for insect and disease control.

-Determination of proper time for harvest and system for minimizing seed damage and loss.

V. OTHER PROJECT ACTIVITIES

Detailed soil maps were completed on 14 sites. This information was correlated with the national cadastral soil series.

Boundary and topographic maps were made for all cooperator sites. In almost all cases the lack of suitable maps required that Project personnel devote considerable time to the preparation of boundary and topographic maps. These were needed to properly design the irrigation system, and to provide base maps for planning cropping programs.

Water quality analyses were made on a total of 12 sites through the cooperation of the Servicio Geologico. Project personnel provided the interpretation of these analyses.

Soil infiltration studies were made on a total of 10 sites and the information interpreted and included in this report.

Many farmers, technicians, agricultural firms, bankers and others in the area were given technical and management advice at their request, on crop varieties, cultural practices, irrigation, surveying, farm equipment, and agricultural engineering.

A total of 26 monthly reports were prepared and distributed, thus accounting for every single monthly period since the Project's inception. The reports contain specific progress information plus timely articles ranging from yields to water use data. One section features the theme-of-the-month in picture form, and thus augments the narrative part of the report. These reports were circulated within Nicaragua to several interested agencies.

Detailed recommendations were presented for the establishment of a --

A) Department of Irrigation and Soil Conservation within MAG
B) National Advisory Committee on Irrigation and Soil Conservation
C) National Water Rights Commission

Action to implement these recommendations was initiated by MAG in 1968, but for various reasons further government action has been delayed.

VI. PRELUDE TO RECOMMENDATIONS

Chapter 9 summarizes many important conclusions which the Consultant has drawn from the information and experiences gained during the 1968-70 Project Adelante Operations. In addition to the findings of fact and judgements already presented in this Executive Summary, the following conclusions are presented as a necessary prelude to recommendations for future action.

As Western Nicaragua begins to adopt irrigation more widely, the change from rain-fed, one-crop-a-year farming to intensive multi-cropping will require major changes in cotton cultural practices to be a part of the year-around irrigated cropping program. However, timing will not permit cotton to be grown entirely during the dry season with irrigation, and there is no apparent economic advantage in growing cotton during this period.

The major problem will be to train the human resources to meet the intensive demands of irrigated agriculture.

There will be problems and delays in getting the people -- owners, foremen, equipment operators, labor and technicians, to make the changes necessary for year-around agriculture. This is the weakest resource in the potential for irrigated agriculture.

The on-farm personnel, from the farm managers to the foremen and the farm laborer, are not prepared at present through training or experience to meet the demands of year-around irrigated cropping. There is a lack of irrigation management ability in what to do, how to do it,and when. There is adequate available labor but it is untrained. Supervisors (labor foremen) are untrained or nonexistent. Technicians from the research stations, the extension service or the banks are not supporting the farmer at the level needed. At present the best help available to farmers is from commercially-oriented sources, which are not always objective nor unbiased.

There will be real economic benefits from irrigation and year-around cropping as the productive use of land is extended to include the entire twelve-month period. Land will only be out of use for the time required to harvest, pre-irrigate, and to prepare a new seedbed and plant. Crops that are presently impossible to grow can be grown in the dry season with irrigation.

Existing credit programs are not geared to the needs of irrigated agriculture. Bank technicians need more taining in irrigated agriculture and should be involved more directly in supervision of credit at the farm site.

Farm equipment is not adequate for the intensive program under the very demanding schedules connected with year-around cropping. Delays in getting machinery to the field at the proper time contributed to low yields and crop losses. Farmers do not have the proper equipment and what they have is in poor repair. This equipment deficiency applies also to post-harvest equipment such as storage, dryers, and other processing machinery.

Ownership units are large enough to justify the investment required in the irrigation system and operating equipment. This is not true in much of the world where land units have been divided into sizes too small to develop an economic or mangement unit.

A normal tendency as cotton acreage declines will be to keep the high-yielding areas in cotton, and to use the less productive areas for irrigation. As the pressures due to lower world price and poorer average yield affect cotton acreage, the normal inclination by the financing agency will be to reduce cotton production on the less suitable land by limiting cotton loans to the best soils. From a lending agency's point of view this may be the soundest way to reduce risk. From the Nicaraguan land use standpoint, this approach may not meet the needs of the agrarian economy.

The better lands have more crop flexibility even without irrigation than the less productive cotton lands. A careful look might suggest to land use planners that cotton should be used on the lower range (but not the poorest) of the previous cotton acreage and reserve the higher classification areas for more intensive land use. This will not come about if the criteria used by lending agencies is the only influence on land use.

To return the highest profit on the investment, irrigation should be combined with the greatest degree of intensive farm management and the most suitable land available. Under present circumstances, the major influence on land use comes from the lending agencies. But the lending agencies are not as concerned with appropriate use of land resources as they are with reducing the risk on their production loans. This, in fact, is what they should be concerned with, but they should also be a part of an overall land use planning group. However, there is no land-use planning group in Nicaragua at this time, but one is needed to be sure that the most suitable land is designated for irrigation.

VII. RECOMMENDATIONS

1. Training Programs should be given first priority.

Training is a major undertaking and should involve active assistance by the banks, INFONAC, MAG, equipment dealers and other commercial organizations.

Participation in training programs should be mandatory for everyone going into irrigation. A requirement that equipment operators, foremen and laborers take part in these courses could be a condition of production loans. Owners who act as farm managers are the group which needs this help most seriously. In some fashion they must be influenced to participate. Training programs must be geared to these different groups of people involved in the farm operation, the farm foremen, equipment operators, laborers, and farm managers.

Farm foremen need to learn how to supervise the laborers and equipment operators and carry out the field operations as laid out by farm managers. These people should know how to keep records and some theory relative to irrigation and crop production.

Laborers need training in hand operations such as thinning, weeding with hoes, moving sprinkler pipe, replanting and harvesting. Women should be included in this training because they are particularly good as members of thinning and weeding crews.

Equipment operators need practical training on a formal basis. There will be new operations to be performed and new equipment used in irrigated farming. The condition of most equipment and the quality of work performed are extremely poor. The workers must have help in order to gear up to the demands of irrigated crops.

Owners and managers need courses in enterprise accounting and analysis and in principles of irrigation, weed control and management factors relating to the problems on their farms.

Training programs must be supported by technical assistance at the farm. This may be supplied by the Extension service and Bank Technicians. These people aren't doing this job now but with support, training and discipline they can provide badly needed assistance.

2. A Machinery Program with Custom Equipment Operators should be activated.

Farmers cannot afford to buy all of the equipment necessary to carry out the intensive work to be done. The major jobs are land preparation, furrowing out, and harvesting. In an irrigated program, some of these jobs, like land preparation (disking, plowing, harrowing) will be done three times as often each year as they are now.

The recommended method to assist the farmers with these peak equipment loads is to establish custom operators with large-size equipment to augment the equipment which the farmers now have.

The people who become involved in this business should be owner-operators. That is to say, loans should be made to individuals who will devote full-time to the management of this specific business. It is essential that the owner not only manage but also be able to operate most, and preferably all, of the types of equipment used. To make the Custom Operator program work, in addition to the proper selection of the owner-operators, there must be:

- A complete order of equipment provided, including a pick-up and trailer.
- Equipment loans at a subsidized rate, or a direct use of the capital equipment funds. This must be a standard medium-term loan which doesn't require non-movable assets as collateral.
- A technical agricultural group, to approve the quality of work performed.
- A guarantee of payment to the operator. The recommended method is that the operator be paid by the bank from the farmer's production loan fund.

-Agreed-on prices for work performed which are high enough to cover total costs, including interest and depreciation plus an agreed-on profit. These prices should be agreed on with the credit organization.

3. A Supervised Production Credit Program should be initiated.

Supervised Production Credit programs are seriously needed as a supporting tool for irrigated agricultural development. Loans should be based on actual costs of production with the proper level of inputs. The loan should not include cost of living. If a cost-of-living loan is needed, a personal loan should be made to the farmer, with the collateral being something other than the crops.

In a Supervised Production Credit program, bank technicians visit the farm repeatedly to be of assistance, to confirm that the inputs are made to the crops and to go over the records for each crop. It is the responsibility of the farmer to keep accurate and detailed records of each operation on each crop. The responsibility of bank technicians is to see that the money resource is used effectively.

4. Land Leveling Capabilities should be developed.

Large areas in the Project area can be leveled for surface application of water with a minimum movement of soil, and thereby minimize irrigation costs. This should be started now by including a unit or two of land leveling equipment in the custom operator's equipment list. A training program is needed for the land leveling equipment operators and this can be done most easily by starting now.

5. A Tissue Testing Laboratory should be equipped and staffed and made available to farmers and for research work.

A Tissue Testing Laboratory is needed for the purpose of developing information on plant nutrition and optimum fertilizer levels. These results cannot be obtained from soil testing and the results from Project Adelante show that there is much to be learned about the kinds and amounts of fertilizers needed for maximum production.

Chapter 9 also includes specific recommendations as to changes believed necessary for successful extension of Project Adelante.

Chapter 1

INTRODUCTION

Final Report on
PROJECT ADELANTE, NICARAGUA 1968-70
A PROJECT FOR IRRIGATION DEVELOPMENT IN WESTERN NICARAGUA

Chapter 1
INTRODUCTION

1.0 BACKGROUND

1.01 - Previous Studies and Work on Irrigation Development in Nicaragua

For more than twenty years technical teams have encouraged irrigation in the Pacific Zone of Nicaragua. Early recommendations for investigation of irrigation possibilities were made in a 1950 report by the Food and Agriculture Organization of the United Nations (FAO) as a result of a visit by a technical team in 1949.

In 1952 a World Bank (International Bank for Reconstruction and Development --- IBRD) team included a similar recommendation as a part of their study of the overall economic situation in Nicaragua.

Between 1956 and 1964 an irrigation specialist provided by FAO worked with the Nicaraguan Government on irrigation development. This work was done with INFONAC (Institute de Fomento Nacional) an agency designated by the Nicaraguan Government in 1954 to make studies and implement irrigated agriculture and crop diversification.

In 1966 a reconnaissance was made by a development team at the request of the Agency for International Development (AID). The purpose was to review all the previous reports and recommendations and existing programs. AID, as part of their assistance to the Government of Nicaragua, asked for a report on:

1. The irrigation potential of the Pacific Zone of Nicaragua, and

2. The identification of Irrigation Projects.

These results were published in October, 1966, in a report entitled "A Program for Irrigation Development - Nicaragua".

After reviewing previous reports, and observing what was being done, two major programs were recommended in this report. The first was an on-farm demonstration project in irrigation, for which the name "Project Adelante" was suggested. The second program was an irrigation development project in the Rio Estero Real Basin. Action on this second project has been delayed until completion of the National Natural Resources Survey to avoid duplication of effort during the pre-feasibility and feasibility study stages.

At the time the study was made which resulted in the recommendation for Project Adelante, there were a number of irrigation projects already under consideration. In fact there were irrigation programs in existence. These were tied to specific crops--as in the case of bananas and tobacco--good programs carried out by INFONAC, but where the success of the program was based on the success of the crop -- and not, therefore, a real measure of overall irrigation potential.

In addition to existing programs of irrigation in bananas, tobacco and rice, there were a number of irrigation projects under consideration. These included the Rivas Project, the Eastern Shore of Lake Nicaragua, the Tuma-Viejo River Project, the Tipitapa-Tisma Project, and projects in the Rio Malacatoya, Rio Esteli, Rio Gil Gonzales, Rio Ochomogo and Rio Manareas areas.

There was no conflict between Project Adelante and these other projects, in fact, to the contrary, as indicated in the report, ---"Project Adelante was designed with the recognition that other irrigation projects would be started which could draw on the experience and information resulting from these on-farm demonstrations. This Project would provide a focal point of coordination of farmers and the Government institutions leading to early development of widespread irrigation."

Project Adelante was designated an irrigation demonstration project, but broader purposes were to be incorporated. The demonstration of irrigation would allow the evaluation, both productively and economically, of new crops as well as traditional crops. Additionally it would provide opportunities to work-out planting schedules and cropping patterns for the year-around use of land, water, management and equipment.

1.02 - Importance of Cotton in Pacific Zone

The Pacific Zone is almost completely a single crop cotton culture, and the heartland of this outstanding cotton production is in the Leon-Chinandega complex. In the mid-50's Nicaragua had taken major steps into mechanized cotton production. Large numbers of needed tractors and the equipment were brought into the country for cotton production. The cotton zone reflected an advanced production system involving mechanization, insect control, weed control and fertilization. This was a major step away from standard traditional agriculture. It was apparent that after a period of time even the cotton production methods, advanced as they were, were becoming traditional. The entire system of production was far ahead of that used for corn, sesame and other existing crops, but by the mid-60's very few, if any, innovations had been developed locally for the production of cotton. The same standard practices that had been adopted initially were being duplicated as cotton plantings expanded even beyond the outstanding soils into the less-adapted soils.

The economic situation in the early 60's was sound. Cotton yields under these soil and climatic conditions were very good; so good that the addition of irrigation systems for supplemental moisture would not bring in sufficient increased yield to justify the expense. But it was apparent that the economy was linked to a single crop, and that no alternatives were available to these growers should anything happen to cotton. There was need for crops that could be used in place of cotton, should the economics of that crop change.

On the borders of the good cotton land, and even on fingers moving into the good cotton, there were lands, soils and conditions not as well-suited to cotton. Since it would be impossible to justify the capital costs of supplemental irrigation on cotton, the immediate need in these cases was for alternative crops for a year-around cropping program, with irrigation.

The day-length between winter and summer does not vary too much at this latitude, so crop selection and cropping programs would be based to a large extent on how the crops fit the dry season and the rainy season. Between May 15 and

November 15 rain can be expected almost every day. During a period in July and August there is a reduction of rains, called The Canícula, which is typical of the Caribbean area, but which is no more dependable than the daily rains are dependable. There can be long dry periods during the rainy season, and the Canícula can experience heavy rainfall. It must be expected that between May and November heavy rains can occur every day. Between November 15 and May 15, there normally is no effective rain. There can be exceptions to this, with some short rains during this period. Normally there is less possibility, by far, of rain during the dry season, than there is of dry periods during the rainy season.

In considering selection of crops as alternatives to cotton, it becomes clear that few have the advantage that cotton has, in being attuned to the natural pattern of rain and dry conditions. The cotton crop is grown during the rainy season and matures as the rainy season declines. There is then an opportunity to pick the cotton, and get it to the gin for processing under completely dry conditions. The cotton crop then, uses up almost the entire year. There are other crops which can be grown during the rainy season, but some mature during the rains, or are short season crops which leaves the land out of production for long periods of the year.

1.03 - Problems of Other Crops Without Irrigation

Therefore, the substitution of alternative crops which would use the soil and other resources most effectively requires that many of them be grown during the dry season, under irrigation. It has been demonstrated in the past that in the better soils of the area, no non-irrigated year-around crops or perennials could compete with cotton. The Chinandega area had been the center of the citrus industry in Nicaragua, but was driven out by cotton. This may be true without irrigation, because the long dry season is not conducive to efficient tree or fruit growth. However, with irrigation citrus is a far more intensive, better income crop, than any annual, even cotton. Crops such as yuca, which require a 12-month growing season, must survive through the dry season. As a result, yuca, like cattle, or citrus, will express a decline in growth during droughts, in fact make use of part of the reserves they have built up when water conditions were more favorable. For this reason it takes longer to get a crop under these conditions; often three to five years to get a steer to market, ...much longer than necessary to get a citrus tree into production, and far lower yields of yuca during a 12-month period; all due to dry season decline.

Corn and sesame have been extremely important crops in terms of the acreage they cover in the Pacific Zone of Nicaragua. Prior to the major diversion to cotton in the 50's, sesame and corn had been important crops in acreage in that area. Both sesame and corn, however, are grown under fairly primitive conditions. The reason for corn's inability to intensify may have been due largely to unadapted varieties. Even now corn varieties have not been developed which produce as effectively in tropical climates as the improved corn varieties do in temperate zones.

Sesame, while an important crop, and a highly desirable edible oil-producing product, continues to suffer from the inability to mechanize the harvest. Sesame must be harvested by hand because of shattering that occurs if the crop is allowed to mature completely.

1.04 - Other Conditions and Problems

An inventory of the resources indicated that there were large expanses of extremely good soil, and more than sufficient high quality ground water for initial development of irrigation. Work was going on by other groups, to determine the extent of the underground reservoirs.

The area had been well opened up by roads. The primary roads throughout the entire Pacific Zone were, and are, extremely good. The secondary roads were more than adequate. Power development had proceeded to quite a degree, particularly in light of the fact that there was very little hydro power available in the country. Plans for additional expansion of the power facilities were going on, and programs were being carried out. The country, because of its experience in both sugar production and coffee production, was not inexperienced in world marketing. So there was no serious limitation caused by an internal, totally provincial, type of economy.

There was a serious limitation in terms of the developing of an irrigated economy---an almost complete lack of experience in water handling. The culture did not include an appreciation of water application nor of the intensive improved practices that are required with irrigated farming in order to justify the expense. There were no trained land levelers in the country; neither engineers nor equipment operators, and there was no equipment in the country for land leveling. It was for these reasons that the portable sprinkler method of irrigation was used in the initial irrigation program.

As outlined previously, there was a need for alternative crops in the area. Cotton growers would need alternative crops, should the income continue to decline, and alternative crops were required for those lands which were not adapted for efficient cotton production. This meant that crops were going to be needed, not for a few small intensive patches, but for widespread acreages. While it would be effective to grow vegetable crops in small intensive garden patches to meet the needs of the local markets of the larger cities, this would not solve the major land problem. These markets were unable to absorb any major acreages of adapted vegetables, such as tomatoes or melons. Crops were needed which could be grown in large blocks, as cotton was being grown. Industrial type crops that could take the place of cotton had to be identified. Additional factors affecting crop selection needed to be considered. There were periods during the dry season of fairly constant, and moderate winds. There were birds that affect some maturing crops during the dry season. In some cases these were migrating birds, whose migratory pattern had to be taken into consideration, but there were also local birds, such as parakeets.

It has already been pointed out that although one governmental organization in the country (INFONAC) had been designated for identification of the irrigation potential and the establishment of irrigation projects, the responsibility for irrigation was not centered in any single organization. There were fragments of irrigation programs spread throughout the governmental organizations. There had been more development of wells and skills in well drilling and water development, both by governmental agencies and by private commercial firms, than there were skills for the use and application of this water after development.

1.1 GENERAL DESCRIPTION OF PROJECT

1.10 - General

As a technical and operational arm of the Ministry of Agriculture and Livestock (MAG), Project Adelante was designed to demonstrate the benefits of improved and diversified cropping systems under irrigation. Furthermore, Project Adelante was intended to assist in establishing a new division for soil and water utilization and conservation within MAG. In addition to the practical on-farm program with new crops and improved practices in irrigation, Project technicians were to assist in the development and strengthening of this new division, and the training of its members.

Project Adelante was initiated in February of 1968. The program was established by the Agency for International Development in an agreement with the Minister of Agriculture and Livestock. Project headquarters were established in Leon, the second largest city in Nicaragua, located approximately 60 miles northwest of Managua. The program was designed to develop technical and economic data under farmer conditions to stimulate the more widespread and profitable use of irrigation. The entire concept of Project Adelante was to initiate irrigation on the farms; to remove the long delays in research and experimentation, and to begin the process of acceptance by farmers; to identify the physical, economic and human factors which could be obstacles to widespread use of irrigation throughout the Pacific Zone.

1.11 - Staff

Contract agricultural technicians, an irrigationist and an agronomist, were located in Leon. These two people were backed up by other United States' specialists, including an ag-economist. The Minister of Agriculture provided the Nicaraguan technicians and a staff of two bilingual secretaries, and a field assistant. The Minister provided the technicians for the program from his existing staff. These included at the outset, an engineer to work with the irrigationist and to provide the Nicaraguan supervision, and an agronomist to work with the agriculturist. Later, a technician trained in Economics was added to the staff to work with the Project Ag-Economics consultant. The demonstration farms were to be located within a fairly short radius of the Leon-Chinandega area in order to provide proper management. In the future, additional demonstration programs could be established in the Sebaco and Somotillo areas as well as the Tisma and Ochomogo zones lying to the south.

1.12 - Irrigation Systems

The Project team started immediately to identify the areas in which Project work would be carried out, to locate cooperators, and to get the wells drilled so that irrigation programs could be initiated. The Project plans took into consideration the lack of experience and skills in irrigation by both management and labor. It was recognized that surface irrigation would be important in the area, and it was hoped that some demonstration sites could be developed for surface irrigation. Surface irrigation would have some advantages in the future because of wind during the dry season, and because of the reduced cost of pumping. But there would be long delays in getting land properly leveled and in getting people trained to handle water under surface methods. Under these conditions, portable sprinkler systems provide important advantages.

Orders were placed through AID and it was possible through the cooperation of a United States sprinkler company, W. R. Ames Co., to purchase six systems, five using sprinklers, and one gated pipe, for the money allocated the program. Each of these systems was to irrigate approximately 20 manzanas of land, (about 35 acres). Orders for this equipment were placed as early as possible so that the equipment would be on hand by the time the wells had been drilled, developed, and the pumps installed.

The sprinkler systems were to become the property of the cooperators under the terms of an agreement between the cooperators and MAG. This agreement provided that for each year that the cooperator continued to carry out his portion of the program in a satisfactory fashion, he would be acquiring an ownership interest in the equipment. At the end of five years of satisfactory cooperation he would own the system. In addition to this incentive to the cooperator, the Project provided that there would be assistance in the acquisition of credit, both for the wells and pumps, and for production credit through the agencies within Nicaragua. A sum of 40,000 cordobas was supplied to pay for the installation of power lines to the pumps by the

National Electrical Organization, ENALUF, as an additional government incentive. The assistance to the farmers by the Project technicians was a substantial incentive. The cooperators were required to finance their well and pump, provide all the equipment and meet the higher costs of production which go with irrigated crops. However during the course of the program the Project made a number of specific contributions to assist the cooperators. These were in the form of imported seeds, some of the insecticides, and even the payment of certain labor costs and equipment operations.

1.13 - Cooperators

Intensive searching for potential cooperators was done in the area. Locations were examined in the back country, northeast of the chain of volcanos, between Villa Salvadorita and San Jacinto, and in the slopes between Telica and Malpaisillo. Since the underground water resources of the area had never been mapped, it was vital that the selected sites be in areas where previous experience indicated a strong likelihood of ample underground water. Sites otherwise quite satisfactory often had to be discarded because of insufficient information of underground water, or because, as in the case of sites along the west slope of volcanos north and northeast of Chinandega, previous well drillers had hit rock without locating water. In addition, the source of power for the pumping of water had to be considered. Wherever possible it would be advantageous to locate near electrical power. And for the benefit of viewers, it would be advantageous to be located in areas near well traveled roads where the greatest number of people could see the result.

The criteria for site selection stipulated that in addition to these points the sites should be on soils which are representative of a large area. It was essential that the owner be a person with the proper attitude and ability to accomplish the purposes, that he had a clear title to the land, and reliable credit rating, and own the necessary equipment.

It became clear that areas suitable for the Project were still being planted to cotton. Since farmers weren't going to destroy a cotton stand to change to irrigated crops, new programs had to wait until after harvest, which was as late as February. If wells weren't established and ready to go, cotton would be replanted by June or July. Therefore cotton dates, as well as water supply construction, had a major effect on the Project timetable.

All in all, more than 90 potential locations were examined. Most of these are shown on Figure 1-1 on the following page. Project Adelante started in February of 1968, and the first sites were selected, and work started on two wells on July 18th. On June 11, 1968 there was an official signup of the first five cooperators, all of whom agreed to devote 20 to 30 manzanas of land to Project purposes. This included associate cooperators, as well as the primary cooperators for whom irrigation systems were designated.

Five primary cooperators were signed up that day. One of these, Mr. Gilberto Quintanilla, was cancelled as a cooperator due to his inability to reach an agreement with Banco Nacional on credit for the well and pump. The negotiations which ultimately led to the cancellation of this cooperator took a considerable period of time, during which time the well was drilled and the pump installed. It was not until July 31, 1969 that it was conclusively determined that Mr. Quintanilla would not be a part of the program. In anticipation of this conclusion and because a sixth cooperator was needed, Ramiro Escobar at site 86 was accepted as a cooperator on April 30, 1969 and his well drilling started on June 12th.

The other original cooperators were Ramon Pineda F., Oscar Galo, Julio Fonseca and Roberto Vaca S. Wells were required on two of these sites; Galo and

PROYECTO ADELANTE

MINISTERIO DE AGRICULTURA Y GANADERIA EN

COOPERACION CON U.S.A.I.D.

UNICONSULT INC.

COOPERATOR SITE LOCATION MAP
LOCALIZACION DE SITIOS DE COOPERADORES

LEGEND	**LEYENDA**
●-- FULL COOPERATOR	● – COOPERADOR PLENO
◓ – ASSOCIATE COOPERATOR	◓ – COOPERADOR ASOCIADO
(No.) – SITES CONSIDERED	(No.) – SITIOS CONSIDERADOS

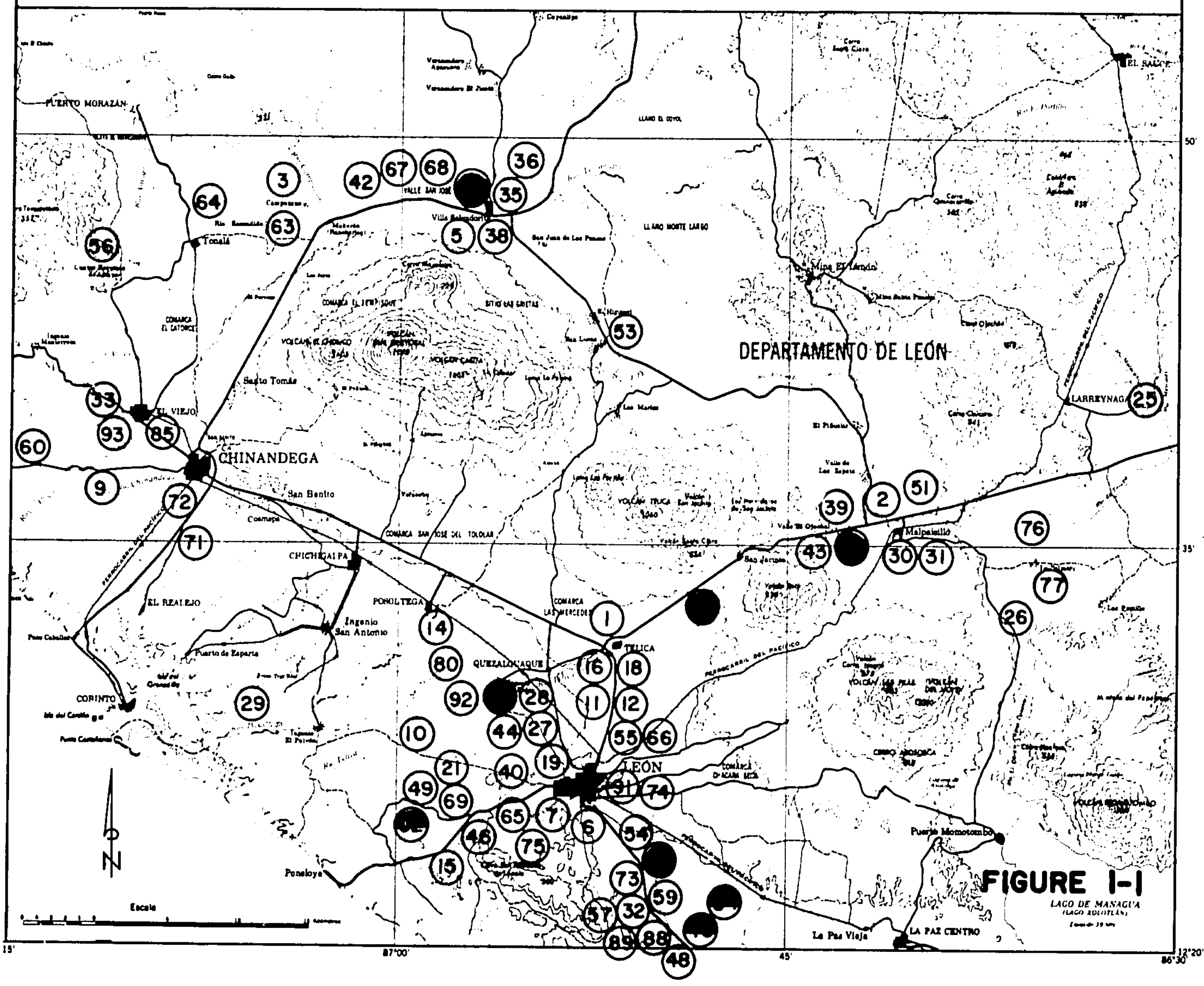


FIGURE I-I

Pineda's. There was an existing well at Fonseca's and a spring for a water supply to Vaca's. Each of these required a pump which needed to be ordered and installed.

The timetable of dates of signup, available water and first crop is as follows:

Site No.	Name	Signup Date	Irrig. Water Available	1st Irrig. Crop Planted
4	Roberto Vaca S.	June 11, 1968	May 29, 1969	Aug. 26, 1969
8	Ramon Pineda F.	June 11, 1968	Feb. 13,1969	Feb. 27, 1969
13	Oscar Galo	June 11, 1968	Aug. 1, 1969	Aug. 21, 1969
50	Julio Fonseca	June 11, 1968	Mar.23, 1969	Apr. 4, 1969
86	Ramiro Escobar	April 30, 1969	Jan. 9, 1970	*Aug. 20, 1969

*Crops were planted prior to available irrigation water.

From the preceding dates it is possible to segregate program activities for the two year period of Project Adelante. The first year was required to select sites and develop water, and this continued to August of the second year before crops were started on all cooperator farms. During this first year, crop investigations were carried out on associate cooperators' sites, primarily at the La Leona and Penjamo farms.

Only two full-cooperators completed all water development and financing arrangements in time to plant irrigated crops late in the 1968-69 dry season. Nevertheless,valuable experience and data were obtained for several irrigated crops. Additional experience and data were obtained from similar work on farms of partial-cooperators.

1.14 - New Crops Studied

New crops were introduced to the area, under irrigation, to give farmers a broad selection of potentially-adapted crops:

Dwarf Castors: Offers farmers an irrigated industrial crop that can be hand- or machine-harvested.

Irrigated Peanuts: Makes it possible to grow and harvest this crop during the dry season without the risk of rain damage.

Millet: Offers advantage of a fast growing crop for seed or forage with low management requirements.

Safflower: An industrial crop which provides a high quality vegetable oil, suitable for widespread planting.

Irrigated Yuca and Quequisque: A new concept for the area to produce high yields in a minimum of time without the problem of drought. Also makes these crops readily available for the market at all times of the year.

High yielding, open-pollinated variety of grain sorghum (Meloland) and castors (Lynn) gives farmers a source of less-costly planting seed than imported hybrid seed.

Vegetable crops: Cucumbers, okra, sweet corn and cowpeas were grown successfully with irrigation and have high potential for local use and/or export markets.

Identification was made of changes in crop growth and maturation characteristics under Nicaraguan climatic conditions, from characteristics normally associated with several of the crops tested. This information is of prime importance in the planning of practical cropping programs for Nicaragua.

1.15 - Use of Improved Cultural Methods

During the 2-year period, project operations permitted introduction and preliminary evaluation of several improved cultural methods, as noted by the following:

-demonstrated that use of a rotary tiller for seedbed preparation for irrigated crops greatly reduces the time for this operation compared to the use of a plow and a disk and eliminates four or more conventional operations,

-used 4-row tractor equipment to make furrows and to cover hand-planted crops of yuca and quequisque,

-demonstrated the use of bedshaping equipment after furrowing-out as an important practice for non-irrigated and irrigated crops. Built and demonstrated a wooden float for preplant smoothing,

-made use of fertilizer attachment on 4-row planters to apply soil insecticide in a narrow band over seed row, thus reducing cost and improving insect control,

-demonstrated advantage of a spike-tooth harrow as proper equipment for final seedbed preparation, and its use for effective weed control when crop plants are too small for cultivating.

-had local certified corn seed graded to uniform seed size to show that this crop can be easily planted with precision, thus eliminating the need for thinning or hand-seeding to obtain desired plant population,

-have discouraged standard practice in the area of applying a potash fertilizer on fields not deficient (most fields in area are high in potash),

-demonstrated the importance of ground spray rigs and the proper nozzle size during the windy period of the dry season.

1.16 - Initial Markets Found

While marketing was not funded as a principal project responsibility, assistance to cooperator was provided in several instances, as represented by the following:

-Peanuts sold to an oilseed processor and a confectioner.

-Oilseed processors gave some assurance that they would buy safflower and castors.

-Irrigated yuca and quequisque were planted at a time so that the harvest would occur when the supply is low and the market is high.

-A feed grain mill indicated that it would buy millet if its feed value equals that of sorghum. An analysis of the millet seed confirmed that it is equal to sorghum.

- Okra seed was harvested and sold to a farmer interested in growing a field of okra.

- Irrigated cucumbers were all sold in the local market.

1.17 - Farm Management Training

Farm management training, "on-the-job", was given where possible to the farm owner, his mandador, and farm workers, including these important aspects:

- Operation of irrigation equipment, and proper irrigation practices.

- Timing of crops for best markets, prevention of bird damage, avoiding harvest during raining periods, etc.

- Keeping good farm records for economic analysis.

- Locating markets.

- Scheduling of farm operations with irrigated crops.

- Training in proper adjustment of equipment.

- Demonstration of efficient use and operation of equipment.

- Techniques for evaluating varieties and cultural practices using regular farm equipment.

- On-the-farm methods of determining soil moisture and estimating water requirements.

- Training in determining need for insect and disease control.

- Determination of proper time for harvest and system for minimizing seed damage and loss.

1.18 - Other Project Activities

Detailed soil maps were completed on 14 sites. This information was correlated with the national cadastral soil series.

Boundary and topographic maps were made for all cooperator sites. In almost all cases the lack of suitable maps required that Project personnel devote considerable time to the preparation of boundary and topographic maps. These were needed to properly design the irrigation system, and to provide base maps for planning cropping programs.

The Project provided the guidance, design and helped with credit arrangements for the drilling of four wells, purchase of pumps and the grant of USAID sprinkler equipment. In addition to four sprinkler systems, there is one surface system (gated pipe) with a diesel pump and a spring water source.

Water quality analyses were made on a total of 12 sites through the cooperation of the Servicio Geológico. Project personnel provided the interpretation of these analyses.

Soil infiltration studies were made on a total of 10 sites and the information interpreted and included in this report.

Agricultural economics studies were carried out for all crops grown and for proposed crops.

Many farmers, technicians, agricultural firms, bankers and others in the area were given technical and management advice at their request, on crop varieties, cultural practices, irrigation, surveying, farm equipment, and agricultural engineering.

A total of 26 monthly reports were prepared and distributed, thus accounting for every single monthly period since the Project's inception. The reports contain specific progress information plus timely articles ranging from yields to water use data. One section features the theme-of-the-month in picture form, and thus augments the narrative part of the report. These reports were circulated within Nicaragua to several interested agencies.

Detailed recommendations were presented for the establishment of a -

A) Department of Irrigation and Soil Conservation within MAG

B) National Advisory Committee on Irrigation and Soil Conservation

C) National Water Rights Commission

Action to implement these recommendations was initiated by MAG in 1968.

1.19 - Field Day

On Field Day, May 8, 1969, the President of the Republic, Gen. Anastasio Somoza Debayle, accompanied by his staff and the American Ambassador and his staff, visited the cooperator farm "San Antonio" and witnessed the irrigation of numerous crops (sorghum, castor, peanuts, yuca, quequisque and okra, as well as other vegetables). About 300 other guests were enthusiastic in their response to a lively discussion about irrigation problems and potential during the midday discussion period.

1.2 GENERAL INFORMATION ON NICARAGUA

1.21 - Location and Description

Nicaragua is the largest of the Central American republics, with a total area of approximately 149,000 square kilometers (57,600 square miles). Located in the tropics between latitudes 11° and 15° north, and between 83° and 85° west longitude (See Plate I), it actually has four major climatic regions (Figure 1-2), ranging from the tropical, humid Caribbean area on the east coast, to the tropical dry region of the Pacific Zone where Project Adelante was initiated.

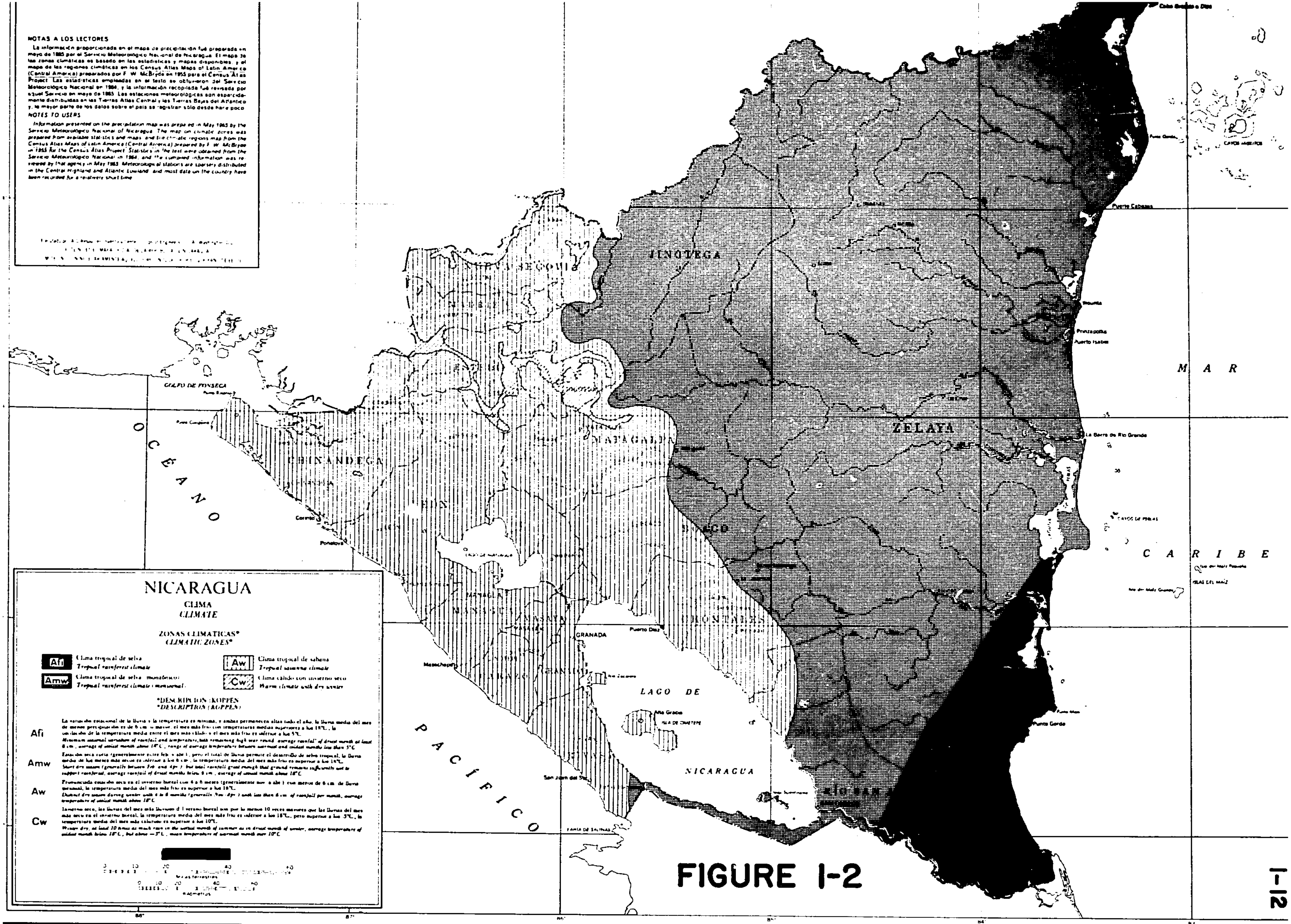
Elevations range from sea level to 2,107 meters above sea level near the Honduras-Nicaragua border (Plate I). The country is divisible into four geologic provinces: the Pacific Coast Plain, the Nicaraguan Depression, the Interior Highlands, and the Atlantic Coastal Plain. Precipitation varies from highs of 6000 millimeters per year (240 in/yr) on the Southeast Atlantic Coast, to as low as 500 mm/yr (20 in/yr) at points in the interior highlands (Fig. 1-3). In the Leon-

NOTAS A LOS LECTORES

La información proporcionada en el mapa de precipitación fué preparada en mayo de 1965 por el Servicio Meteorológico Nacional de Nicaragua. El mapa de las zonas climáticas es basado en las estadísticas y mapas disponibles, y el mapa de las regiones climáticas en los Census Atlas Maps of Latin America (Central America) preparados por F. W. McBryde en 1955 para el Census Atlas Project. Las estadísticas empleadas en el texto se obtuvieron del Servicio Meteorológico Nacional en 1964, y la información recopilada fué revisada por aquel Servicio en mayo de 1965. Las estaciones meteorológicas son esparcidamente distribuidas en las Tierras Altas Central y las Tierras Bajas del Atlántico y, la mayor parte de los datos sobre el país se registran sólo desde hace poco.

NOTES TO USERS

Information presented on the precipitation map was prepared in May 1965 by the Servicio Meteorológico Nacional of Nicaragua. The map on climatic zones was prepared from available statistics and maps, and the climatic regions map from the Census Atlas Maps of Latin America (Central America) prepared by F. W. McBryde in 1955 for the Census Atlas Project. Statistics in the text were obtained from the Servicio Meteorológico Nacional in 1964, and the compiled information was reviewed by that agency in May 1965. Meteorological stations are sparsely distributed in the Central Highland and Atlantic Lowland and most data on the country have been recorded for a relatively short time.



NICARAGUA

CLIMA
CLIMATE

ZONAS CLIMATICAS*
*CLIMATIC ZONES**

Afi	Clima tropical de selva *Tropical rainforest climate*	**Aw**	Clima tropical de sabana *Tropical savanna climate*
Amw	Clima tropical de selva (monzónico) *Tropical rainforest climate (monsoonal)*	**Cw**	Clima cálido con invierno seco *Warm climate with dry winter*

*DESCRIPCION (KOPPEN)
**DESCRIPTION (KOPPEN)*

Afi	La variación estacional de la lluvia y la temperatura es mínima, y ambas permanecen altas todo el año; la lluvia media del mes de menos precipitación es de 6 cm. o mayor; el mes más frío con temperaturas medias superiores a los 18°C.; la oscilación de la temperatura media entre el mes más cálido y el mes más frío es inferior a los 5°C. *Minimum seasonal variation of rainfall and temperature, both remaining high year round; average rainfall of driest month at least 6 cm.; average of coldest month above 18°C.; range of average temperature between warmest and coldest months less than 5°C.*
Amw	Estación seca corta (generalmente entre feb. y abr.), pero el total de lluvia permite el desarrollo de selva tropical; la lluvia media de los meses más secos es inferior a los 6 cm.; la temperatura media del mes más frío es superior a los 18°C. *Short dry season (generally between Feb. and Apr.) but total rainfall great enough that ground remains sufficiently wet to support rainforest; average rainfall of driest months below 6 cm.; average of coldest month above 18°C.*
Aw	Pronunciada estación seca en el invierno boreal con 4 a 6 meses (generalmente nov. a abr.) con menos de 6 cm. de lluvia mensual; la temperatura media del mes más frío es superior a los 18°C. *Distinct dry season during winter with 4 to 6 months (generally Nov.-Apr.) with less than 6 cm. of rainfall per month; average temperature of coldest month above 18°C.*
Cw	Invierno seco; las lluvias del mes más lluvioso del verano boreal son por lo menos 10 veces mayores que las lluvias del mes más seco en el invierno boreal; la temperatura media del mes más frío es inferior a los 18°C., pero superior a los -3°C.; la temperatura media del mes más caluroso es superior a los 10°C. *Winter dry, at least 10 times as much rain in the wettest month of summer as in driest month of winter; average temperature of coldest month below 18°C., but above -3°C.; mean temperature of warmest month over 10°C.*

[redacted]

0 10 20 40 60
Millas terrestres
0 10 20 40 60
Kilómetros

FIGURE 1-2

NOTAS A LOS LECTORES

La información proporcionada en el mapa de precipitación fué preparada en mayo de 1985 por el Servicio Meteorológico Nacional de Nicaragua. El mapa de las zonas climáticas es basado en las estadísticas y mapas disponibles, y el mapa de las regiones climáticas en los Census Atlas Maps of Latin America (Central America) preparados por F. W. McBryde en 1956 para el Census Atlas Project. Las estadísticas empleadas en el texto se obtuvieron del Servicio Meteorológico Nacional en 1984, y la información recopilada fué revisada por aquel Servicio en mayo de 1985. Las estaciones meteorológicas son esparcidamente distribuidas en las Tierras Altas Central y las Tierras Bajas del Atlántico y, la mayor parte de los datos sobre el país se registran sólo desde hace poco.

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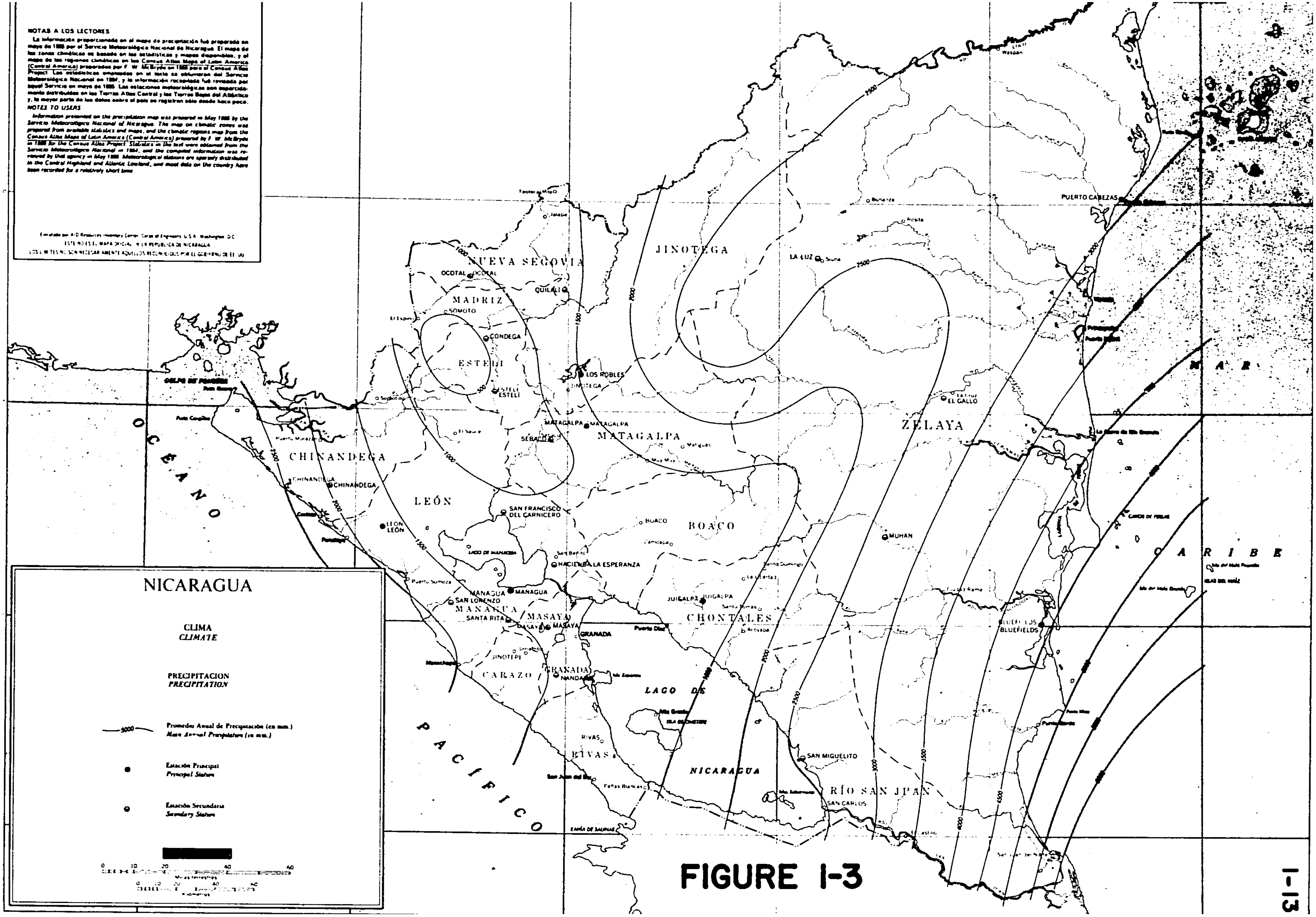
Compilado por AID Resources Inventory Center, Corps of Engineers, U.S.A., Washington, D.C.
ESTE NO ES EL MAPA OFICIAL DE LA REPUBLICA DE NICARAGUA
LOS LIMITES NO SON NECESARIAMENTE AQUELLOS RECONOCIDOS POR EL GOBIERNO DE EE. UU.



NICARAGUA

CLIMA
CLIMATE

PRECIPITACION
PRECIPITATION

—5000— Promedio Anual de Precipitación (en mm.)
Mean Annual Precipitation (in mm.)

● Estación Principal
Principal Station

○ Estación Secundaria
Secondary Station

[redacted]

0 10 20 40 60
Millas terrestres
0 10 20 40 60
Kilómetros

FIGURE 1-3

Chinandega area of Project Adelante, less than one (1) percent of the total annual precipitation of about 1500 mm/yr (60 in/yr) falls during the 5-month period, December through April, each year.

For many statistical reporting purposes three geographic zones are used:

Pacific: Departments of Chinandega, Leon, Managua, Granada, Carazo, Masaya, and Rivas.

Interior: Departments of Boaco, Chontales, Esteli, Jinotega, Madrid, Matagalpa, Nueva Segovia.

Atlantic: Departments of Zelaya & Rio San Juan. (This area sometimes is referred to as "The Mosquito Coast.")

The chain of more than twenty volcancoes on the Pacific Ocean side, some still sporadically active, and the two large fresh-water bodies, Lakes Managua and Nicaragua, give the country a unique combination of dominant physical features. Lake Nicaragua has an area of 8,300 sq. km. (3,200 sq.mi.), and is the same size as Lake Titicaca, largest of the South American lakes. It is about twice the size of Great Salt Lake, Utah.

1.22 - Population

Total population of Nicaragua in 1969 was estimated at about 1,900,000 persons. The annual rate of population increase recently has been around three (3) percent.

Figure 1-4, based on the 1963 population of 1,540,000 persons, indicates the distribution of rural and urban population. In 1963 about 59 percent of the population lived in rural areas, and about 41 percent in urban areas. As in most places around the world, the percentage of urban dwellers continues to increase.

Table 1-1 lists 1964 population estimates by the Bureau of Statistics for larger Nicaraguan cities.

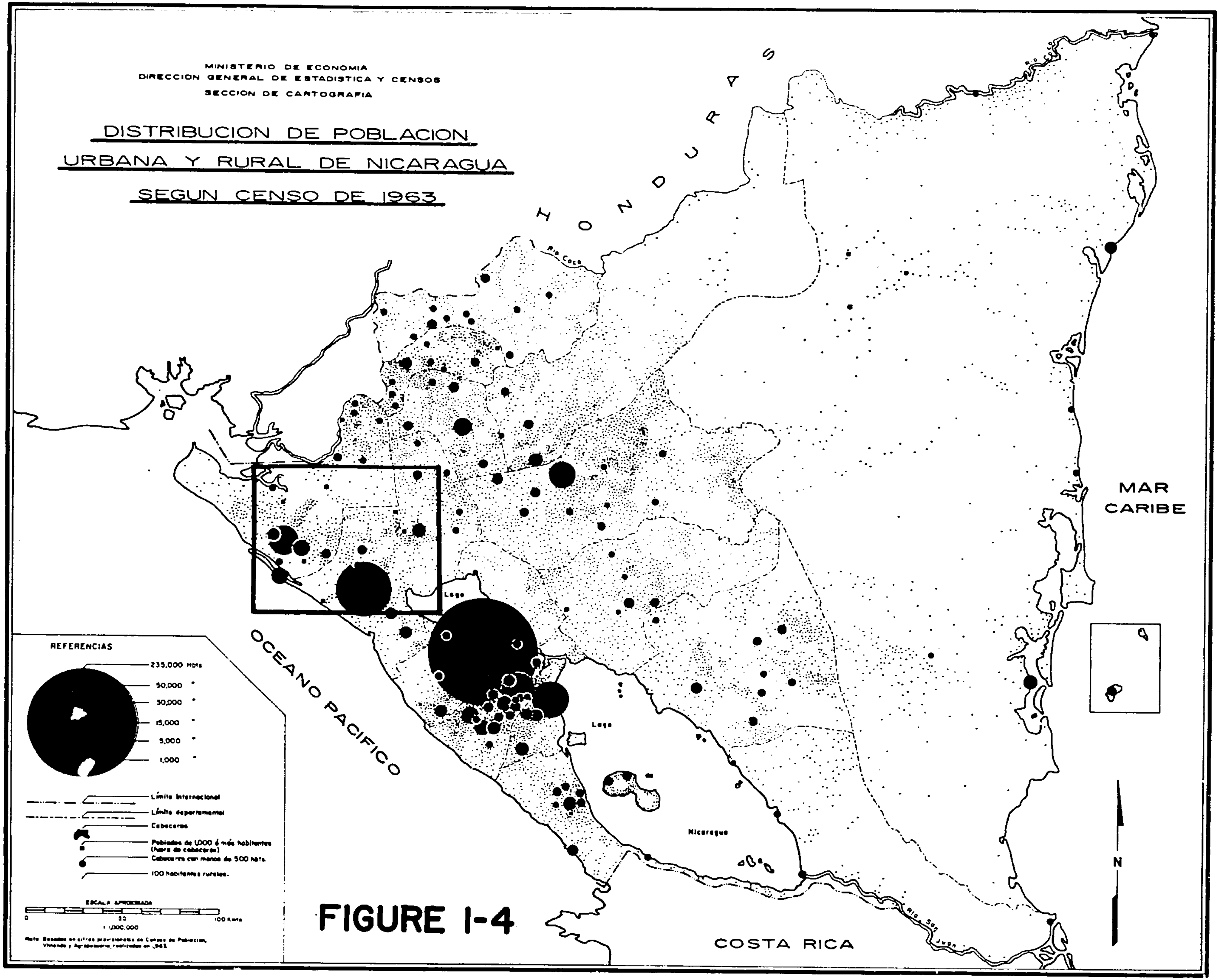
Table 1-1

POPULATION OF LARGER CITIES

1964

Managua	255,462	Esteli	13,751
Leon	49,435	Diriamba	11,777
Granada	31,014	Bluefields	10,422
Masaya	25,507	Prinzapolka	8,019
Chinandega	24,633	Puerto Cabezas	6,372
Matagalpa	16,634		

Source: Bureau of Statistics 1964



MINISTERIO DE ECONOMIA
DIRECCION GENERAL DE ESTADISTICA Y CENSOS
SECCION DE CARTOGRAFIA
DISTRIBUCION DE POBLACION
URBANA Y RURAL DE NICARAGUA
SEGUN CENSO DE 1963
HONDURAS
Rio Coco
MAR CARIBE
OCEANO PACIFICO
Lago
Lago de Nicaragua
Rio San Juan
COSTA RICA
N
REFERENCIAS
235,000 Hbts
50,000 "
30,000 "
15,000 "
5,000 "
1,000 "
Límite Internacional
Límite departamental
Cabeceras
Poblados de 1,000 ó más habitantes (fuera de cabeceras)
Cabeceras con menos de 500 hbts.
100 habitantes rurales.
ESCALA APROXIMADA
0
50
100 Kms
1:1,000,000
Nota: Basados en cifras provisionales de Censos de Población, Vivienda y Agropecuario, realizados en 1963

FIGURE I-4

1.23 - Economy

1.231 - General

Although agriculture is the largest sector of the Nicaraguan economy, manufacturing and industry have been increasing, especially during the last few years. In 1968, the latest year for which official Central Bank figures were available at the time of the writing of this report, the Agricultural Sector constituted 21.3 percent of the Gross Domestic Product (GDP), while Manufacturing and Industry contributed 15.1 percent.

However, approximately 50 percent of industrial production, such as sugar, soluble coffee, and fresh meat, is based on the processing of agricultural products. Agricultural products, raw and processed, accounted for about 80 percent of Nicaraguan exports in 1968, chief among which were cotton, coffee, and beef. Cotton alone accounted for 37 percent of the total value of exports in that year. As much as 60 percent of those employed work directly in agricultural production or in associated agricultural industries.

Tables 1-2 and 1-3 summarize data on some of the Key Economic Indicators for Nicaragua.

1.232 - Distribution of Activities

Managua is the national capital and commercial and manufacturing center of the country. Historically the country developed primarily around the settlements in the Pacific Zone, and about 60 percent of the people live there now. This area has large areas of rich volcanic soils which are farmed extensively. The east coast is rich in timberlands, as well as in fishing and mining resources, but because of the heavy forests and high rainfall, this area has not been developed or well-populated. Plans have been made to increase east coast development.

Figure 1-5 gives a general indication of the location and distribution of economic activities in Nicaragua.

1.233 - Influence of Cotton

During the last decade cotton production has had a strong influence on the overall Nicaraguan economy. Cotton exports reached an all-time high in 1965 of $66,131,900 representing 44.4 percent of all exports. In 1968 cotton exports decreased in value to $59,675,400, with the greatest portion of the decrease resulting from lower prices. Production, however, decreased by about 20 percent, but export volume was essentially maintained by sale of carryover stocks. Export volume has been decreasing each year since 1965. Another 25 percent reduction in crop production is estimated to have occurred in 1969. The decrease in export value in 1969 and 1970 may be as much as $12,000,000 each year.

Some of the loss in export value due to falling cotton prices and decreased production has been, and possibly will continue to be, offset by increased export earnings from beef, coffee, and seafood, but the problems of the cotton industry have adversely affected the total economy.

1.234 - Other Industrial Activities

Table 1-4 gives the total value of production by principal industrial categories. Table 1-5 gives units of production for several major items. Manufacturing of new products such as chemicals, paper, petroleum, and metal products, and electrical appliances, is growing more rapidly than that of traditional items, although the latter still represents 75 percent of industrial production.

TABLE 1-2

GROSS DOMESTIC AND NATIONAL PRODUCT AND PER CAPITA PRODUCTION
NICARAGUA 1965-1968

U.S.$1.00 = 7 cordobas

Item	Millions of U.S.$				Percent			
	1965	1966	1967	1968	1965	1966	1967	1968
GROSS DOMESTIC PRODUCT (GDP) (1958 Prices)	559.0	576.1	606.6	636.9	100.0	100.0	100.0	100.0
1) Primary Activities	182.5	169.1	176.5	182.1	32.7	29.4	29.1	28.6
Agriculture	149.5	129.6	133.5	135.7	26.8	22.5	22.0	21.3
Livestock & Poultry	28.9	34.7	37.5	40.4	5.2	6.0	6.2	6.4
Forestry	2.2	2.4	2.5	2.7	0.4	0.4	0.4	0.4
Fishing	1.9	2.4	3.0	3.3	0.3	0.5	0.5	0.5
2) Secondary Activities	97.4	112.3	113.9	123.1	17.4	19.5	18.8	19.3
Manufacturing Industry	71.4	80.5	86.1	95.9	12.8	14.0	14.2	15.1
Construction	18.1	23.2	19.8	20.3	3.2	4.0	3.3	3.2
Mining	7.9	8.6	8.0	6.9	1.4	1.5	1.3	1.0
3) Tertiary Activities	279.1	294.7	316.2	331.7	49.9	51.1	52.1	52.1
Commerce	111.2	115.0	120.2	123.5	19.9	19.9	19.8	19.4
Government	40.5	45.3	53.7	59.3	7.2	7.9	8.9	9.3
Transport & Communications	28.2	29.2	30.6	31.4	5.1	5.1	5.0	4.9
Banking	11.9	14.0	14.8	15.2	2.1	2.4	2.5	2.4
Electricity & Water	10.1	11.4	14.0	17.0	1.8	2.0	2.3	2.7
Housing	39.2	40.5	42.0	43.3	7.0	7.0	6.9	6.8
Other Services	38.0	39.3	40.9	42.0	6.8	6.8	6.7	6.6
POPULATION, millions	1.655	1.715	1.777	1.842				
GDP (1958) per Capita Dollars	$ 338	$ 336	$ 341	$ 346				
GROSS NATIONAL PRODUCT (Current Prices)	587.7	612.0	657.0	700.0				
GROSS DOMESTIC PRODUCT (Current Prices)	602.8	628.5	675.3	716.7				

Source: 1968 Information Annual, Central Bank of Nicaragua

TABLE 1-3

KEY ECONOMIC INDICATORS
NICARAGUA 1966-1968

(Values in millions of U.S.$, unless indicated otherwise)

U.S.$ = 7 cordobas

Item	1966	1967	1968
Gross Domestic Product (GDP) constant 1958 prices	576.1	606.6	636.9
Constant GDP/Capita (U.S.$)	336.0	341	346
Investment as % of GDP, constant prices	23.2%	21.1%	19.1%
Money supply (cash & demand deposits)	80.7	77.2	72.5
Comm'l bank credit outstanding	127.3	144.6	158.1
Interest rate, Central Bank, percent	3-8	3-8	3-8
Interest rate, Comm'l bank, prime, percent	8	8	9
Public Debt Outstanding, External	75.2	97.1	130.2
External Debt Service Ratio (to Exports)	6.1	6.7	7.5
Net Gold & Foreign Exchange Reserves	22.5	-9.1	15.4
Balance of Payments (Net monetary movements basis)	-12.2	-20.4	+5.5
Production, Major Items			
Cotton, thousand bales	485	504	400
Coffee, thousand bags 60 kilos each	514	540	552
Sugar, thousand metric tons	69	103	118
Corn, thousand quintals*/	3,450	3,829	4,400
Rice, thousand quintals	727	813	923
Beer, thousand liters	13,627	14,800	17,700
Beef, thousand pounds	N.A.	98,600	115,000
Cement, thousand bags of 94 lbs.	1,940	2,000	2,600
Elec. power consumption, million kwh	294.4	335	406
Total Exports, FOB	142.2	151.7	162.3
Exports to U.S.	30.6	41.7	44.6
Exports to Central American Common Market	16.2	18.2	24.6
Total Imports, CIF	181.9	203.9	184.6
Imports from U.S.	83.0	87.6	69.6
Imports from CACM	31.6	42.8	46.2
Imports from West Germany	12.5	14.0	11.2
Imports from Japan	9.9	13.4	14.0

*/ 1 quintal = 101.4 lbs.

Sources: Central Bank of Nicaragua
U.S. Embassy Nicaragua estimates

TABLE 1-4

VALUE OF NICARAGUAN INDUSTRIAL PRODUCTION

(in millions of US $)

Category	1967	1968
Food	97.6	110.1
Beverages	22.2	24.8
Tobacco	9.8	10.6
Textiles	9.9	10.7
Clothing & Footwear	12.2	12.3
Lumber and Cork	6.3	7.7
Furniture	3.5	3.7
Paper & Allied Products	2.5	3.1
Printing & Publishing	2.7	2.9
Leather & Leather Products	2.5	2.6
Rubber Products	1.1	1.2
Chemicals	27.2	28.0
Petroleum Products	13.6	14.2
Non-Metallic Mineral Products	6.9	8.0
Metal Products	9.4	11.1
Mechanical & Electrical Equipment	1.1	1.3
Transportation Equipment & Repair	2.4	2.7
Miscellaneous	3.7	4.1
Total	234.6	259.1

TABLE 1-5

VOLUME OF SELECTED ITEMS OF NICARAGUAN INDUSTRIAL PRODUCTION

Principal Items
(Millions of Units)

Items	Units	1967	1968
Meat (Beef)	Pounds	65.5	72.8
Shellfish	Kilograms	2.9	3.1
Sugar	Quintals	2.1	2.2
Crackers & Biscuits	Pounds	3.0	3.6
Oatmeal	Pounds	5.5	8.6
Edible Vegetable Oils	Pounds	37.1	45.0
Soluble Coffee	Pounds	0.4	0.3
Carbonated Beverages	Cases	4.7	4.9
Beer	Liters	14.8	17.7
Cigarettes	Numbers	1,097	1,181
Cotton Fabrics	Yards	11.4	12.3
Lumber	Board Feet	59.9	61.2
Cement	Bags	2.0	2.6
Matches	Boxes	30.0	36.2
Refined Petroleum	Barrels	2.8	3.2
Paint	Liters	9.8	11.0
Flour	Pounds	43.8	53.6

Source of Above Tables: Information Annuals, Central Bank of Nicaragua

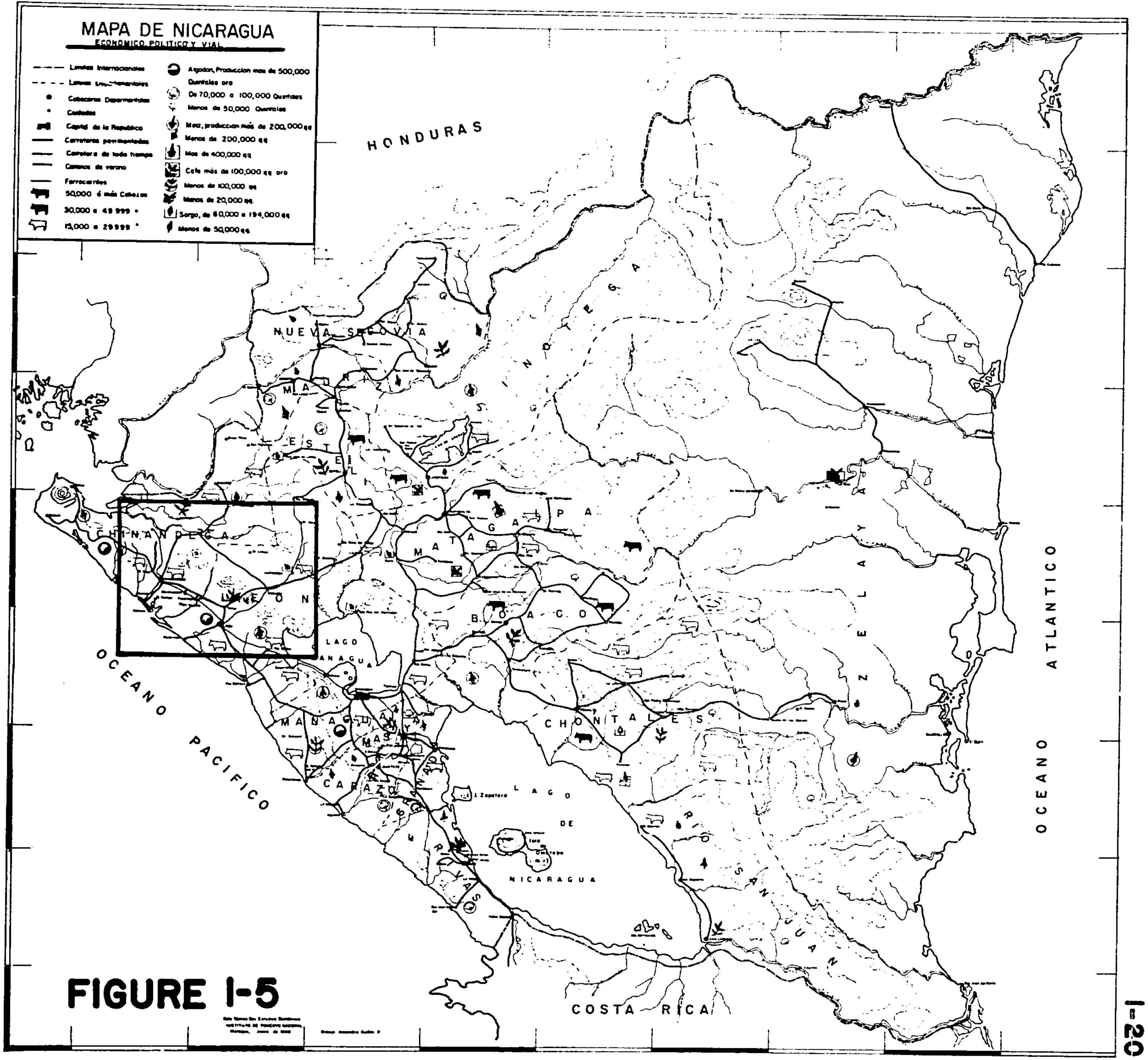

MAPA DE NICARAGUA
ECONOMICO, POLITICO Y VIAL
Limites Internacionales
Limites Departamentales
Cabeceras Departamentales
Ciudades
Capital de la Republica
Carreteras pavimentadas
Carretera de todo tiempo
Caminos de verano
Ferrocarriles
50,000 ó más Cabezas
30,000 a 49 999 "
15,000 a 29999 "
Algodon, Produccion mas de 500,000 Quintales oro
De 70,000 a 100,000 Quintales
Menos de 50,000 Quintales
Maiz, produccion más de 200,000 qq
Menos de 200,000 qq
Mas de 400,000 qq
Cafe más de 100,000 qq oro
Menos de 100,000 qq
Menos de 20,000 qq.
Sorgo, de 60,000 a 194,000 qq
Menos de 50,000 qq
HONDURAS
NUEVA SEGOVIA
MADRIZ
ESTELI
JINOTEGA
MATAGALPA
CHINANDEGA
LEON
BOACO
ZELAYA
CHONTALES
LAGO DE MANAGUA
MANAGUA
MASAYA
CARAZO
GRANADA
RIVAS
I. Zapatera
Isla de Ometepe
LAGO DE NICARAGUA
RIO SAN JUAN
OCEANO PACIFICO
OCEANO ATLANTICO
COSTA RICA

FIGURE I-5

Some signs of oil, of uncertain commercial quantity and quality, were found off the Atlantic Coast in 1969. Mining of newly-found deposits of lead, zinc, and molybdenum may begin soon. Copper and gold, and some silver, are exported now.

Shrimp and lobster production is becoming increasingly important. Exports of shellfish have tripled since 1964, and approached $6,000,000 in 1969. Several types of timber have been important export items, but the resource has not been utilized to its optimum extent, especially in the eastern half of the country.

1.235 - Central American Common Market

Contributions have been made by CACM to the overall health of the economy, despite the adverse effects of the war between two of the partners, El Salvador and Honduras. The program includes the liberalization of trade among the five member nations, the other members, in addition to the two named, being Nicaragua, Guatemala, and Costa Rica. Fiscal, financial, industrial, and tariff agreements are intended to provide the industry and businesses of the CACM countries with a market of more than 12,000,000 people. Inter-regional trade increased from 36.8 million dollars in 1961 to 141.9 million dollars in 1965. Many problems remain to be resolved before CACM will be as successful as intended, but there are reasons for optimism as regards its future.

1.236 - Balance of Payments

International payments by Nicaragua are roughly in balance, but the level of reserves is not high because of reduced import earnings recently; principally due to the cotton situation.

1.24 - Transportation and Ports

At the end of 1968 Nicaragua had more than 10,000 kilometers of highways, half of which were paved or all-weather roads. Figure 1-6 shows the road network as of 1966.

There are 317 kms. of railway that join the main port of Corinto with the principal cities of the Pacific. Highway transport has continued to make inroads on rail traffic. Only about 13 percent of all Corinto cargo is transported by rail.

Corinto, on the northwest coast, has been expanded and is the principal port. San Juan del Sur, Puerto Somoza, and Puerto Moragan are other Pacific ports. On the Atlantic side, Bluefields' port of El Bluff, San Juan del Norte, and Puerto Cabezas are main ports. When Bluefields and the Pacific Coast are connected by completion of the Rama Road, Bluefields shipping is expected to increase.

Navigation on Lakes Managua and Nicaragua was important in the past, but is considerably less now. A lake transport study was completed recently in the hope of finding ways to improve transportation of persons and commerce on Lake Nicaragua.

1.25 - Energy

Total installed electrical energy capacity in early 1969 was around 157,000 kilowatts, with total consumption being about 406 million KWH per year, about 80 percent of which is supplied by ENALUF, an autonomous government department. Three new rural electric cooperatives are being established with financing from GON, ENALUF, and U.S.AID. These will add more than 13,000 square kilometers of service area to the ENALUF system.

1.26 - Favorable Investment Climate

The Nicaraguan government and the private sector encourage foreign investment, especially where it will aid in the wise development or increased use of natural resources. Agro-industries especially are needed, and desired, as they provide a key link for a whole chain of integrated production links, beginning with increased farm production, and ending with processed food stuffs or fiber articles for sale in Nicaragua, CACM, or abroad. The long-term economic prospects are good, despite short-term problems.

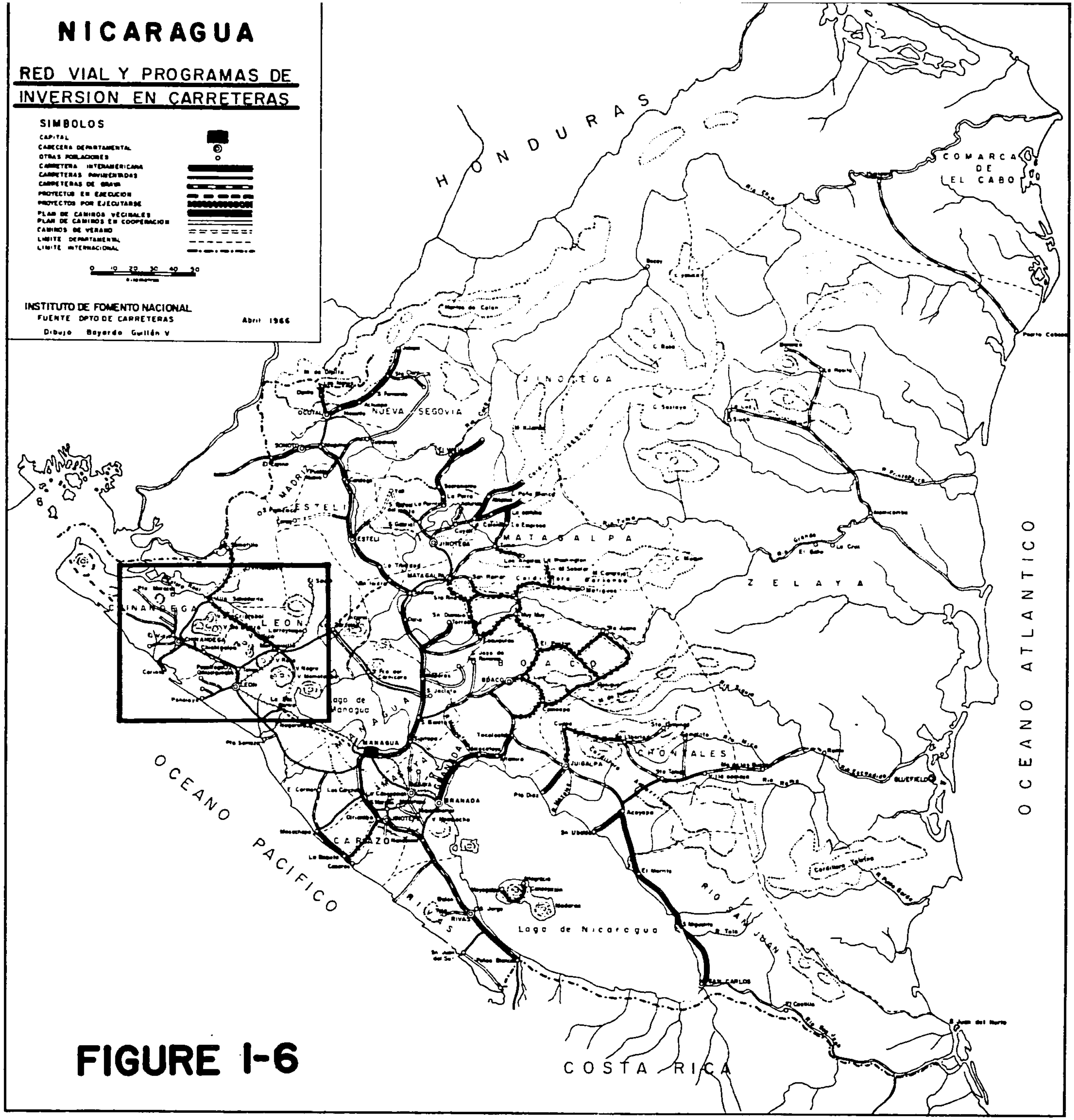

NICARAGUA
RED VIAL Y PROGRAMAS DE INVERSION EN CARRETERAS
SIMBOLOS
CAPITAL
CABECERA DEPARTAMENTAL
OTRAS POBLACIONES
CARRETERA INTERAMERICANA
CARRETERAS PAVIMENTADAS
CARRETERAS DE GRAVA
PROYECTOS EN EJECUCION
PROYECTOS POR EJECUTARSE
PLAN DE CAMINOS VECINALES
PLAN DE CAMINOS EN COOPERACION
CAMINOS DE VERANO
LIMITE DEPARTAMENTAL
LIMITE INTERNACIONAL
0 10 20 30 40 50
INSTITUTO DE FOMENTO NACIONAL
FUENTE DPTO DE CARRETERAS
Abril 1966
Dibujo Bayardo Guillén V
HONDURAS
COMARCA DE EL CABO
JINOTEGA
NUEVA SEGOVIA
MADRIZ
ESTELI
MATAGALPA
ZELAYA
CHINANDEGA
LEON
BOACO
MANAGUA
CHONTALES
CARAZO
RIVAS
GRANADA
Lago de Managua
Lago de Nicaragua
RIO SAN JUAN
OCEANO ATLANTICO
OCEANO PACIFICO
COSTA RICA
MANAGUA
LEON
CHINANDEGA
ESTELI
JINOTEGA
MATAGALPA
BOACO
JUIGALPA
GRANADA
JINOTEPE
RIVAS
SAN CARLOS
BLUEFIELDS
OCOTAL
Puerto Cabezas
S. Juan del Norte
Corinto

FIGURE I-6

Chapter 2

OVERVIEW OF NICARAGUAN AGRICULTURE

Chapter 2

OVERVIEW OF NICARAGUAN AGRICULTURE

2.0 - INTRODUCTION

Nicaragua has an agricultural economy. The livelihood of its people depends on agriculture, and the intensity of its agriculture has not progressed to the point which allows it to release people from the farms for industrial purposes, nor has it developed an industrial economy to the point where it can utilize its people in industry. The latitude of Nicaragua is between 11° and 15° North which provides a warm climate throughout the entire year. These temperatures, coupled with hours of sunshine that never vary too greatly between summer and winter, establish certain limitations as to the type of agricultural cropping that can exist.

The Pacific Zone of Nicaragua is the intensive production area of the country, and in this area cotton has dominated the land use scene for the last decade. Plantings exceeded a third of one million acres.

Cotton brought intensive mechanization and widespread industrialization and replaced corn, sesame, and even citrus. Cotton was able to utilize the soil and climate more effectively than any other crop. It grows in the rainy season and is harvested and ginned during the long dry period. The land is taken up for the entire year to produce a crop of cotton. Varieties from other areas are well adapted and fertilizer practices and insect control procedures were successfully transplanted to the area without expensive readaptation.

The agricultural picture in 1970 is for a major reduction in cotton acreage. The country does not have a substitute crop to utilize this diverted land with the income potential that cotton had a few years ago. The better soils are being kept in cotton and the lands with production limitations are in need of new crops.

Corn is a major land use crop in the area but is grown on many small holdings largely under primitive conditions. Yields are not high enough to envision a major expansion under irrigation during the dry season. For the wet season, corn ranks extremely high and provides an alternative crop possibility for lands taken out of cotton.

Sugar cane is a well-adapted crop in the Pacific Zone. There is no indication that the acreage will increase significantly beyond the processing capacity of existing mills.

Rice production has increased to a level beyond domestic needs. There are widespread areas adapted for rice with easily accessible irrigation water. Post harvest facilities are inadequate and with the increased world rice crop there may be little incentive at present for any major expansion in rice acreage.

Livestock production can be a sound and viable industry in the Pacific Zone, but the long dry season without irrigation has restricted growth of both meat and milk. Irrigation will allow intensification of animal enterprises on large areas of land in this use.

Soils, topography, climate and water supply are very favorable in the project area for intensive agriculture. Farm units are large enough in most cases so that machinery operations are not restricted. Basic farm equipment is in good supply, and the general picture is one of advanced agriculture. In fact agriculture is a mixture of extremes - subsistence peasant farming typified by the commonly seen oxcart and span of oxen, and rather modern agriculture supported by mechanical cotton pickers and airplane crop spraying.

The agricultural potential is relatively undeveloped. Although a new degree of sophistication was brought in for cotton in the 1950's, not all of the practices were suited to Nicaragua's conditions. It is significant that almost no practices have been developed to meet special needs of Nicaragua. Furthermore, the imported practices stayed in cotton and have not moved into other crops, so that what was modern, has become traditional.

Nicaragua produces a large list of crops in the Pacific Zone. In addition to those mentioned earlier, they grow coffee, bananas, grain sorghum, mangoes, papaya, citrus, watermelon, squash and onions. Some less well known crops are plantain, a brother to the banana, yuca, which is known to many as tapioca, and quequisque, a plant similar to taro which is used in Hawaii to make poi.

Nicaraguan agriculture is distinctly tropical in a year-around warm climate. Half the year is dry and half is wet. There is an abundance of labor, water, and good soils, but none of these resources is fully utilized.

2.1 - EXISTING AND PROJECTED LAND USE PATTERNS

The government has estimated that roughly 75 percent of the land, other than forest lands, is potentially cultivatable for either crops or pasture. Eighty-eight percent of the potentially-cultivable land still unused in Nicaragua in 1963 was in the Atlantic Zone. Less than 4 percent of the land was unused in the Pacific Departments. The remainder of the country (interior) had less than 8 percent of the potential still unused. Total potential cultivable land was estimated as shown in Table 2-1.

TABLE 2-1

USE OF POTENTIALLY CULTIVATABLE LAND

NICARAGUA - 1963 (manzanas)

Departments	Potential Cultivatable Area	Area Cultivated in 1963	Unused Potential
Pacific Chinandega, Leon, Managua, Granada, Carazo, Masaya, Rivas	1,380,000	1,224,000	156,000
Interior Boaco, Chontales, Esteli, Jinotega Madrid, Matagalpa, Nueva Segovia	1,786,000	1,483,000	303,000
Atlantic Zelaya & Rio San Juan	4,027,000	523,000	3,504,000
TOTAL	7,193,000	3,230,000	3,963,000

TABLE 2-2

AREA IN CULTIVATION - NICARAGUA

(Manzanas)

1 Manzana = 1.74 acres

Source: GON

	1951	1954	1955	1957	1963	1969	1972
Sesame	28,350	30,000	24,200	11,500	9,300	15,100	25,000
Cotton	23,900	60,700	123,600	105,100	134,700	209,000	220,000
Rice	23,000	48,500	25,900	36,000	32,300	60,700	75,400
Sugarcane	20,300	22,800	24,600	25,800	32,500	38,000	43,200
Corn	160,500	198,700	169,700	256,300	200,700	302,800	350,500
Sorghum	53,000	62,700	68,600	79,900	79,800	90,000	116,500
Bananas	18,800	17,700	17,000	16,100	16,100	23,070	35,900
Beans	---	---	---	---	---	87,000	172,900
Cocoa	1,800	2,580	2,290	2,480	2,290	2,300	2,300
Tobacco	980	890	870	820	790	3,000	4,300
Pasture	1,549,800	1,757,200	1,832,300	1,952,400	2,535,100	2,700,000	2,700,000
Coffee	73,600	85,800	90,360	97,100	128,100	134,300	138,400
Peanuts	190	170	170	160	130	140	140
Potatoes	800	710	680	630	500	4,150	4,530
Yuca	3,600	3,740	3,770	3,850	4,100	11,180	12,010
Tomatoes	420	430	430	440	470	500	520
Onions	300	310	320	330	350	370	380
Cabbage	160	170	170	180	190	200	300
Other Vegetables	540	570	580	610	690	730	650
Coconuts	1,150	1,120	1,110	1,090	1,030	1,090	1,120
Achiote	160	160	170	170	180	190	200
Citrus	980	1,010	1,020	1,040	1,110	1,210	1,290
Plantains	34,470	37,230	38,210	40,240	47,000	51,300	54,300
Pineapple	1,040	1,110	1,130	1,180	1,330	1,410	1,450
Henequen (Sisal)	570	610	620	650	730	780	800
Total	1,998,410	2,334,910	2,427,800	2,634,070	3,229,490	3,738,520	3,962,090

TABLE 2-3

SELECTED CROP PRODUCTION AND REVENUE-NICARAGUA

Crop	Volume per Year Thousand of Quintals		Value per Year in Thousands of Cordovas[1]		Yield per Manzana			
					Quintals per Manzana		Cordovas per Manzana	
	1967	1972 Projected	1967	1972 Projected	1968	1972 Projected	1968	1972 Projected
Sesame	129	372	7,500	21,000	11.1	--	603	833
Cotton	440[2]	--	447,300	--	2.15[5]	--	2,144	2,439
Rice	1,683	5,477	38,600	152,000	46.6	--	1,146	1,937
Sugarcane	1,327[3]	1,823[3]	46,400	64,000	38.4[6]	42.2[6]	1,396	1,566
Corn	3,468	14,887	59,300	255,000	15.9	--	217	720
Sorghum	1,215	6,200	29,200	149,000	30.9	--	622	1,277
Bananas	603	11,198	24,100	437,000	206.9	660[7]	1,895	22,122
Beans	919	3,630	59,000	233,000	12.3	--	772	1,350
Cocoa	11	13	2,100	2,500	--	--	1,060	1,101
Tobacco	22	107	4,900	32,000	28.1	30	2,837	8,940
Pasture	--	--	119,500	154,000	--	--	51	57
Coffee	--	--	243,200	256,000	--	--	1,846	1,846
Potatoes	312	429	10,200	14,000	79.9	94	2,611	3,094
Yuca	203	402	5,300	7,300	40.3	80	726	1,440
Livestock and Poultry[4]								
Total Livestock and Poultry			453,000	632,000				
Beef Cattle (head/year)	220	244	343,000	--	Total Cattle in 1969 - 1,700,000			
Hogs (head/year)	268	471	39,000	--	Total Hogs in 1969 - 550,000			
Poultry & Eggs	--	--	58,000	--				
Milk & Milk Products (liters)	301x10^6	--	--	--				

Notes:
(1) Values in 1958 Cordovas (1968-69 Values approximately 12 percent higher)
(2) Bales of 480 pounds
(3) Thousands of Tons
(4) Note change in Volume Units
(5) Bales per Manzana
(6) Tons per Manzana
(7) For new plantings

Source: Unpublished reports of MAG and office of Planning, plus 1968 Central Bank Annual Report

Table 2-2 presents figures for the areas devoted to the cultivation of many of the crops grown over the past few years in Nicaragua, and projections made by GON for the areas of those same crops in the year 1972.

The figure of 3,665,520 manzanas under cultivation in 1969 includes approximately 2,700,000 manzanas of pastures, and also fallow lands. In 1967 fallow lands represented about 20 to 25 percent of the cultivated land, other than pastures.

In 1968 less than 45,000 manzanas of land had irrigation, and 26,000 manzanas of this total was in the Departments of Chinandega, Leon, and Managua.

2.2 - EXISTING AND PROJECTED CROP PRODUCTION PATTERNS

Table 2-3 gives an indication of the volume and value of some of the major items of Nicaraguan agricultural production as of 1967.

Also shown are some projections, or objectives, tentatively set by the Government as 1972 goals.

2.3 - LAND TENURE

According to the Agricultural Census of 1962-63, private farm ownership in Nicaragua was as indicated in Table 2-4.

TABLE 2-4

AREA, DISTRIBUTION, AND AVERAGE SIZES OF FARMS IN NICARAGUA, 1962-63

Farm Size	Farms		Area		Average Area Per Farm
	No.	Percent	Manzanas	Percent	Mzs.
1-9.9 Mzs. (Family)	51,936	50.8	190,098	3.5	3.7
10-49.9 Mzs. (Family)	27,976	27.4	614,136	11.2	21.9
50-488.9 Mzs. (Medium Multi-Family)	20,794	20.3	2,408,618	44.1	115.8
500 Mz. & Larger (Large Multi-Family)	1,495	1.5	2,248,311*	41.2	1,504.0
	102,201	100.0	5,461,163	100.0	53.4

Source: Office of Planning, and unpublished MAG data

*Note: 57 percent, or about 1,282,400 manzanas, are in seeded or natural pastures.

Considerable amounts of public domain lands exist, some of which is occupied and farmed without benefit of title. A program of giving title to these lands to families was initiated in 1965 under the Agrarian Institute of Nicaragua (IAN). Between January 1965 and February 1968 IAN had passed 4,174 titles to parcels of land with a total area of 154,996 manzanas. While some of the public lands are not suitable for intensive agriculture, for various reasons including remoteness, parts require only a minimum of infrastructure before they can be made productive.

2.4 - KEY AGRICULTURAL INPUTS

2.41 - Introduction

Nicaragua is generally well served with the materials and services required for intensive agricultural production. As irrigation brings new crops into the area, additional facilities and back-up materials will be required. This is a brief review of some of these production support inputs, based on experience in Project Adelante. Industry and government will have to work with agricultural organizations and farmers to make sure these inputs are efficiently established for improved production, reduced unit cost of production and effective post-harvest handling and marketing.

2.42 - Fertilizer

Fertilizer generally is available for the programs of production in the country. This is particularly true of the major elements, nitrogen, phosphate and potassium. It is less true of the minor elements as these needs have not been adequately identified. At the present time, if there is need, as there has been in Project Adelante, for zinc or boron, it has been necessary to establish small plots using technical material purchased from a drugstore. The major fertilizer use will continue to center upon urea and ammonia as the most widespread sources of nitrogen and for diammonium phosphate (21-53-0, 18-50-0, etc.) for combinations of nitrogen and phosphate. Sources of triple superphosphate for pre-plant broadcasting, as well as for other uses, have not been adequately established for use by the farmers. Commonly used materials presently available include potassium, and the relationship between this element with nitrogen and phosphate may not be the most efficient. Urea and 21-53-0 will become the most important fertilizers in the irrigated program because of their versatility, including their ability to be used through a sprinkler system when desired.

2.43 - Seed

Sources of seed are improving. The time of year when certain seeds are available has been limiting. This will have to be expanded into year-around availability of seed, under controlled climatic conditions, so that for irrigated agriculture these are available during the important planting periods. Prior to this, much of the seed has been available only at rain season planting time. Seeds of a number of crops will have to be located and made available in Nicaragua for the new crops that are being identified in Project Adelante. These include castor beans, safflower, millets, okra, cucumbers, as well as others.

2.44 - Agricultural Chemicals

Insecticides and pesticides are available in the country, except for weed and disease materials. There has not been, as yet, the need or the request for materials for weed and disease control, so these are not adequately handled throughout the area. Experience indicates that weeds will be an important problem under irrigation. New weed materials will have to be identified quickly, recommendations made, and materials carried for farmer use. Materials are in fair supply for plant disease and nematodes. These are not adequately understood by the handlers and the farmers in the area, so information will have to be made available quickly and the recommendations refined as rapidly as possible.

2.45 - Machinery and Equipment

Throughout the Pacific Zone the available machinery and equipment is inadequate for an improved practice program, as evidenced by the experience in Project Adelante. There are no furrowers for construction of beds. There is a need for bed-shaping and precision planting equipment. This would have been extremely helpful also in the cotton program, but it has never been tested or provided. There is inadequate equipment, as indicated in other portions of this report, on ground spray rigs. Such simple things as nozzles are not available from suppliers in the proper sizes for ground sprayers. Spare parts are inadequate at the present time, and it may be that shifts in machinery will have to be made until decisions and programs are made on spare parts.

2.46 - Credit

The Existing credit program is not adequate for irrigation and irrigated crops at the present time, because of the newness of irrigation in the area. The understanding of costs of production by credit representatives is completely inadequate. New programs are needed for supervised production credit, and for medium and long-term credit. The lending institutions, both government and private, should be providing leadership and support to the agricultural individuals and organizations who are determining the programs. There needs to be new terms of reference for production credit as a resource for production. The lending institution must become a partner with the farmer and the farm organizations, rather than either a philanthropist or a figure of authority that determines the entire cropping program and practice.

2.47 - Cleaning, Drying, and Storage

Cleaning, drying and storage facilities and programs of crops have improved, but need additional support. New crops require new kinds of processing, and processing is a requirement for orderly and effective marketing. Improved cropping leads to seasonal surges of crops which increases the normal typical six-month low price, six-month high price fluctuation in prices. Storage is essential at an early date to level out these fluctuations as much as possible. Increased amounts of crops grown are expected which will require drying. These facilities must be available so that it does not become a limiting factor in the production of otherwise well-adapted crops. Crops such as castor beans and safflower require hulling and processing facilities. In the case of castors there is a requirement for combine attachments and processing to put castor oil into the market.

2.5 - MARKETING

2.51 - General

Agricultural marketing in Nicaragua ranges from simple traditional native markets for the sale of many fruits and vegetables, to the modern, relatively sophisticated activities of the National Cotton Commission and the Nicaraguan Coffee Institute. While cotton, coffee, and cocoa move through fairly-well defined marketing channels, and the small, but growing, dairy industry also has many of the essential elements of good marketing, production, and controls, numerous problems exist in the marketing of fruits and vegetables, livestock, and basic grains. Since all of these latter items are principal production products of irrigated agriculture, a few comments on principal marketing procedures and problems affecting them are in order.

One of the more recent studies on agricultural marketing problems in Nicaragua was performed by a team of specialists from Louisiana State University in 1969. The study was made at the request of the Ministry of Agriculture and Livestock, and with the cooperation and assistance of the U.S. Agency for International Development. The remaining comments in this section are based on that study, and supplemental information observed by Project Adelante staff.

2.52 - Fruit and Vegetable Marketing

Presently considerable quantities of fruits and vegetables are imported annually into Nicaragua, primarily from neighboring countries. Domestic output of these items is almost totally for fresh consumption.

The Oriental Market in Managua serves as the principal distribution point for fruit and vegetable (and other food) supplies for the country. Efficiency and sanitary conditions could be improved considerably. A large proportion (up to 50 percent, for some items) are not sold within the week of purchase. Loss estimates due to lack of proper handling and holding facilities range as high as 60 percent for some of the more perishable items. A modern, complete, wholesale food distribution center has been recommended to replace the existing Managua Market Center.

Truck owners and/or produce buyers, in many instances the same person, are a major factor in the establishment of prices. As an example, the trucker will buy a whole field, in place, at a total price. He then harvests to meet his demands in Managua. Very few farmers go directly to the retailer, or make contracts with the supermarkets. The small vegetable grower close to the major cities may set up stands, or go from door-to-door to sell his produce. However, the larger farmers and those at greater distances from the market, generally have a transportation problem and consequently prefer to sell on the farm.

Actual movement of fresh produce from farm to wholesaler to retailer results sometimes in the same produce being shipped twice - once to the wholesaler and then back over the same route to a market nearer the source farm. This problem is not unique to Nicaragua, but certainly adds to the consumer cost. Table 2-5 shows the Place of Origin of Selected Crops as stated in the indicated marketplace to Project Adelante personnel, for the month of March 1968.

TABLE 2-5

PLACE OF ORIGIN OF SELECTED CROPS IN NICARAGUA, MARCH 1968

PRODUCT	MARKETPLACE			
	Managua	Granada	Leon	Chinandega
Cabbage	Matagalpa & Costa Rica	Costa Rica	Matagalpa	Matagalpa
Onions	Sebaco	Sebaco	Sebaco	Sebaco
Bell Pepper	Costa Rica	Costa Rica	Costa Rica	Managua
Bell Pepper seasoning	Masaya	Masaya	Masaya	Managua
Leaf Lettuce	Costa Rica	Masaya	Managua	Managua
Cucumbers	Costa Rica	Matagalpa	Managua	Managua
Cantaloupe	Granada	Granada	Managua	Managua
Pipian	Grenada	Managua	Chinandega	Managua
Squash	Masaya	Managua	Chinandega	Chinandega
Green Beans	Costa Rica	Costa Rica	Costa Rica	Managua
Tomatoes, salad	Costa Rica	Costa Rica	Masaya	Managua
Tomatoes, cooking	Granada & Masaya	Granada	Masaya	Managua
Rice	Nicaragua	Nicaragua	Granada	El Salvador
Potatoes	Guatemala	Guatemala	Guatemala	Guatemala

Grade standards currently do not exist, and are needed. Evidence of growing consumer demand in Nicaragua for quality vegetables was noted in the consistently higher prices paid for better-quality tomatoes.

Most canned fruits and vegetables sold in the stores and markets are imported. While the development of Nicaraguan processing facilities is desirable, this cannot be accomplished economically without a substantial increase in fruit and vegetable output. At the same time, potential growers of these crops need to have an identifiable market before they can risk large-scale production. Integrated planning and efforts are required, involving farmer, processor, and the government.

2.53 - Grains

Increased production since 1963 in Nicaragua gave the country a slight surplus in basic grains in 1969. If this trend continues, Nicaragua soon will become a net exporter of rice and corn, as well as producing a small surplus of beans and sorghum. At the same time, it appears that an overall surplus exists in these commodities among the Central American Common Market.

Serious problems apparently exist in the area of price stabilization and supports and in developing exports. Present programs seem to encourage increased production despite the surplus condition, and export possibilities are not particularly bright. At the same time, there are opportunities for increased production of corn and sorghum for the expanding livestock industry. Price stabilization of basic grains is the responsibility of the National Institute of Commerce for the Exterior and Interior (INCEI).

100 new agricultural centers and 5 grain elevators now under construction by the National Bank and INCEI will alleviate, but not eliminate, the present poor grain-drying situation. Losses as high as 30 to 40 percent are occurring due to mold, insect and rodent attacks, and quality losses in processing. However, some large producers have access to adequate drying systems. The LSU study estimated that even after completion of the new centers, there will be a storage shortage of 83,000 MT of grain, and that future production increases will aggravate the shortage.

There is a need also for introduction of grading standards for grain.

2.54 - Livestock and Livestock Products

2.541 - Beef Production

During the 5-year period 1964-1969 beef ranked third as a source of foreign exchange income for Nicaragua. Short-run prospects seem to be good to maintain and perhaps expand future beef sales to the U.S.A., according to the LSU study. However, realization of the maximum benefits from beef production depends upon improvements in several of the marketing aspects of the business.

Currently it is generally necessary for the seller to make appointments with potential buyers before bringing the livestock to market. It is not uncommon for sellers to experience delays of one to five months in the sale of livestock to comply with cattle "flow" determined by the slaughterhouse. The procedure results in a "buyers" market.

Payment is made by weight, with no recognition of differences in quality. Grading standards definitely are needed.

Excessive branding (12 to 14 brands, in some instances) has caused significant losses in hide values.

A network of buyers, agents, local dealers and subdealers provide market information. Under these conditions the information is word-of-mouth, and often the quoted selling price bears little resemblance to the price actually received by the producers after all deductions.

An embargo presently exists on the export of live animals.

Nicaraguan meat generally is lean beef from grass-fed animals which are not "finished" before slaughtering.

2.542 - Hog Marketing

Pork is in short supply in Nicaragua, and consequently the marketing problems for hogs are not as critical, at the present, as those related to beef cattle. Lack of market organization and grading standards, and poor sanitation during the meat-handling processes, are the areas which require special attention and improvement. A considerable portion of pork sold to internal consumers is produced by large operators or imported, but a significant number of small farmers have begun to produce hogs for market, as well as for family consumption.

2.543 - Dairy Marketing

Milk production in Nicaraguan has increased by about 1,000,000 gallons per year for the last decade, but the number of producers has declined from 400 in 1958 to 270 by early 1969. The fluid milk industry operates under a classified price plan with two classes of milk --- "fluid" and "industrial". All fluid milk and fluid milk products used in bottled form for direct consumptionare classified as "fluid" milk. Butter, cheese, ice cream, milk powder, and similar products are classified as "industrial" milk products.

Prices are regulated at both the consumer and producer levels by the National Milk Products Company (ENPL).

Substantial quantities of non-fat dry milk solids are imported from the U.S.A., Holland, and Denmark.

A few improvements in efficiency and a review of pricing policy, were suggested by the LSU Study, but in general this small segment of the livestock industry appears to be operating satisfactorily, although perhaps limited, as yet, in size, and to the major population centers.

Chapter 3

DESCRIPTION OF PROJECT AREA

Chapter 3

DESCRIPTION OF PROJECT AREA

3.0 - TOPOGRAPHY

The project area (Plate I and Figure 1-1) lies primarily within the slopes of the northwestern portion of the Pacific Coastal Plain, but extends eastward to include a small portion of the Nicaraguan Depression. The latter geological feature is not readily identified on planimetric maps, but is easily noted on a profile section such as is shown in Figure 3-1. The plain is characterized by nearly level to gently-sloping relief, with most of the principal farming areas lying within elevations of 50 to 150 meters above sea level.

A chain of active and dormant volcanoes in the central part of the area is the dominant land feature. The range, with a maximum elevation of 1745 meters, punctuates the otherwise near-level appearing landscape. A few isolated tongues of lava occur east of the highway between Telica and Chinandega.

3.1 - SOILS

Project area soils generally are deep and fertile, and are derived from recent (geologically) alluvium and volcanic deposits. Deposition of material from past and present volcanic activity has contributed materially to the alluvial mantle, resulting in many cases in the formation of relatively recent soils underlain by older buried soils.

The soils of the project farm sites are characteristic of those found and mapped by the organization charged with the measurement and inventory of natural resources, generally referred to as "Catastro", during their recent soil survey of the Pacific Coastal Plains Area. They are generally very deep (more than 4 feet in depth) with occasional small areas underlain by duripans of variable thickness consisting of cemented volcanic material.

Surface textures vary from sandy loams to clay loams, with colors ranging from dark browns to dark grayish-browns. Except for the heavy montmorillonitic clay soils known locally as "sosoquite," the surface soils posses a crumb to granular structure and a friable consistency when moist. Several of the soils examined contained a thin plowpan at depths ranging from 15 to 20 cms. below the surface, the result of disking to the same depth year after year

Subsoils are generally finer in texture, and range from sandy loams to clays. They are usually more compact than the surface soils. Colors vary from dark browns to grays to dark yellowish browns. Massive to angular blocky structures predominate.

With exception of the "sosoquite" soils, of which none were mapped on the project cooperator farm sites, the soils are moderately well-drained. Permeabilities range from slow to moderate, while surface runoff is generally slow, but is medium to moderately rapid in areas having stronger slopes and finer surface textures.

The soils are neutral to slightly acid in reaction in the surface and subsurface strata, and are free of harmful concentrations of salts and alkali. Surface content of organic matter is low to moderate, whereas levels of phosphate and potassium are medium to low and medium to high, respectively. Cooperator site soils were primarily under cotton culture, but are adaptable to a wide range of climatically

PROYECTO ADELANTE

PERFIL DESDE TELICA A MALPAISILLO

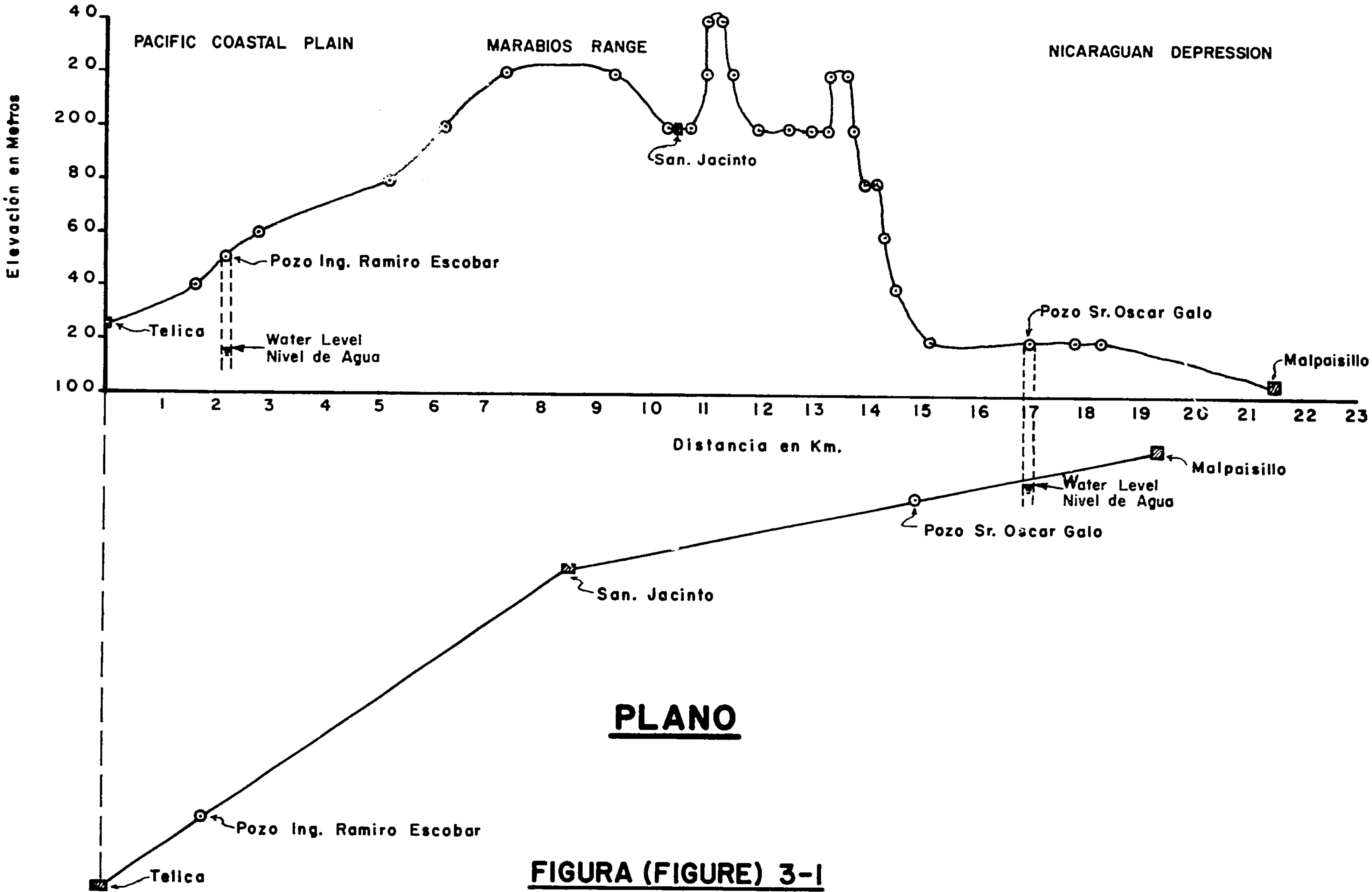


FIGURA (FIGURE) 3-1

PROYECTO ADELANTE

MINISTERIO DE AGRICULTURA Y GANADERIA EN

COOPERACION CON U.S.A.I.D.

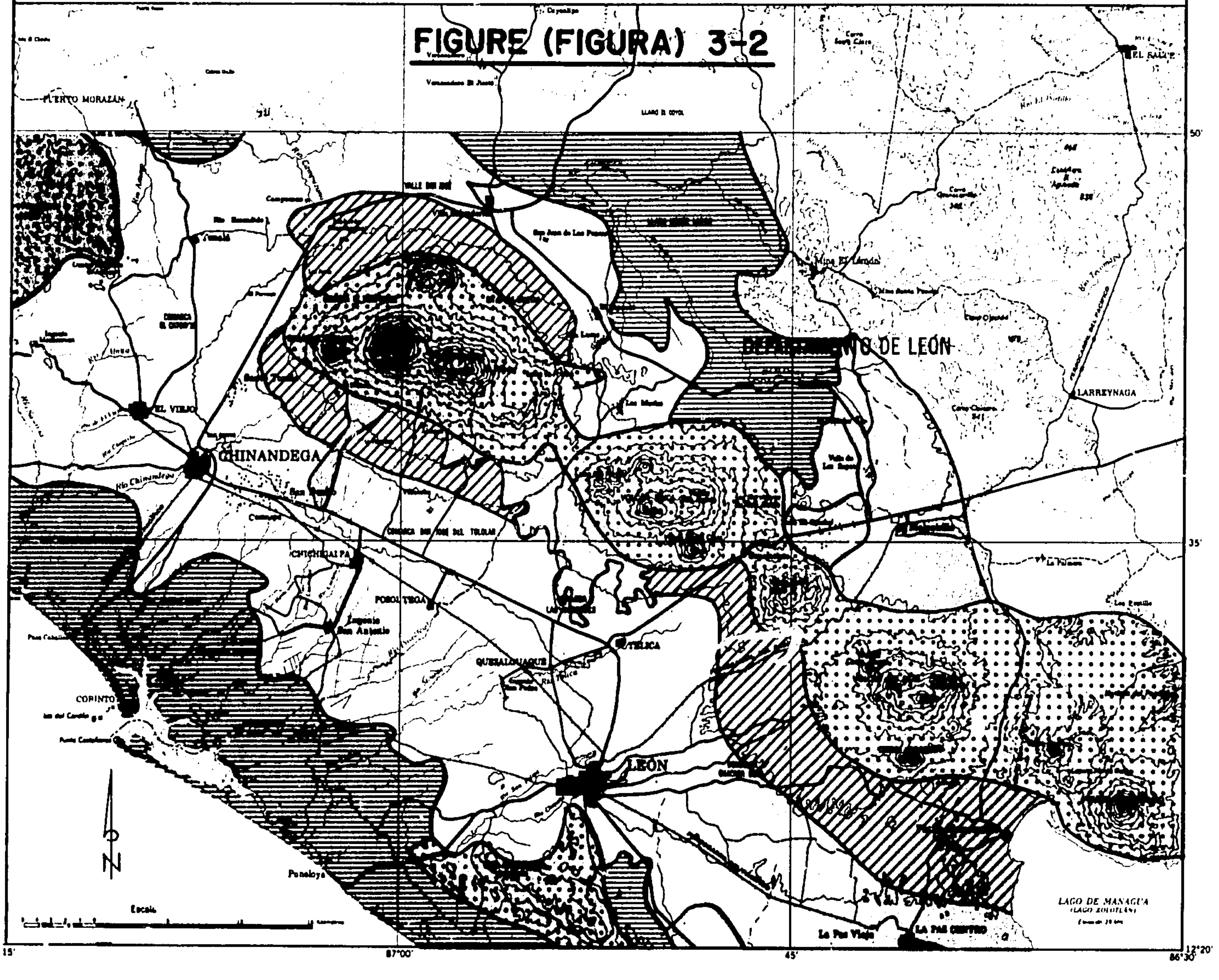
UNICONSULT INC.

GENERAL SOILS MAP

MAPA GENERAL DE SUELOS

LEGEND	LEYENDA
Ⓐ – Deep, level medium textured soils	Ⓐ – Suelos planos, profundos, textura media
Ⓑ – Transitional – deep & undulating	Ⓑ – Transicional, ondulado y profundo
Ⓒ – Shallow (1/2 to 2 ft.), level	Ⓒ – Delgados – (1/2 a 2 pies), planos
Ⓓ – Heavy plastic black clays	Ⓓ – Arcilla negra pesada, planos
Ⓔ – Volcanic rock, broken relief	Ⓔ – Roca volcanica, relieve quebrado
Ⓕ – Volcanoes & mountainous relief	Ⓕ – Relieve volcanico y montanoso

FIGURE (FIGURA) 3-2



adapted crops. Most will respond to balanced applications of fertilizers.

A generalized soil map showing broad soil groupings is presented in Figure 3-2. This map was prepared on the basis of on-site visual reconnaissance of the project area, information gathered on soils from auger borings made at selected locations within the project environs, and by photo interpretation using aerial photographs of the project area. The map was prepared during early phases of the project and over the past two years has been modified as more was learned of the area. Detailed soil maps and complete descriptions of the soils found in each of the project demonstration farm sites are presented in Appendix II of this report.

In 1968 an eruption of an active volcano in the area, Cerro Negro, occurred. Ashes drifted over a large part of the project area for a period of approximately 43 days. The area affected is shown approximately in Figure 3-3. During days when the activity was most intense, ashes and cinders were deposited on foliage, homes, buildings, and streets to a depth sufficient to cause considerable inconvenience, and possibly some direct damage, although no studied estimates were made of the latter.

3.2 - CLIMATE

3.21 - General

The project area is located in the tropical dry region of the Pacific Zone (See Plate I and Figure 1-2). Precipitation generally ranges from 1500 to 2000 mm/year (60 to 80 inches/year), on the average, but there are consecutive periods of from 5 to 7 months when little or no precipitation occurs during the months of November through May. Hence the designation "dry". The area also is characterized by a double-peak rainy season, with a somewhat-dry season, locally-known as the "Calícula", occurring in between the two peaks. The long dry period and the Calícula are both major considerations in planning and executing sustained agricultural operations in this otherwise very favorable climate. The average annual temperature is around 26°C (80°F), but there are no frosts and seldom does the temperature exceed 37°C (99° F). The humidity is high during the rainy season, and this, in combination with the warm average air temperature, tends to make for some discomfort during these times of the year.

3.22 - Precipitation

Table 3-1 summarizes precipitation data at the two principal weather stations in the area of the National Meteorological Service. These are both second-order type stations. Also shown are precipitation collected by Project Adelante from small stations established at Cooperator Sites and at the Leon Project office. Unfortunately project data are not complete, but it is planned that future data will be collected routinely and accurately. The project data does show, however, some of the variability in monthly rainfall which can be expected in the total project area.

Figure 3-4 graphically presents the Leon and Chinandega precipitation data, and clearly illustrates the general time of occurrence of the Calícula. Annual isohyetals previously have been shown in Figure 1-3.

One of the more important conclusions drawn from onsite experience over the initial project years, is that the times of the beginning and end of the rainy season, and of the Calícula, are variables. Two to four weeks variation in time can occur, which produces difficulties in scheduling planting and harvesting for many crops which can be adversely affected. The effect may range from insufficient water for a non-irrigated crop, or from rain-damage to a crop not-yet-harvested,

PROYECTO ADELANTE
MINISTERIO DE AGRICULTURA Y GANADERIA EN
COOPERACION CON U.S.A.I.D.
UNICONSULT INC.

GENERAL AREA COVERED BY VOLCANIC DUST IN 1968
AREA GENERAL CUBIERTA POR POLVO VOLCANICO EN 1968

LEGEND
LEYENDA

⁙ – Predominate area covered by dust from Cerro Negro Volcano
Area generalmente cubierta por el polvo del Volcán Cerro Negro

▥ – Occassional area covered by dust from Cerro Negro Volcano
Area ocasionalmente cubierta por el polvo del Volcán Cerro Negro

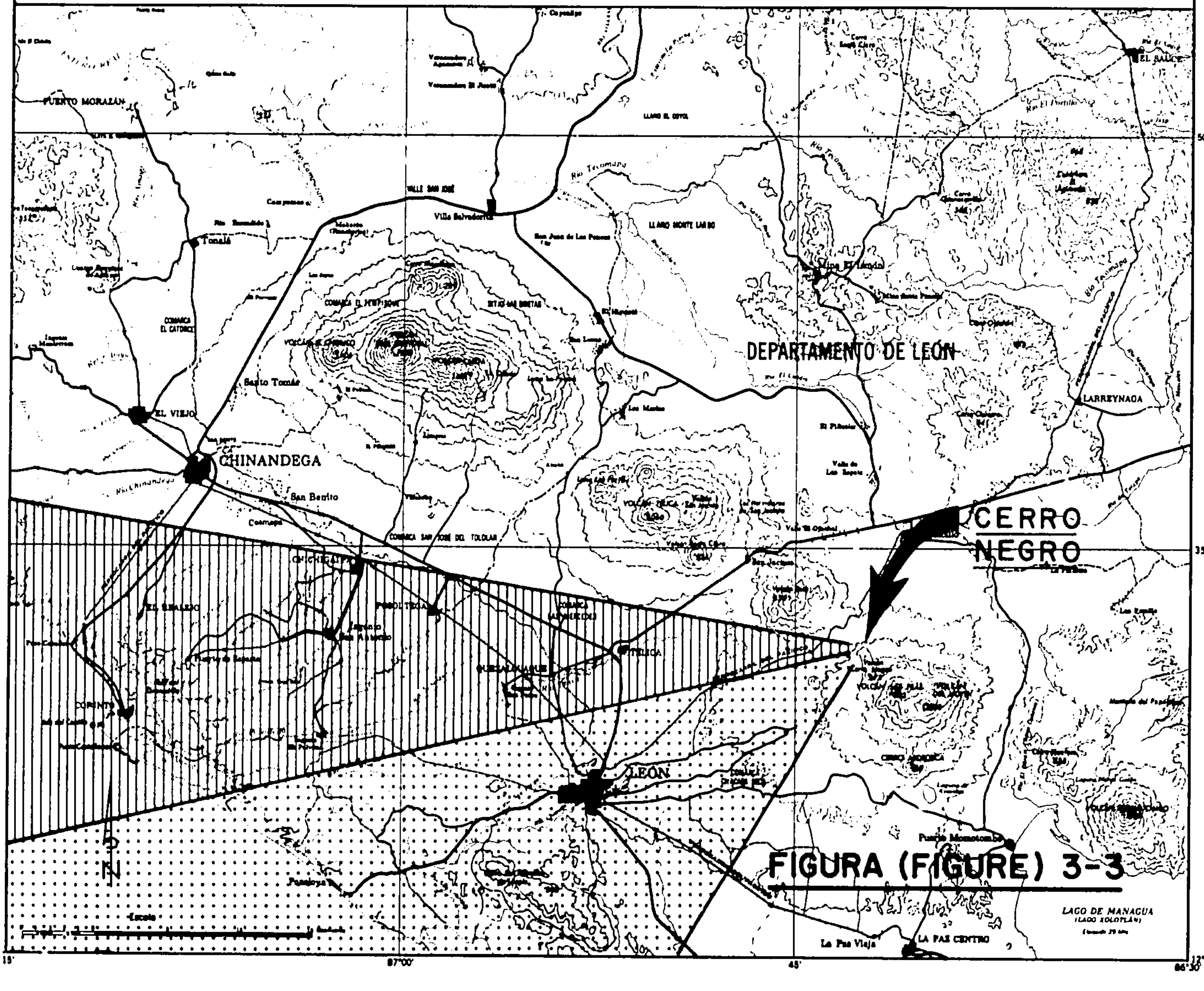


FIGURA (FIGURE) 3-3

CUADRO 3-1

DATOS DE PRECIPITACION PLUVIAL EN MILLIMETROS

AREAS DE LEON Y CHINANDEGA, NICARAGUA

Estaciones Del Servicio Meteorológico Nacional

Estación	En.	Feb.	Mar.	Abr.	Mayo	Ju.	Jul.	Ago.	Sept.	Oct.	Nov.	Div.	Anual
LEON - Promedio	0	0	1	23	122	298	108	134	331	455	91	1	1555
1955-68 Máximo	4	0	16	94	286	631	287	347	566	1354	378	9	2698
Mínimo	0	0	0	0	0	131	2	3	138	243	0	0	959
Promedio Nº dias pluvial	0.1	0	1.6	1.3	7.2	13.3	6.7	7.0	14.0	11.0	3.7	0.3	66.2
CHINANDEGA - Promedio	0.3	3	4	29	149	405	227	199	390	511	102	5	2069
1955-68 Máximo	3	19	29	131	356	822	424	426	478	1640	289	64	3583
Mínimo	0	0	0	0	0	165	69	61	281	254	30	0	1435
Promedio Nº dias pluvial	0.2	0.3	0.2	1.7	7.8	19.0	13.5	13.2	21.9	21.7	6.5	0.6	106.6

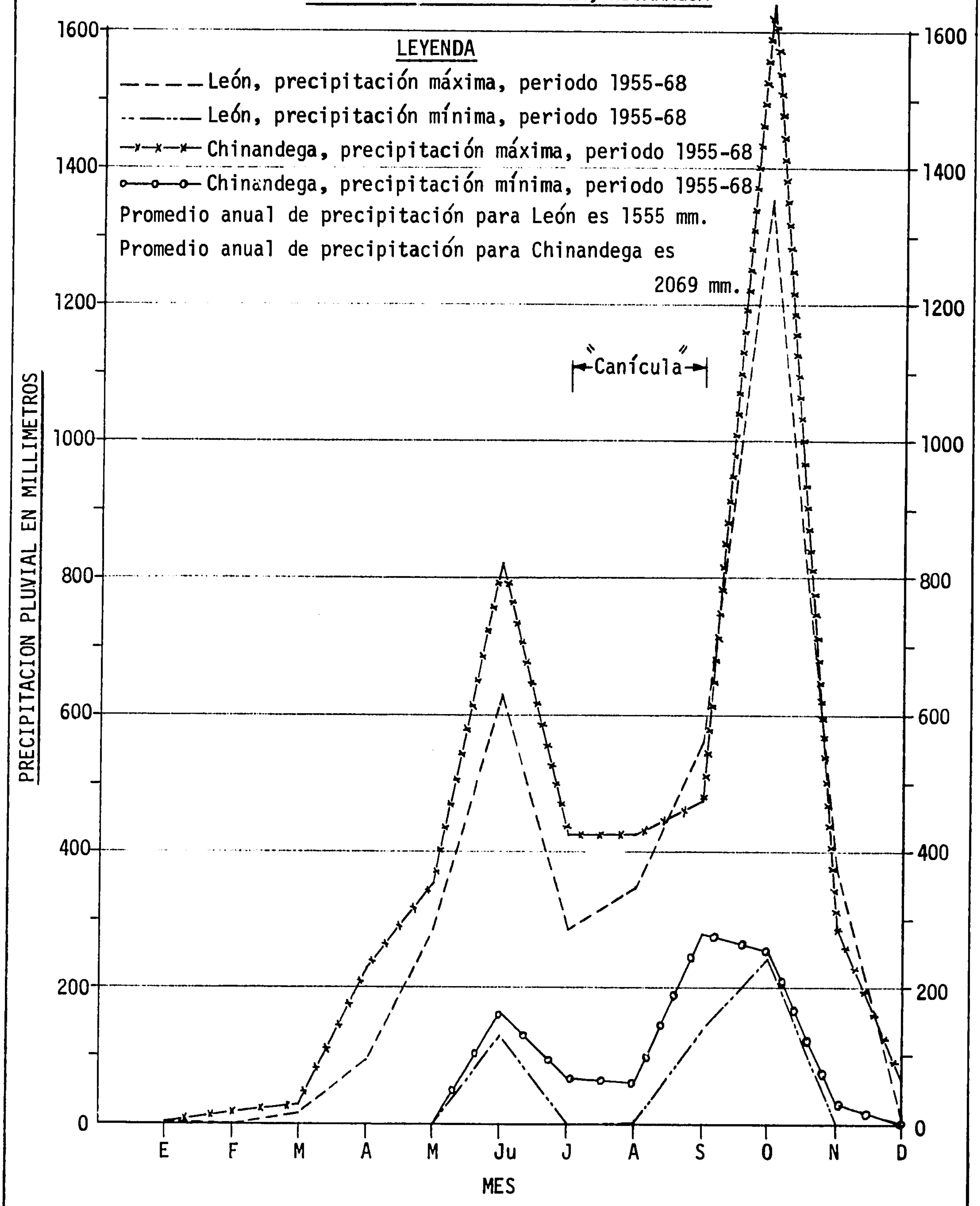
Estaciones de Proyecto Adelante

Estación	En.	Feb.	Mar.	Abr.	Mayo	Ju.	Jul.	Ago.	Sept.	Oct.	Nov.	Div.	Anual
				(1970)	(1970)	(1970)	(1970)	(1970)	(1969)	(1969)	(1969)		
Sitio de Cooperador #4	0	0	0	-	-	219	149	187	304	293	132	0	
#8	0	0	0	-	130	210	148	279	271	373	75	0	
#13	0	0	0	-	193	244	147	292	366	308	114	0	
#50	-	-	-	-	-	-	-	-	407	-	-	-	
#62	0	0	0	-	-	-	128	216	400	366	83	0	
#84	-	-	-	-	-	152	-	224	254	547	-	-	
#86	0	0	0	-	171	244	128	359	-	680	279	0	
Oficina Central de Adelante, León	0	0	0	43	198	126	195	328	325	745	202	0	
Campamento de Carreteras, León	0	0	0	20	175	145	125	216	-	533	147	0	

Fuente de Datos: Servicio Meteorológico Nacional - León y Chinandega
Sitios de Cooperadores - Proyecto Adelante, MAG

FIGURA 3-4

PRECIPITACION PLUVIAL EN MILLIMETROS
AREA DE LEON Y CHINANDEGA, NICARAGUA



Promedio anual de precipitación para León es 1555 mm.
Promedio anual de precipitación para Chinandega es 2069 mm.

Fuente: Servicio Meteorológico Nacional, León y Chinandega irrigated or non-irrigated.

Tropical hurricanes seldom, if ever, have extended into the Pacific Zone of Nicaragua. Most storms are of the convective type, and occur in the afternoons or evenings. Generally they are of short duration. The "temporal" storms, lasting from a few hours to several days, are of the cyclonic type, and bring large quantities of water.

October is the month in which the greatest storms and precipitation amounts have occurred. In October 1960 precipitation of 1354 mm (53 inches) was recorded in Leon and 1640 mm (65 inches) in Chinandega. 800 mm (31 inches) of rain fell in Chinandega from October 27 to October 30, 1960 the greatest intensity being 81 mm/hour (3.2 in./hour), during one of the temporals which occurred that month. (Source: Natural Resources - Cadastral Inventory, Nicaraguan Pilot Project, U.S.AID, U.S. Army, and GON Office of Planning, March 1966).

3.23 - Temperature

The relative uniformity of temperature throughout the year can be noted from the data in Table 3-2 and in Figure 3-5(a). The climate is warm, but not hot, and frosts never occur.

Data collected by the Project at Cooperator Sites falls within the experience range of the Chinandega station.

3.24 - Relative Humidity

Useable data on relative humidity in the area is non-existent, except for recent data collected by Project Adelante at Cooperator Site No. 8 in 1969 and 1970 and summarized in Table 3-2. Data exists for the Chinandega station, but for only one measurement per day, taken at 7 a.m. The humidity at that time of day is almost always greater than the daily average, and hence gives an incorrect impression of the area humidity.

A hygrothermograph installed in the late Spring of 1969 at Site No. 8 unfortunately malfunctioned most of the time, and relatively valid continuous relative humidity readings did not begin until almost the Spring of 1970. Dry and wet bulb readings were made at the Site each day also. When operating correctly, the hygrothermograph indicated that peak (95-100%) relative humidity values occurred at night (when not raining), start dropping about 6 a.m., and reach a minimum about 2 or 4 p.m., at, or shortly after, the time of maximum daily temperature. Average daily relative humidity during the dry season may be in the range of 65 to 70 percent. On rainy days the average may be 90 to 95 percent.

3.25 - Evaporation

Evaporation data for Chinandega is suspect in that many of the values recorded are outside, by appreciable amounts, normal ranges of values expected for the climatic conditions of the area. Evaporation rates less than 2.5 mm/day would not be expected, and even if occurring, never to persist for a period of 30 days. Hence monthly recorded values for pan evaporation less than 90 mm/month are suspect. At the same time, evaporation rates greater than 20mm/day would be expected to be rare, as would monthly rates of 500 to 600 mm.

CUADRO 3-2

TEMPERATURA, HUMEDAD RELATIVA, EVAPORACION Y DATOS DE VIENTO - AREA DE LEON Y CHINANDEGA, NICARAGUA

Estación	En.	Feb.	Mar.	Abr.	Mayo	Ju.	Jul.	Ago.	Sept.	Oct.	Nov.	Dic.	Anual
				TEMPERATURA EN GRADOS CENTIGRADO									
CHINANDEGA													
Promedio entre 1956-68	24.4	24.7	26.5	28.0	27.1	26.4	26.9	26.8	26.4	26.2	25.4	24.4	26
Máximo Absoluto	41	39	40	39	38	38	39	38	39	37	39	36	41
Mínimo Absoluto	7.5	10	12	14	16	17	15	16	15	16	14	11	7.5
Máximo Promedio	32.5	33.5	33.6	34.8	33.4	31.2	32.8	32.7	31.7	31.2	31.8	32.3	
Mínimo Promedio	16.7	17.0	17.0	20.4	21.4	21.6	21.2	20.9	21.0	21.2	19.4	18.0	
Cooperador Sitio #8 1/													
Promedio	25.4	26.8	28.0	28.6	28.2	27.8	26.7	26.1	23.8			25.6	
Máximo	36.8	37.0	35.0	35.0		34.5	33.4	33.9	30.0			32.8	
Mínimo	16.1	16.7	18.9	18.9		21.2	20.7	18.7	18.1			16.1	
1/ Datos de 1969-70													
				HUMEDAD RELATIVA EN POR CIENTO									
Cooperador Sitio #8 2/													
Máximo	100	100	100	100	100	100	100	100	100			98	
Máximo Promedio		85.7	96	95	99.6	97.8	99.5	99.0	99.6			96	
Mínimo Promedio	41.2	46.8	49	52	55.1	57.8	58.6	58.1	65.5			55	
Mínimo	30	37	42	42		50	50	46	58			35	
2/ Datos de 1969-70													
				EVAPORACION EN MILLIMETROS									
CHINANDEGA* 3/													
Promedio Mensual	150	153	176	164	133	131	147	126	122	179	104	128	1717*
Máximo Mensual	226	229	257	269	202	328	247	196	166	870*	141	217	2348*
Mínimo Mensual	117	122	139	140	30*	73*	86	89	56*	41*	65*	[illegible]	1480
3/ Datos entre 1955-68													
Cooperador Sitio #8 4/													
Mensual	257	256	236	285	246	192	158	180	161			197	
Promedio Diario	8.28	9.15	7.62	9.5	7.94	6.4	5.1	5.8	5.4			6.34	
Máximo Diario	10.4	15.4	11.0	17.0		10.5	7.9	10.0	7.2			9.1	
Mínimo Diario	3.0	3.3	3.6	2.6		3.6	3.1	3.3	3.6			3.2	
4/ Datos de 1969-70													
				VIENTO EN KILOMETROS POR HORA A 10 METROS ARRIBA LA SUPERFICIE									
AEREOPUERTO LAS MERCEDES													
CERCA DE MANAGUA - 1968	13.7	11.7	15.0	12.4	4.1	7.6	11.7	10.2	6.1	5.7	6.7	12.4	
				NEBULOSIDAD EN ESCALA DE OCHO									
MANAGUA 5/													
Máximo Medio Dario	6.5	5.9	5.9	6.5	7.3	7.8	7.8	7.7	7.9	7.8	7.0	6.5	7.1
Mensual Medio	3.8	3.5	3.5	4.4	5.6	6.7	6.6	6.3	6.5	6.5	5.0	4.0	5.2
Mínimo Medio Dario	0.9	0.8	0.9	1.8	3.4	4.7	4.4	3.8	4.3	4.5	2.4	1.3	2.8
5/ Datos entre 1958-66													

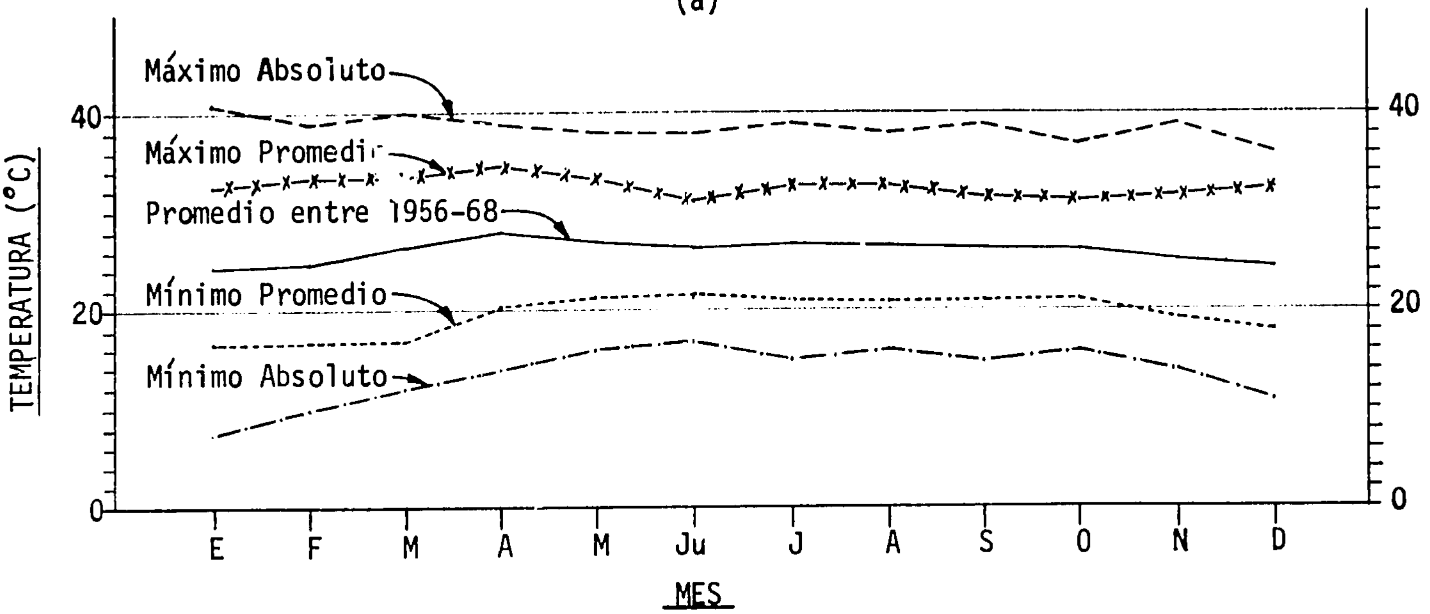
Fuente de Datos: Chinandega: Servicio Meteorológico Nacional
Cooperador Sitio #8: Proyecto Adelante y MAG
Las Mercedes: Informe de G.H. Hargreaves, Diciembre de 1969, sobre el "Proyecto Adelante"

FIGURA 3-5

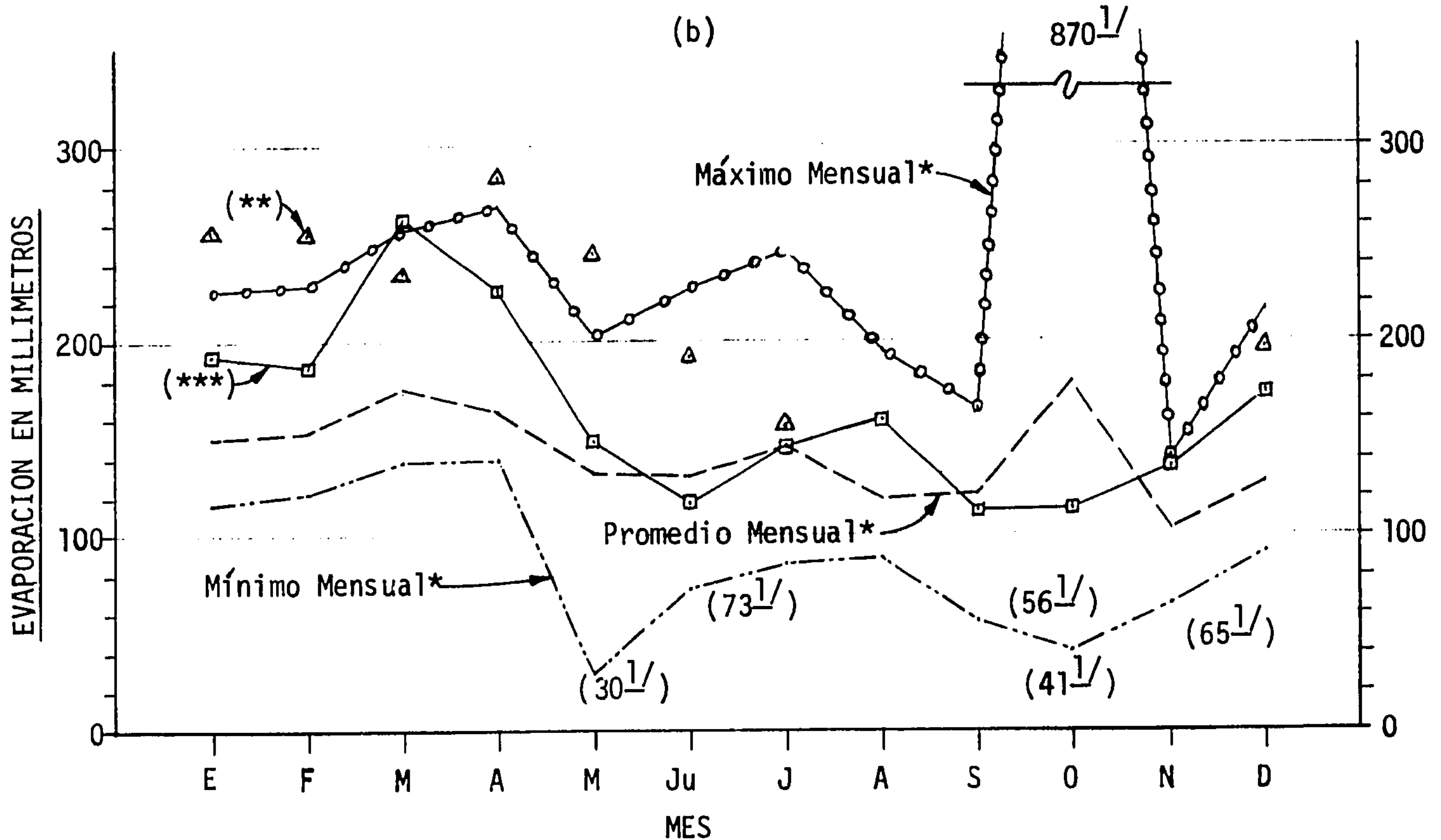
DATOS DE TEMPERATURA Y EVAPORACION

AREA DE LEON Y CHINANDEGA, NICARAGUA

(a)



(b)



* Datos de la estación de Chinandega, periodo 1955-68: ** Datos de Proyecto Adelante, Sitio #8, años 1969-70: *** Calculado por la ecuación de Christiansen, ASCE, Junio,1968
1/ Datos sospechosos

Evaporation data from a U.S. Weather Bureau Class "A" Pan at Cooperator Site No. 8 in 1969-70 tends to confirm the preceding statements. Monthly recorded values approached or exceeded values indicated as maximums during dry months at Chinandega. See Table 3-2 and Figure 3-5(b).

Evaporation then remains among those items for which additional data needs to be collected. In the interim, an average annual pan evaporation of around 2000 to 2500 mm is probably indicative of what might be expected under project conditions.

3.26 - Wind and Cloudiness

Only qualitative information on these items was available in the project area. It is reported (U.S.AID, U.S. Army, Catastro, 1966, previously cited) that, except for a couple of months during the dry season, winds are moderate. Strong winds then sometimes cause crop damage. 1968 data from the main airport near Managua are shown in Table 3-2.

Cloudiness is another climatic factor which affects crop growth and water use. Data from Managua is included in Table 3-2. As would be expected, cloudiness is greatest during the rainy season.

3.3 - WATER

3.31 - Surface Water

The Project Adelante Area is characterized as being one of the poorest in the country in terms of surface water supplies, despite a high rainfall during 6 months of the year. Permanent river flows in winter and summer are few in number, while natural lakes and ponds are practically non-existent. It is typical of the entire Pacific Coastal drainage area, which consists of numerous short, generally steep (except in the lower reaches), river channels. River lengths vary between 10 and 50 KM.

The only flows that are considered worthy for use as sources for irrigation are the summer flows. These, however, are very poor, and the possibility of constructing large reservoirs for the storage of summer surplus flows for later release during the dry season, is remote, due to the topography, permeability of the soils and the value of lands that would be submerged by such works.

A few privately-owned diversion dams, some being of temporary nature, have been built along the lower reaches of some of the rivers to divert water to adjacent lands. Flows decrease considerably as the dry season progresses, and many of the streams become intermittent, with no flow, before the end of the season. Hence irrigation development from surface supplies has been limited.

The Posoltega River, for example, is used as part of the total irrigation system of the "Ingenio San Antonio" sugar estate, which is the most complete and extensive irrigation system in the entire northwestern zone of the country (11,000 manzanas of sugar cane and 2,000 manzanas of pasture). In addition to the river flow it has been necessary to drill 40 wells, of reported capacity up to 2,000 gallons per minute, to meet peak irrigation requirements.

The only stream near the project area with some years of gaged runoff is the Tamarindo River, which is a few kilometers south of the area. It has been equipped with a recording gage since 1954. The average annual flow during the seven year period 1958-64 was 2.6 cubic meters per second. The maximum monthly average was 15,500 cms, for October, while the maximum year averaged only 5.6 cms, and the minimum year averaged only 0.84 cms.

While this is one of the larger coastal streams, its runoff characteristics are believed to be typical. River flows in this region have a wide range of variability, and can change rapidly. While the high water on the Tamarindo from the October 1960 temporal lasted for more than three days, storm runoff normally drains away quickly.

The hydrograph of the surface runoff for the October 1960 storm in the Tamarindo had a volume equivalent to a runoff of 162 mm from the drainage basin area. Since rainfall over the basin was estimated as 600 mm, the surface runoff was about 26 percent of the rainfall. The subsurface runoff, including baseflow, was estimated as about 24 percent of the rainfall.

Stream waters in the area generally are suitable in quality for irrigation, but exceptions have been noted in some areas of Nicaragua which apparently are influenced by water from some types of volcanic deposits. Hence the quality of any proposed source, especially small local springs or streams, must be checked before planning for utilization proceeds very far.

In the extreme north and in the northeastern part of the project area lies the drainage area of the Rio Estero Real. While it drains into the Gulf of Fonseca and the Pacific Ocean, it is considered separate from the general Pacific Coastal Drainage Basin. The main channel has a length of 137 KM. and a total drainage area of about 3,000 square kilometers. Principal tributaries are the Villanueva (and its tributaries, the Rios Achuapita, Grande, El Portillo, and Quebrada Seca), and the Rios Tecomapa, Olomega and Galilao. In October 1966 a Reconnaissance Survey and Report made to the U.S.AID Mission in Nicaragua by Development and Resources Corporation of New York City, identified this basin as having perhaps the best potential in Nicaragua for substantially increasing intensified irrigated agriculture in the Pacific Zone. A proposed reservoir on the Rio El Portillo below its confluence with Rio Grande, might provide a firm water supply for about 11,000 manzanas of irrigated land.

The Salvadorita-Malpaisillo Unit of the Rio Estero Real Basin comprises the eastern portion of the Project Adelante area, and has perhaps 30,000 gross manzanas of cultivatable land. This unit would not receive water from the proposed reservoir, but the referenced report indicated the belief that a total watershed development plan in this area could include both surface and ground water development. (One of the cooperator sites, No. 13, is in this unit).

Complete studies are needed in the Estero Real Basin before the feasibility of any of the suggested plans can be established.

3.32 - Ground Water

Ground water is plentiful in a great portion of the project area, especially the western part, and not too deep. All recent prior studies in the area, including those sponsored by U.S.AID and FAO, have recognized this important area asset. More than one government-sponsored program of investigation and development are in progress now to determine the full extent of this resource, and/or to utilize it for irrigation development, in addition to continued private development of wells. While the latter continues, past well development has been primarily for domestic, and stock watering purposes, but irrigation uses have been increasing, mostly for bananas, sugarcane, and pasture.

Practically all of the ground water is found under free water table (unconfined) conditions. Depths to water in the Leon area range from one meter to more than 65 meters below ground surface. In the Malpaisillo area static water levels are from 30 to 65 meters below ground surface, but drilling a well here is more risky in that there seems to be more opportunity of the water being corrosive. Figure 3-6 has been prepared to show in a general way only, the location and nature of various ground water zones in the project area.

The ground water aquifers of the Leon area consists of pyroclastic material and volcanic ash, covered with a thick layer of permeable soil which acts as an excellent recharge source. Very preliminary estimates by U.S.AID in 1966 indicated that the annual recharge might be in the range of from 75 to 150 mm depth over the entire area near Leon. If present studies confirm this, the safe yield of the underground aquifers is a very large, and significant, quantity of water.

Individual well yields vary, of course, with location and the knowledge, skill, and performance of the well driller. Yields as high as 2000 gallons per minute (gpm) have been reported. Project experience confirms that this is not an unexpected yield. One project well yields about 1400 gpm. It has a depth of 260', a drawdown of 32' and a static water level of 25' below ground surface. The casing diameter is 12". The specific capacity then is 43 gpm per foot of drawdown.

Other project wells varied from an 8 1/2"-diameter casing to 12" casings, and from 160' to 240' in depth. Yields were from 300 to 600 gpm, and specific capacities from 8 gpm/foot to as high as 66 gpm/foot. These generally can be considered good yielding wells.

Ground water quality throughout the area is considered to be good. The United Nations Ground Water Study Team now studying the area has found this to be true to-date. Since the commencement of Project Adelante in early 1968, no ground water unsuitable for irrigation came to the attention of project staff, although many water analyses and verbal inquiries were made. The water supply from a spring at one cooperator site, while too saline for some salt-sensitive crops, successfully helped produce more salt-tolerant crops. Again, as for surface water supplies, water analyses should be made so that the quality of the water, and its proper application, can be ascertained.

3.33 - Relationship between Ground and Surface Waters

Surface runoff from storms disappears rather rapidly in the area; within a few hours or days. The flow in the rivers after the surface runoff has passed, is sustained by ground water flow, which in turn is replenished annually from infiltrating precipitation over the entire area.

As ground water use in the area increases, some lowering of subsurface water levels will occur during the dry season. These levels then will rise again as the underground reservoirs are replenished during the wet season. This lowering of ground water levels will tend to cause a decrease in ground water flow to nearby streams, and consequently they may "go dry" earlier than at present. Some reports were received that such a decrease in surface flows may have occurred already, but verification or dismissal of this claim cannot be achieved without careful collection of facts and detailed studies. If such does occur, those who are affected directly, such as diverters from surface streams, will be the first to notice. However, any such tendency noted in the dry season of 1967-1968 probably resulted from the below normal rainfall which occurred in the 1967-1968 wet season immediately preceding, rather than from ground water pumping, which still is very limited in extent and amounts.

GROUND WATER QUANTITY ZONE DESCRIPTIONS

DESCRIPCIONES DE ZONAS CUANTITATIVAS DE AGUAS SUBTERRANEAS

▒	Estero Real Basin	Excellent chances of obtaining high yield wells with low pumping lifts.	Cuenca Estero Real	Excelente: Buenas posibilidades de encontrar pozos de alto rendimiento y con bombeo de succión baja.
▥	Malpaisillo Basin	Risky: some chance of hitting hot corrosive water high in sulfur. Moderate to deep pumping lifts.	Cuenca Malpaisillo	Riesgoso. Hay posibilidad de encontrar agua corrosiva caliente con alta cantidad de azufre. Bombeo de succión moderada a profunda.
▩	Volcanic Ridge Foothills	Good to poor: higher incidence of hitting a dry hole in this zone. The recharge basin is limited and the pumping lifts will be moderate (120') to high (200').	Cerros al Pie de La Cordillera Volcánica	Posibilidades buenas a pobres: Alta probabilidad de encontrar pozos secos en esta zona. La cuenca de recarga es limitada y el bombeo es succión moderada (120') a alta (200').
▨	Pacific Bench	Good to excellent: This area is laced with deep drainage channels and the outflow of these streams seems to be highest during the dry season. The pumping lifts will be low to moderate (75' to 100') depending on relative elevation and nearness to a drainage channel.	Mesa del Pacifico	Posibilidades buenas a excelentes: Esta área está enlazado con cauces profundos y el efluente de estos aparece ser más alto durante la época seca. El bombeo es succión bajo (75') a moderada (100') dependiendo de elevación relativa y lo cercano a los cauces.
░	Rio Grande Basin	Excellent: Relatively low pumping lifts (50' to 75') and excellent recharge basin.	Cuenca Rio Grande	Posibilidades excelentes: Bombeo de succión relativamente baja (50 - 75 pies) y cuenca de recarga es excelente.

PROYECTO ADELANTE

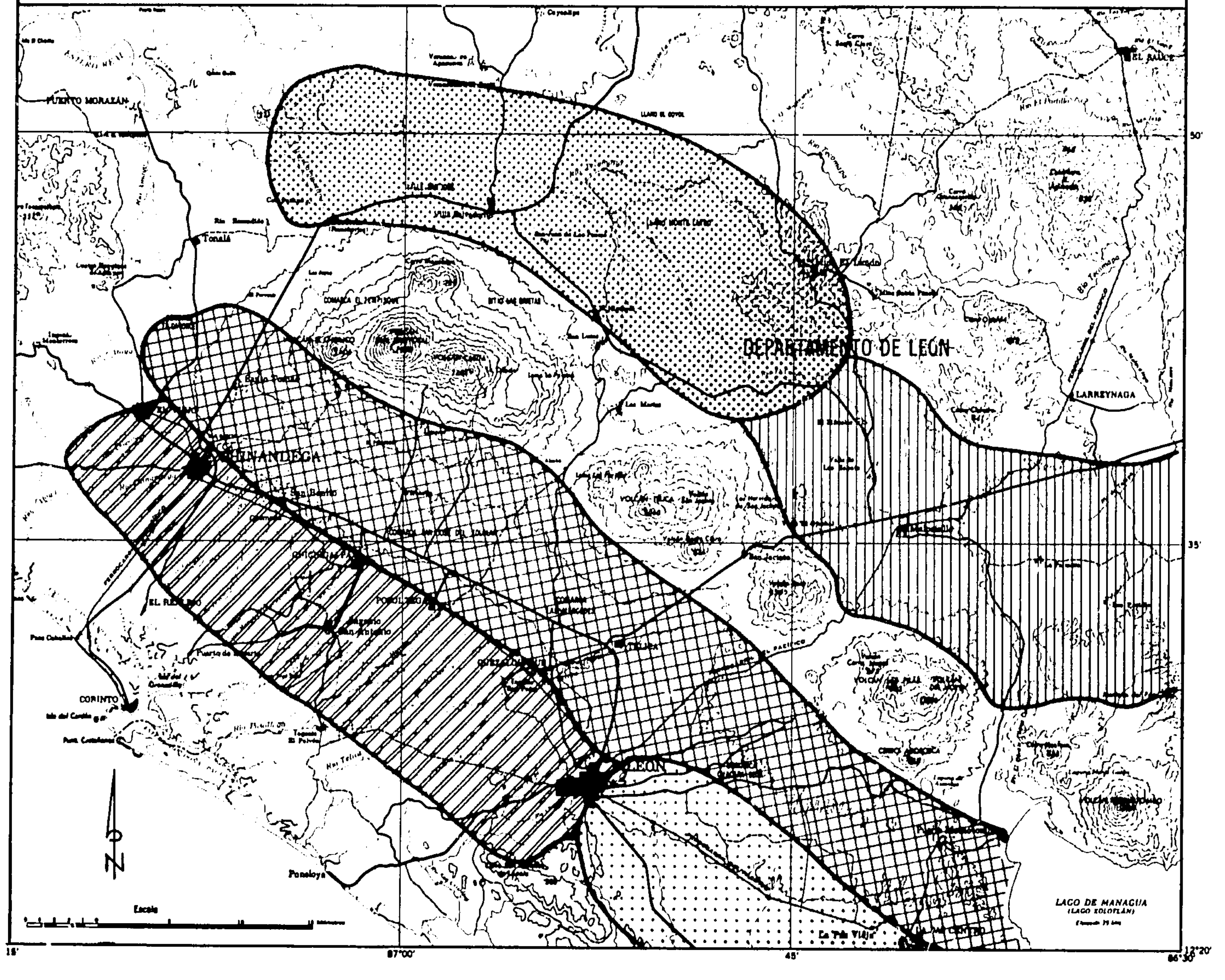
MINISTERIO DE AGRICULTURA Y GANADERIA EN
COOPERACION CON U.S.A.I.D.
UNICONSULT INC.

GROUNDWATER QUANTITY ZONE MAP
ZONAS CUANTITATIVAS DE AGUAS SUBTERRANEAS

See opposite page for description of zones shown below.

Véase página opuesta para descripciones de las zonas delineadas abajo

FIGURA (FIGURE) 3-6



Nevertheless, it is worthwhile to note the direct physical relationship, and sequential cause-and-effect, between ground and surface waters. Intelligent water resources development requires simultaneous consideration of both types of water, and their interrelationships. Integrated planning and operations considering both types are known as "Conjunctive Operations" of ground and surface water systems.

3.34 - Water Rights

At the present time Nicaragua has no formal Water Code, and few (if any) actively-enforced regulations covering the withdrawal, diversion, or use, of surface and underground waters. This is a normal situation in areas where water is considered to be in surplus supply. The majority of states in the U.S.A., in 1950, were in a similar situation. It is when water becomes a scarce commodity that the need for formalized laws, and regulations governing its use, and enforcement, becomes mandatory in societies which use law as an instrument of equity and justice.

Nicaragua does have several laws relating to water, but there is no regulatory or recording agency, other than the Judiciary. That is to say, unless a person can reconcile his differences with his neighbor in a dispute over water, his only legal recourse is to the courts, and each case requires an independent investigation of all facts. Unless a court decision has been rendered, one would have no way to prove his right to a water use, and even then, such a decision probably would not be binding upon persons who were not parties to the court action.

Now that the potential of irrigation has begun to be realized, Nicaragua has initiated action to develop a modern Water Code (or Law). The Ministry of Economics, Industry, and Commerce has been working on this project now for several months, and has completed a draft of Basic Principles. Other studies also are being made which include aspects of this subject (i.e., the Natural Resources Inventory; the UNDP Ground Water Study; the FAO Study of Water Law in Central America).

Irrigation development cannot achieve its potential in the Project area until a Water Code has been successfully implemented. The reasons for this need, together with recommendations on the establishment of a National Water Commission and on basic principles of a Water Code, were set forth in a Project Adelante Special Report to MAG in May 1968. That report is included as Appendix I of this Final Report.

The Minister of Agriculture and Livestock took official action in August 1968 to implement some of these recommendations, but government action was delayed, for various reasons.

3.4 - PEOPLE

As may be seen from perusal of Figure 1-4 in Chapter 1, the Project Area is well-populated. There are ample supplies of farm workers, farm superintendents, mechanics, and businessmen of all types necessary to support a more intensive type of agriculture, such as is irrigated agriculture. As has been mentioned previously, the existing cotton agriculture is very modern, in practically all aspects, including the use of mechanical pickers, airplane spraying, and cotton ginning. Many of the Nicaraguan farmers and businessmen are highly-educated; several being graduates of U.S. engineering or agricultural schools. While most lack specific experience in irrigation, they have all the abilities necessary for success in such work including the attributes of being shrewd businessmen, with the desire, although not always the means, to maintain their generally progressive attitude which has helped the area develop.

The two greatest deficiencies in the area of human resources, which tend to hold-back accelerated agricultural development, are:

1. Lack of sufficient numbers of high-level technical personnel such as engineers and agriculturists.

2. Lack of organizational frameworks at the national and local levels through which farmer groups and the government can act cooperatively to plan, finance, execute, and operate irrigation, soil conservation, flood control, and drainage works, including many important aspects of marketing, credit, and supplies which, although coming through the private sector, may need government encouragement and assistance.

The more rapidly these deficiencies are diminished or eliminated, the more rapid will be the pace of economic development in the Pacific Zone of Nicaragua.

3.5 - TRANSPORTATION

Roads - One of the Country's major highways which connects Managua with the port of Corinto, traverses the project area. This is a first class all-weather highway which passes through the important cities of Leon and Chinandega, and the major villages of Telica, Quezalguaque, Posoltega and Chichigalpa. Important branches of this road are: Route 24, from Chinandega to Somotillo, which is also paved and which passes through the important agricultural center of Villa Salvadorita; Route 26, Telica to San Isidro, also a first class all-weather road, which connects the Pacific Zone departments with those of the Zone of Segovias and the towns of Malpaisillo and Santa Barbara.

This network of primary roads is further complemented by a system of secondary and tertiary roads of which the following are the most important: the road between Chinandega and Cosigüina, also called the "millionaires highway", is in the process of construction and until construction is completed is passable only during the summer months; Route No. 22, Chinandega to El Viejo and No. 14, between Leon and Paneloya are both asphalted; the roads between El Viejo and Torrala, from El Viejo to Ingenio Monterrosa and between Chichigalpa and Ingenio San Antonio to Puerto Esparta are passable throughout the year.

Inter-communication between the rural inhabitants is made possible by the extensive network of roads described above and assures access to most of the villages within the area.

Railroad - The Pacific Railroad of Nicaragua connects the capital of the country with its important maritime port of Corinto and the cities of Nagarote, La Paz Centro, Leon, Pasoltega, Chichigalpa, and Chinandega. An important branch line connects Leon with El Sauce. The old Chinandega-Puerto Morazan spur is no longer in service. A narrow gage line is owned and operated by the Sugar Estates ("San Antonio") and connects the refinery with the cane fields and the seaport of Esparta.

The importance of the railroad has diminished with the advent of more and better roads but never-the-less continues to be a means of transportation that is economical and safe, especially for the transporting of large and heavy loads.

Seaports - Corinto is the principal seaport of Nicaragua, and one of the better ports in Central America. Its present utilization exceeds its designed capacity, due to the fact that more than 50% of the country's exports and imports are handled at this port. It is only 20 kilometers from Chinandega, and 50 kilometers from Leon. Other nearby ports include the Port of Somoza, some 50 kms. from Leon, on the mouth of the Tamarindo River; the small private Port of Esparta, belonging to Ingenio "San Antonio"; and the Port of Potosi, situated on the Cosigüina peninsula, which jointly serves El Salvador by means of ferryboat service.

Airports - In the cities of Leon and Chinandega are located the airports of Goday and El Picacho, respectively, which serve privately-owned aircraft as well as those which are rented and used for agricultural spraying. There is no regular commercial airline service to these airports and their use is strictly for agricultural enhancement of the region. In addition to the two airports previously mentioned, many of the larger farms have landing strips which are used by the owners for their own aircraft, and aircraft used for spraying crops.

3.6 - COMMUNICATIONS

A comprehensive system of communications links the project area with the capital city of Managua and other important cities of the country. The communications network consists of telephone, television, newspaper and telegraph service.

Leon and Chinandega have automatic telephone service which serves private subsribers as well as government offices. The smaller outlying communities are generally served by a few phones, usually installed in public buildings, for the entire community to use.

There are no television stations within the project area. However, television programs are received from two channels located in Managua, which serves approximately 10,000 T.V. sets in the country in 1967.

In addition to the major newspapers published in Managua, two local newspapers, "Novedades" and "El Centroamericano", are edited and printed in Leon. The combined subscriptions of these latter newspapers totalled over 23,000 in 1965.

Radio-telephone circuits link the east and west coasts, and telegraph service extends to all parts of the Country. The National Radio, with 47 broadcasting stations, is operated by the Government.

3.7 - ENERGY

Electric power is available throughout the western portion of the project area through the facilities of ENALUF, an autonomous government department. While distribution networks are incomplete as yet, electricity can be considered as being available at relatively reasonable rates anywhere in the western project area. The ENALUF network and local cooperative distribution networks are being improved with the aid of a recent $10.2 million loan from AID in 1968.

Power in the eastern and northern portions of the area is not yet completely tied into the main ENALUF network, but the principal cities and villages receive power from diesel-electric generating plants, most owned by ENALUF or local government agencies, although some are privately-owned.

The large sugar estate at Ingenio San Antonio owns and operates a large steam-electric generating plant. There is one small hydro-electric plant near Chichigalpa.

60-cycle alternating current is generated, and supplied to customers normally at 240/120 volts, 3 or single-phase, as in the United States.

3.8 - ECONOMIC ACTIVITIES

The project area and its environs are predominantly agricultural. Consequently most all of the economic activity revolves around the agricultural sector. Cotton plays a major role in the economies of Leon and Chinandega; the principal industrial plants of these departments consist of cotton gins and cotton seed oil extraction plants. The largest sugar refinery in the country, called "San Antonio", is located in the department of Chinandega. This refinery produces approximately 70% of the total sugar consumed in the country as well as other products produced from sugarcane such as rum, molasses, and industrial alcohols. The refinery employs many technical people including agronomists, economists, field-labor personnel and others, thereby making it a major source of employment and business activity in the project area.

The National Bank of Nicaragua, which is the prime lending institution of the Country, has branch offices in most of the larger populated towns within the two departments. It makes loans to farmers primarily for cotton and livestock farming.

Agricultural implement agencies are very active in the area. Even the smallest farmer has basic farm equipment consisting of a tractor, disc, plow, planter, and other minor implements, all of which has led to the establishment of equipment repair and maintenance shops and a permanent outlet for replacement parts, gas, oil, lubricants, etc.

The combination of all these agriculturally-related elements generates the circulation and increase in capital which is used in the development of public works, betterment of the community, a broader field for investments and a higher standard of living for the area inhabitants.

Chapter 4

AGRONOMICS

Chapter 4

AGRONOMICS

4.0 - INTRODUCTION

4.01 Soils

The soils and climate within the Project area make it possible to grow a wide selection of crops. The soils range from a heavy clay to sand with a large extension of deep clay loam and loam types (rated as Class I and II soils in the land use classification). Many crops of the temperate zone can be grown successfully as well as the crops of sub-tropical and tropical zones.

4.02 - Crops

The Project area was known as the "breadbasket" area during the colonization of the Spanish in Central and South America. During this time corn, beans sesame, cotton and citrus were cultivated along with other tropical fruits and vegetables. The flourishing cotton market of the late 1940's changed the area to a monoculture type of farming. Even citrus groves were taken out and nearly all of the tillable land was planted to cotton. Modern farm equipment and practices for cotton production were introduced during the 1950's.

Cotton production fits into the weather pattern of the area. The early rains of May and June wet the soil profile for seedbed preparation, followed by planting during July and August. Within these two months the period of less rainfall known as the "canícula" provides a period for harvesting and planting. The rains normally increase again in intensity during September and October, then slackening again in November and stopping completely from November 15 to May 15. During this dry period, the cotton can be harvested. Even farmers with poorer practices and management were able to make a profit because of this ideal rainfall pattern coupled with low labor costs and good cotton prices.

During the late 1960's, the price for cotton began to decline. Along with this, the Nicaraguan farmer was experiencing an increase in production costs. The control of insects often required more than 30 applications of insecticide; the modern equipment for cotton was requiring expensive repair and replacement; and years with either excessive rain or drought were lowering yields and profits.

Cotton is not expected to disappear from Nicaragua, but farmers will begin to limit the acreage to best adapted lands.

4.03 - New Requirements Under Irrigated Farming

Irrigated farming requires a completely new concept of management for most Nicaraguan farmers. It requires management skills as well as organized crop planning, schedule of operations, complete cost records and the ability to analyze and improve production methods. No longer can the farmer let his farm foreman and laborers supervise the operations, nor merely hope for a market for his produce. He must take an active part in all phases of his agricultural business.

4.1 - SOILS MANAGEMENT

4.11 - Plowing

In the short time Project Adelante operated it was evident that certain changes were needed in soil management. Proper tools are not always available to the farmers. The following discussion covers the use of such tools as the moldboard plow, the rototiller, spike tooth harrow, and others.

The basic operation in preparing the soil for growing a cultivated crop is plowing. In the more advanced agricultural countries, the moldboard plow is the most common implement used. It breaks the soil loose, and inverts the soil covering the trash and weeds. The moldboard plow is considered an important tool in preparing a seedbed with a minimum of additional tillage and subsequent moisture loss. The two-way plow (this has two sets of plows with one set moving the soil to the left and the other to the right) keeps the soil from getting out of level which is important in irrigated farming. In addition the performance of wide equipment such as four- or six-row planters is improved following moldboard plowing.

Moldboard plows are practically non-existent in Nicaragua. It's not known how the disc plow became so commonly used, but no doubt the disc plow was part of the general farm equipment that was brought into the program when the improved cotton equipment was brought in from the United States. There's no question but that the moldboard plow will play an important role in Nicaragua. Prior to its being generally used, there will have to be moldboard plows brought in by the equipment dealers. They will have to be demonstrated and spare parts will have to be available. The reduced trashiness following a moldboard plow, the improved turning of the soil, and the reduction in the unevenness of the land following plowing, are reasons why the moldboard plow should be encouraged.

A disc plow may be easier to adjust but observations of work being done by disc plows in Nicaragua illustrate that the plow depth is always the same, and is extremely shallow. At the depth where the plow hits, a very definite plow pan is being developed in a large number of the fields in Nicaragua. This is particularly important to cotton growers because the cotton root is so sensitive to an impacted layer.

If these were soils containing rocks and tree stumps, there might be some argument in favor of the disc plows. At present they are doing an extremely poor job in the fields of Nicaragua, and causing mechanical problems that are adversely affecting crops.

4.12 - Seedbed Preparation

The rototiller is an implement that mulches the soil and pulverizes both the soil and trash with a series of spinning knives. Normally in more highly structured soils with finer textures the rototiller is not recommended for continued use. There are times, however, when the rototiller has advantages for soil preparation use in Nicaragua. Under conditions of irrigation when timing is so important, and farmers wish to get a crop in with a minimum of equipment operations, the rototiller can do the soil preparation quickly and effectively in one operation. This is particularly true following the chopping of cotton when growers wish to get a crop in immediately after picking. At the present time growers use a plow and then disk a number of times to prepare a seedbed. They spend a great deal of time and money to pulverize the soil, establish hardpans and lose all the available moisture in the topsoil. One operation with a rototiller would be far superior to the present method of seedbed preparation.

4.13 - Special Problems

Plowpan

A plowpan is often caused by continuous operation of an implement at the same depth. This layer can be broken up by changing the depth of the tool that's being used. Should it get to be too serious a problem, a subsoiler or chisel can eliminate the problem. Even though these soils in Nicaragua are extremely good with a high sand fraction, there will be adverse effects as a result of working them too wet.

Surface crusting

Work with these and other implements in the Project have indicated that a number of changes can be made in farm implements in Nicaragua to the advantage of the crop and the farmer. Instead of the continuous use of the disk harrow, it has been found in Nicaragua and in other countries, that final smoothing and mulching can be done more quickly and inexpensively with a spiketooth harrow. A large area can be covered quickly with a minimum loss of moisture. As farmers are aware, the soil surface can crust immediately after a rain or an irrigation. If this thin crust forms over small-seeded crops, the crop may be lost or the stand reduced and require replanting. The crust can easily be broken with a rotary hoe or spiketooth harrow. This operation must be done before the plant is pushing against the crust, so as to not injure the young emerging seedling. An additional benefit from this operation is the removal of young, emerging weeds.

Surface drainage

All of the crops in the Pacific Zone are planted flat at the present time. There are a number of advantages in planting many crops on a raised bed. This is particularly true in furrow-irrigated crops but is additionally true for dry land crops such as cotton. At the present time there is a minimum of equipment that can be used to do this job in Nicaragua. Furrowing shovels are required to make the furrows whereas bed-shapers are used to smooth and shape the beds. During the rainy season the furrows move the excess rain-water away from the young plants and provide immediate drainage. In the case of many crops, this will reduce the problem of root rot. In other locally grown crops such as yuca, it can provide for easier mechanical harvesting.

Information concerning the equipment used for furrowing and bed-shaping was supplied in monthly reports. The equipment can be used with bedded crops, by establishing the width from center of bed to center of bed, to the same width that growers are now planting cotton. On the top of each bed, two rows can be grown, each one toward the shoulder of the bed. This is particularly useful in the production of sesame, millet and even safflower. This would be useful for grain sorghum, but for the time being would not be the best distance for corn. In order to get a field in proper shape to furrow out it will be necessary for growers to either use a landplane, or if this is not possible, a simple wooden float. This can be made from heavy planks, on edge, to form a rectangle about 8 feet wide and 16 feed long. Boxes can be put on the corners to add rocks or sacks of sand for extra weight. A float of this type, built by Project Adelante, is extremely useful in land preparation.

Erosion

Green manure crops may play an increasingly important role in the Pacific Zone of Nicaragua. Under the heat conditions of the dry season in Nicaragua, it is important to keep a crop in the soil the year around. Organic materials burn up during the dry season. Under irrigation, lands will be in production throughout the entire year. In the event that it's impossible to plant a crop during the rainy season, a green manure crop of cowpeas, or some similar fast growing legume may be used in the rotation. These crops may be planted in May with the first rains, and turned under just before crop planting time during the canícula of July and August. A crop of this type will introduce the green manure component into the soil as well as the nitrogen it produces on its nodules, and will also serve to protect the soil from erosion during the period of heavy rainfall.

4.2 - PLANT NUTRITION

4.21 - Basic Fertilizers

The details of plant nutrition in Nicaragua are not as well understood as they are in the United States. Based on the experience in Project Adelante nitrogen is the most limiting element for crop production. With as much water going through the soil profile from rainfall alone, more visual symptoms, including general yellowing due to nitrogen deficiency, would be expected. Corn in Project Adelante definitely shows the visual deficiencies of nitrogen, firing of the lower leaves, and yellowing as it does in temperate zones. None of the crops in Project Adelante ever received enough nitrogen to reach the luxury range.

Urea has become one of the most popular sources of nitrogen. A characteristic of its action affects the efficiency of use in Nicaragua. When urea is applied to the soil, it is completely soluble and will be moved down in the soil profile as far as the water from rain or irrigation goes. This may take it below the roots. In a short period after application urea hydrolyzes to ammonium and fixes to the soil, and will not be moved deeper by water. The experience in Project Adelante indicates that increased amounts of nitrogen will have to be used with irrigated crops to get maximum production and most economic production. This allows higher populations of plants per manzana.

Soil information and crop observations indicate that phosphate is an essential requirement in the soils of the Project area. Phosphate must be available at the time the plant sprouts and during its initial stages, and if it is not available then, the farmer has adversely affected his crop and would be wasting money to put it on at a later stage.

Indications are that the potassium normally used by farmers in the Project area is not bringing them any crop return. Additional studies will have to be made to determine whether this is true in all soils.

Present levels of fertilization on Project Adelante farms are far from adequate. There should be large increases in nitrogen and phosphate applications on parts of each field, with careful yield checks.

4.22 - Minor Elements

The unknowns in nutrition in the Project area include the micro-elements. At one Project farm near Telica, certain areas of grain showed a striation in sorghum leaves. These symptoms were first thought to be zinc deficiency. Tissue analysis showed this to be boron deficiency. Subsequent crops on the same farm, both corn and castor beans, showed similar symptoms of minor element deficiency. The symptoms of the corn were exactly like those on the sorghum with striations on the leaves, and dwarfing of the corn in the young stages. The castor beans showed a leaf symptom of inner veinal chlorosis with distortion of the leaf. The results of a plot where boron was sprayed on both corn and castor beans were not definitive. On other Project sites where the level of nitrogen and phosphate was at a higher point, similar symptoms were observed. It is quite possible that there is micro-nutrient deficiency throughout the area that will be affecting crops. This may become of major importance when the nitrogen or phosphate levels have been raised to their proper level.

4.23 - Evaluation of Plant Nutrition in Project Area

Evaluation of nutrition in the area and on Project sites indicate that farmers are not putting on sufficient nitrogen or phosphate, and that the timing is wrong. There are losses of nitrogen due to leaching. The fact that potassium is being used on soils where it is not needed is not necessarily detrimental to yields but does cost extra money.

The two problems in plant nutrition are: timing of application and methods of application. At present, the amount of phosphate applied per manzana is inadequate and the method of application does not meet plant needs. Phosphate is particularly important to the plant in the young stages. If it is broadcast onto the field, and the plants haven't developed a root system, they get only a very small percentage of what is applied. As this is already a minimal amount, the plant does not receive the required amount.

Methods of fertilizer application are less than satisfactory throughout the Project area, due to inadequate equipment for broadcasting, for proper placement below the seed and for proper side dressing.

The facilities for determining plant nutrient deficiencies are inadequate for the farmers in Nicaragua. Programs of soil analysis have been started to provide guidelines for fertilizer recommendations. This is an important step in the evaluation of plant needs, but plant growth problems will require tissue analysis. At the present time there are no facilities in Nicaragua for this kind of study. It is too time consuming to check out all of the minor elements singly and in combination, covering all of the various conditions of soils in the Pacific Zone. It is recommended that tissue analysis be initiated in the near future.

Nitrogen and phosphate may be applied to a crop in luxury amounts. This is not always true in the case of potassium, or with minor elements. Growers should not anticipate a problem with zinc, manganese, or other minor elements. Based on tissue testing or previous experience, fertilizer applications can be made to plantings, but without these guides, use of these materials is not recommended.

4.3 - WEED CONTROL

4.31 - Hand

The long dry summer season from November to May is the most effective period for weed control in the Pacific Zone of Nicaragua. Methods employed for weed control in Nicaragua are hand cultivation - normally with a machete - and mechanical cultivation with the tractors.

The addition of irrigation has increased the weed problem severely on cooperator sites. A program for better weed control must be practiced through the use of mechanical devices and weed control chemicals where irrigated programs are carried out. The machete is an effective tool for many uses, but it is not a good weed control instrument. Many of the larger weeds are chopped with machete, which cuts them back but it doesn't eliminate them. The long handled hoe in the hands of a trained crew will clean up an entire field rather rapidly with little if any loss of plants, or when required, crews can carry on a thinning program along with the weeding. Project Adelante introduced long handled hoes onto the farms. Well-trained crews will be needed for weeding and thinning.

4.32 - Chemical

There will need to be more tests carried out with various types of weed control materials. These include the general contact killers such as week oils, for ends of the fields and buffer strips, and the selective pre-emergence and post-emergence sprays that are available on the market today.

4.33 - Mechanical

For mechanical weed control, a wide selection of equipment is available. The plow, disk harrow, cultivator and rotary chopper are on most farms in the project area. Some farms have the rotary hoe and on a few, there are spike-tooth harrows and tine or finger weeders. There are many other implements for general and specialized weed control. The existing equipment in the project area is adequate for good weed control if used correctly and adjusted properly.

Cultural techniques will need to be developed to reduce weed problems as the work in Project Adelante demonstrated. When crops are planted into good moist seedbeds, and not irrigated until they have gained an appreciable amount of growth, there is far less weed competition than in fields where the seeds are planted into inadequate moisture and irrigated for emergence. This procedure brings up weeds over the entire field, and requires cultivation while the planted crop is still extremely small. This not only causes loss to the planted crop but is an expensive operation.

4.34 - Weeds Common to the Project Area

The Pacific Zone of Nicaragua doesn't have a large number of serious weed problems that occur in other areas. Bermuda grass (Cynadon dactylon) does not become the problem as it does farther north. There is an extremely serious pest that may become an even bigger problem in the future, Nutgrass or Nutsedgel (Cyperus esculentus L., and Cyperus rotundus L.). This sedge develops small nutlets at the roots and the plant is extremely difficult to eradicate. Each time the top nutlet is cut off, the second one on the chain germinates and develops a new plant. If this kind of crop is disked and spread around the field, it will spread the weed throughout much of the field. Until recently there has been no really effective control for the crop. A parasitic insect has been discovered which eats this particular plant, and there is hope for eradication of this plant pest.

Under irrigated conditions of Project Adelante there were, in addition to the nut sedge, large populations of pig weed or red weed (Amaranthus) of more than one species. Another serious weed is Purslane (Portulaca Sp.), a fast-growing annual succulent weed which covers the ground very rapidly and extracts moisture and plant nutrients that should be used by the young crop plants.

There were fewer weeds in Project Adelante fields than would occur under other types of irrigation because the water did not contain weed seed. Irrigation water that is taken from a ditch, or a stream, or a lake, will often carry large amounts of weed seed which are broadcast over the fields. In these cases, screening devices should be placed after the pump in order to remove these seeds.

4.4 - DISEASES

4.41 - General

Following the introduction of new crops in the Project area, there was little occurence of plant disease; however, new crops became more widespread, disease problems became more important. There were some problems of significance that should be described.

4.42 - Major Diseases Affecting Project Crops

The corn in the Project area was affected very rapidly by stunt disease which is a new virus disease in the area. There were seedling disease problems on bean plantings, in some cases so severe that one planting had to be removed and another crop planted. The diseases that hit these beans acted like Rhizoctonia or Fusarium. These are disease organisms that attack the young germinating plant and are particularly harmful during that period prior to emergence. The conducting tissue is affected and if enough damage has been done the plant dies.

Root rot diseases are of importance and should be watched on safflower and tomatoes as well as other crops. Of particular importance to safflower is Phytophthora drechsleri. Using the variety safflower 208, which the Project introduced to Nicaragua, there was only slight damage from Phytophthora root rot. Tests made with a large number of varieties were not conclusive but indicated that Fusarium and Verticillium wilt to safflower are not a problem.

There were numerous instances of leaf diseases on sorghum plants typical of Helminthosporium. It was not felt that these were part of the cause of the low yields of sorghum in the Project. The problem of capsule mold on castor beans was extremely serious but can be eliminated if the crop sets and matures during the dry season.

There was no available information on nematodes in the entire area. It is suspected that there are nematodes in the area and tests with materials, such as NEMAGON may indicate whether or not the nematode will be a factor in plant production.

Botrytis headrot in safflower will restrict the production of this crop to the dry season. This fungus, Botrytis cinerea, inflicts the head and can destroy the crop. Timing again is the answer to this particular problem.

The virus diseases on the melons, cucumbers, watermelon and squash will be serious at certain times of the year. Disease problems on cooperator sites of Project Adelante were severe enough at times to cause decrease in yields and even loss of stands.

4.5 - INSECTS

4.51 - Soil Insects

Although not insects, included in the broad group of pests should be mentioned the losses from rats which can occur as they did in Project Adelante in yuca stands, and the losses in many crops from Garrobo(Iguanas). These are two of the more exotic of the pest-insect problems that faced the Project, though not the most serious. None of the other problems were new.

The most destructive insects in Project Adelante were the worm-type insects, both the soil types, such as the lesser cornstalk borer and the seed-corn maggot, which succeeded in destroying a complete stand of young corn, and the worms which attack the aerial portions of corn, beans, castor beans, etc., shortly after plant emergence. There were additional insects, such as the white fly, which caused no visible economic damage to the crop; the leaf hopper which transmits the corn stunt disease, but otherwise is of no economic significance on Project crops, and others which caused minor damage such as ants, mole-crickets, white grubs, etc.

4.52 - Problems of Insect Control

Two problems occur in insect control. During the rainy season it is extremely difficult to keep a material on the leaves because of the washoff from the rain. And during part of the dry season it is difficult to get adequate coverage with airplane spraying because of the gusty winds which occur. The problem of the dry season can be overcome by the use of ground rigs. There are very few of these in the area, and the cooperators of Project Adelante did not have workable ground rigs for use on crops. The Project spray rig was an adjustable boom rig which is a fairly inexpensive piece of equipment and quite adequate for the needs in the Project except for tall corn. Two experiences from the Project should be guides to all farmers spraying row crops in the Pacific Zone in Nicaragua. Most tractor drivers drive at excessive speeds when spraying. The speed should be calibrated and a mark made on the throttle so that the driver can check to be sure that he is not exceeding this speed. Normally this would be approximately three miles per hour.

The second difficulty is that the spray nozzles commonly available or on a rig when purchased, produce a spray that is too fine. The droplet size is so small that it is very easily moved by the wind. For this reason the Project purchased new spray tips. The size recommended for this area is a T-jet 8005 or 6505 or their equivalent. Normally a spray rig comes equipped with an 8003, and this puts out a spray much too fine for the windy conditions that occur in the Pacific Zone of Nicaragua. These larger nozzles apply more material per acre and this is taken into account when mixing the batch in the tank. If the spray nozzle delivers 50 gallons per acre, less of the active insecticide is added per gallon of water than if the nozzle delivers 30 gallons per acre. Water is just a carrier to get the insecticide spread over the plants. There are very few nozzle sizes available at the commercial outlets in Nicaragua.

Most cotton spraying is done by airplane, and ground rigs have not been too essential. Under irrigation they will be very important for use during the dry season. This does not preclude the use of airplanes on large acreages, when conditions permit.

The most difficult insect problems occur in crops such as corn and sorghum, where worms are located inside the whorl of leaves which is difficult to reach with a spray material. In cases such as this, granular material will be more effective as it can be dribbled down into the plants. Granular applicators will be needed to apply this material. At present, hand granular applicators are available on the market in Nicaragua and can be used for small fields.

4.53 - Damage to Project Crops

Some growers are considering irrigated pasture as an adaptable crop for their land. This choice is based on past problems they have had with insects on cotton and their desire to find a crop that has no insect problems, as well as less labor and marketing problems. Insect problems should be a consideration in selecting alternative crops under irrigation.

Insect problems varied considerably in the new crops tested and demonstrated in Project Adelante. The analysis of crops included not only insects, but rats,garrobos and particularly birds. Those crops which had the least pest problems were safflower, castor beans, fox-tail millet and quequisque.

Yuca suffered no damage from pests except for some root-cutting by rats. Work done by other organizations in Nicaragua indicates that the round-headed borer is located in Nicaragua and attacks yuca. This is a stem borer attacking from just below the soil line to a few inches above the soil surface. There was, however, no evidence of this problem in Project Adelante plantings.

A field of pearl millet was attacked and the entire seed crop taken by parakeets within two days. This was a small plot, located in an area where little if any other feed was available. Pearl millet can be the host to army worms in the later stages and because of extreme height is difficult to treat. Large size fields could be treated by airplane with satisfactory results.

The most continuous and serious insect damage was in corn and sorghum crops. The damage was in the young seedling stage. In one case in Salvadorita the entire crop of pajamaca, sweet corn, was completely destroyed. This particular variety is extremely attractive to worms. Planting at another time of year, in May of 1970, on the Pineda site, with preventative treatment there was no damage from worms. But corn and sorghum are severely attacked by worms and low yields which occur in Nicaragua in both of these crops may be due, in part, to the damage from these insects.

Beans are similarly sensitive, both the red and white bean as well as cowpeas. In the seedling stages, these attacks seriously set back, and can even kill the plants.

With a ground rig and proper attention, corn and sorghum can be well protected from insect damage. Management and observation time is required and the additional costs of spraying, both the operation and material, must be taken into consideration.

4.6 - HARVEST

4.61 - Shortcomings of Present System of Harvesting

Project Adelante was consistently slow in completing crop harvest. This always results in reduced profits in an intensive year-around irrigated crop program. In one case a crop of grain sorghum was almost completely lost because harvesting was delayed and then extended over a long period.

A peanut field was abandoned with much of the crop in the ground because harvesting took so long that the nuts started to swell and sprout.

Two castor bean fields and the following ratoon crop were economic losses because of inadequate harvesting equipment.

4.62 - Conclusions from Project Adelante Experiences

A number of conclusions can be drawn from Project Adelante experiences.

- Management attitudes toward harvest which are based on experience in cotton must change. There is lots of time to pick cotton and if necessary, more pickers may be engaged.
- This approach is not satisfactory in irrigated crops and year-around cropping.
- Multiple picking will require the development and training of crews for crops like cucumbers, okra and market tomatoes.
- Corn can continue to be picked by hand until yields and acreage can justify mechanical pickers. Hand pickers should be supported by wagons to reduce picker time spent in hauling.
- Traditionally hand harvested crops like yuca and quequisque can be adapted to mechanical harvest.
- The social needs for finding work for people should not be used as a reason to continue inefficient and slow harvest methods. There will be needs for semi-skilled and skilled labor in intensive agriculture. Even unskilled labor can be utilized during the growing season.
- In order to reduce the time a field is out of production, harvest must commence as soon as the crop is ready. Residue removal, and land preparation, or chopping for a ratoon crop when applicable, should follow harvest immediately. At times both operations,

harvest and land preparation may be going on in a field simultaneously. During dry periods in the rainy season this type of management may gain a crop for the grower.

- Custom operators equipped to do specialized harvesting seem to have a place in a new intensive agricultural economy. An example would be an operator who owns a peanut thresher and the required digger-shakers to keep it operating. Growers with operations too small to justify the purchase of this equipment could hire the harvesting done to the advantage of the farmer and the custom operator.

- Thresher-huller equipment for castor beans, combines for sorghum and millet, diggers and loaders for yuca would fit equally well into custom operator programs.

The two peak work periods in agriculture are the land preparations and planting period and harvest. In intensive agriculture under irrigation these become a single more accentuated peak, occurring two or even more times a year. To keep the land in production for as much of the time as possible, the entire operation of harvest through replanting must be done as efficiently and quickly as possible.

4.7 - MARKETING

4.71 - General

Marketing experiences in Project Adelante identify some of the problems of farmers moving into intensive irrigated agriculture with new crops. Marketing problems are much the same throughout the entire world. A major part of a farmer's profit is going to come from the effort he puts into marketing. There are no commodity needs in the world waiting for farmers to discover them. There is no stable market in any of these commodities that will insure a reasonably good market and profit to the farmer. In the marketing of a crop, the market decisions are made long before the crop is planted. If a farmer is able to produce a crop at a cheaper price per unit than others, and if it is a crop for which there is a reasonably good demand, the farmer will be able to market into existing channels and make money. If a farmer is growing a crop inefficiently and uneconomically, even an extremely good market will not save him over any period of time.

4.72 - Experiences in Marketing Project Crops

As the market changes, different kinds of marketing efforts that must be made are illustrated by crop experiences in Project Adelante.

Peanuts

Peanuts that were first grown under irrigation in Project Adelante had to be sold to markets that were located by Project personnel. This included people who made candy, in Managua, and in areas outside of Managua. There was no great "demand" for peanuts for oil or any other uses during these early stages. As of the time of writing this report, processors have taken a new position in Nicaragua, resulting in a widespread available market. The farmer no longer has to go shopping to locate an outlet for this crop. This is a major change in a very short time. Whether the farmer can make money at the price these processors pay is entirely based on his yields and cost of production.

Castor Beans

During the very early stages of the Project a field of native castor beans was located on the road between Managua and Leon at kilometer 25. Marketing work was done on castor beans long before a crop was ever planted on Project Adelante sites. The buyer was located and it was found that castor beans were used for pharmaceutical purposes in Nicaragua, and that there was a good market at a good price. By the time Project cooperators had grown the crop and cost of hulling subtracted from the market price, left an almost negative figure as profit for the farmer. Castor beans have a real potential as an industrial crop, on widespread acreages in Nicaragua, and must continue to be considered one of the important alternative crops for irrigated agriculture in this area.

The question then becomes, how do farmers market in a different fashion in order to make it a profitable crop. As indicated in an earlier section on harvesting, the crop must be handled so that profits and time is not eaten up by slow hand harvesting and inefficient hulling. This must be done by a combine adapted for this purpose. The resources for crushing and extraction must then be identified in the country. If adequate resources are not available, small oil plants must be started either by groups of growers or somebody in the oil business presently connected with castor beans. This is not difficult and doesn't take too long to do. This will enable farmers to market their castor beans in an orderly fashion and in a profitable manner. If the market is an export market it will probably be found that it is to the farmers' and processors' advantage in Nicaragua to export as oil, rather than to export as bulky castor bean feed. This marketing work went on for two years during the program of Project Adelante. The solution is not complete but the answers to marketing are available. The difficulties with the existing market should not be reason to throw out castor beans with the obvious potential it has for the area.

Millet

Millet was a new crop introduced into Nicaragua. It's a grain crop that fits local conditions. Feed buyers in the area indicated their interest to purchase this when questioned by Project personnel, depending on its feed value. Tests were made of the millet grown in the area, which indicated that the millet could be substituted for other presently used feeds. This crop can be grown with some assurance that there will be markets. This doesn't mean that at the time the farmer gets his millet off the field there will be people waiting to pay top feed prices to take it off his hands. On the contrary, a new crop is often penalized because it's not known by the trade. If there is an opportunity to force the price down because the crop has a small group to which it can be marketed, then this will work to the disadvantage of the farmer. In the case of millet, farmers will want to bring this crop in during the dry season when it should be grown, have some sort of understanding with a buyer that it will be worth a percentage (100% or slightly less, depending on agreement) of the value of corn or sorghum at harvest time, and that the buyer would be interested in so many tons of this commodity. Even with this kind of agreement, storage facilities such as metal bin buildings, or similar kinds of storage, must be available to the grower so that he is able to hold the crop for a period of time if prices are completely unattractive.

Sorghum

Sorghum is an important alternative crop for irrigated agriculture in the Pacific Zone in Nicaragua. Many growers feel that the price is too low for them to grow it economically. The real problem based on experience in the Project is that yields are too low, not the price. On the first of June, 1970, prices for grain sorghum were higher in Nicaragua than they were in the United States. Grain sorghum will have to yield 100 to 140 qq. per manzana in order to make money for the farmers under irrigated conditions. There will rarely be a market with a price high enough to make money with yields lower than this. At the present time the yields in the area are far less than this. There seems to be no limiting factor other than the standard cultural and management inputs which will restrict top yields. If grain sorghum prices were so low as to be uneconomical at top yields, then the farmer has a decision as to whether he should get into the livestock feeding business and market his sorghum through cattle. Again the farmer must have the flexibility to make these decisions and not be driven into a sale that causes him a loss. Increased storage facilities in the area are assisting the farmer in getting past these low price periods.

Safflower

After the first planting of safflower in the Leon area, contacts were made with oil companies to determine whether they would be in a position to use this crop for oil. The reception was extremely good. What the price will be and how this material will be used is yet to be determined, but marketing of safflower will not keep this crop from becoming an important alternative crop on thousands of acres of the Pacific Zone as irrigation develops.

Cucumbers

Early in the stages of the Project a plan was examined for the production of small cucumbers for pickling. There is an outstanding market in the United States for this small pickle because labor prices in the States are so high that it is no longer profitable to hand pick this small size at the tonnage per acre and price per ton. Contract discussions were held with outlets in the United States and plans were formulated for the growing and brining of these cucumbers, to be shipped in barrels to the United States for processing into pickles. The marketing in the case of this intensive crop is not the limiting factor. As it turned out, investigations of plant production of a number of varieties of pickling cucumbers showed them to be extremely promising and the crop produced under these conditions was easily sold in the fresh market since the amount grown was too small for brining. Insufficient time has gone by to make further inroads into the pickle market in the United States. This is a very intensive crop and will require the services of fairly well-trained labor crews and good management in order to make this a successful crop in Nicaragua, but the opportunity is there.

Okra

Planting of okra was made on Site No. 8 because of a need in the United states for this crop. This is a crop similar in requirements to cucumber since it also must be picked daily. Labor costs are restricting the production in the United States. The demonstration illustrated that the crop was completely adaptable and when the production got beyond the ability of the untrained picking crew, the crop was allowed to mature to seed. This seed was used by an associate cooperator to plant a 12-manzana field and the harvest of that crop was exported to the United States.

Quequisque

Quequisque which is normally grown as an extensive crop in Nicaragua was grown in rows under good conditions of fertilizer and irrigation. The production from this crop in a subsequent planting by an associate cooperator was exported to the United States and also sold in the local market.

An example of a marketing opportunity was the introduction and production of an open-pollinated variety of grain sorghum. This was grown because the variety is very adaptable throughout different latitudes in the world, and from it, growers can produce their own seed unlike hybrid varieties. Hence, in this case there was an opportunity to produce a grain sorghum crop that could be marketed as seed stock for other farmers in Nicaragua. This would be the first step in the specialization of certain farmers in the production of many seeds including hybrids.

4.8 - PRODUCTION OF ROW CROPS

4.81 - Grain Sorghum (Sorghum vulgare)

Grain sorghum is very well adapted to irrigated cropping programs in the Pacific Zone and fits a need that few other crops can fill. The best time to grow sorghum in this area is during the dry season since a crop that matures during the rain season can germinate in the head with accompanying crop loss and low yields.

As compared to other irrigated crops, grain sorghum would be considered a medium to low intensity crop. Large acreage blocks can be planted without serious stresses on management, equipment or labor. This is a good crop for use in large properties to utilize land fully and keep equipment in operation. Price for sorghum will continue to be about as it has been. At these prices, grain sorghum will return a profit if yields are nearer their potential. Single crop yields must reach 100 to 140 quintales (6,000 - 8,000 pounds per acre).

There are many factors which could account for yields not reaching these levels.

a. Low plant population and wide rows
b. Fertility of nitrogen and phosphate have not approached the optimum level
c. Weeds, insects and birds have all taken a share of the crop

Even under irrigation when moisture is optimum, these factors can keep a sorghum crop from making optimum production. In addition to these, Boron deficiency as well as deficiencies of other micronutrients may be retarding yields. Varieties presently in use seem to be well adapted, however, none is producing in an acceptable range. When the limiting factors have been overcome, the varieties may present a different picture as to adaptability. Project Adelante variety work resulted in yields as high as 74.9 qq/mz (4,280 lbs/acre) for AKS 614, a bird-resistant variety from Arkansas.

Ratoon yields were as high as 49.6 qq/mz (2,840 lbs/acre). Ratoon as a practice can not be evaluated until yields have reached their proper level. If ratoon crops produce two-thirds of the first crop, the ratoon yield may be expected to be 65 qq/mz or more.

Field yields of the ratoon crop are not high enough to recommend the practice. With anticipated yield increases however slight, ratooning will be part of the cropping plan; in situations where time is too short to get another crop in and harvested in the time available, a ratoon crop may be the answer, or when management and equipment are tied up in a more intensive crop and at the same time a large block of sorghum has just been harvested, it will be far better to be producing a ratoon crop than to let the land and equipment remain idle.

Markets for grain sorghum in Nicaragua have not been developed in the livestock industry adequately to utilize an expanded acreage of this crop in the irrigated area. More storage facilities including increased on-farm structures, will lead to a degree of stabilization of price.

There are other problems with production, such as birds, insects, and diseases which are becoming well understood. Project Adelante found adequate answers for these and these have been described in various monthly reports.

4.82 - Castorbeans (Ricinus communis L.)

The castorbeans presently grown in Nicaragua are used for pharmaceutical products and hydraulic fluid. The industry is small and primitive.

The local variety was grown in the Project under irrigation although it was known that this variety was not acceptable for intensive use because it grows so tall. Under irrigated conditions it grew over 12 feet and never flowered in a normal growth period (5 months) so the crop was destroyed.

New seed of the variety Lynn arrived from the United States at this time and successful plantings were made with this seed. Previous testing of three varieties was carried out at La Leona with Lynn, Hale and Baker 296. Lynn appeared to be best adapted for Project purposes and so larger amounts were ordered. Lynn, like other new dwarf internode varieties, is susceptible to capsule mold so must be grown so the fruit sets and matures during the dry season. Under Nicaraguan conditions this variety grows to about six feet in height and requires about five months to set sufficient seed to justify a harvest. Project Adelante experience showed that it is better to dry the plant down for harvest by spraying with a desiccant rather than wait for the crop to dry due to moisture stress. As pointed out in monthly reports, the ratoon crop initiates new growth much more rapidly if soil moisture has not become a limiting factor to plant growth. Earliness of the second crop is important in order to get maximum yields prior to the beginning of the rainy period.

Castorbeans are a well-suited crop for irrigated lands in Nicaragua. The production can be completely mechanized. Although the crop can be hand-harvested and then hulled mechanically, the delay in using this method will reduce the yield of the ratoon or second crop. Special combine attachments are necessary and due to the toxicity of the plant, machines must be used solely for castorbeans.

There are no serious insect problems, but young plants must be protected from armyworms.

Oil processing facilities need to be established in the production area and marketing channels for castor oil must be developed.

Hybrid varieties will out produce open-pollinated varieties but not to a degree that makes their use mandatory during the early years in Nicaragua. Tests should be made with hybrids on field scale but until top yields are being produced, there is more advantage in a one-variety, open-pollinated program so seed may be saved and used.

Ratooning will be done by the combine. Further cutting of the plant should not be required. If the crop is hand harvested, chopping should follow immediately at a height of approximately ten inches or more. This second crop will mature in 90 to 100 days. Therefore, in order to get two crops matured during the dry season, the crop should be planted in the Canícula or no later than September 15.

Castorbeans are a moderately intensive crop in the same group of crops as grain sorghum. Large numbers of acres can be taken up by this crop with relatively little special management. The lack of damage by birds and insects allows time for management of specialty crops.

4.83 - Corn (Zea mays)

Corn grown in Nicaragua has been used mainly for human consumption. Only during recent years have improved varieties and cultural methods been introduced. Many small farmers plant improved varieties but do not fertilize or use insecticides. Under these conditions farmers realize very few benefits from the use of these varieties. Improved varieties include open-pollinated and hybrids of both white and yellow seed.

Besides being used for flour and refreshments, corn ears are harvested about the time pollination has started. These small ears, known as "chilote" are used in soups, salads and sometimes are processed. Field corn is also used as roasting ears or "elote" in the hard dough stage of development. A small amount of corn is used for animal feed.

The good market for "chilote" and "elote" during the dry season offers farmers with irrigation a high profit crop in a very short period. "Chilote" is ready about 50 days after planting and "elote" in about 70 days.

Varieties

Improved synthetic varieties available include the white seed types: Salco (110 days), Nicaragua Synthetic 1 or 2 (90 days). Both Salco and Synthetic 2 are relatively short in height (8 to 10 feet) with fair resistance to the stunt disease. Yellow seed type, Nicarillo (110 days), is tall (10 to 12 feet) but has good resistance to the stunt disease.

Hybrid varieties include Poey, Pioneer, Dekalb and Rocamex - varieties which have not been evaluated or used extensively on Project farm. Rocamex H-507 is very tall (12 to 15 feet) and susceptible to the stunt disease. The new Pioneer varieties for the tropics are reported to have good resistance to the stunt disease.

Insects

The major problem is corn stunt disease, a virus transmitted by the leaf hopper, which causes a malformed plant and often a complete crop failure. Best control is resistant varieties. Since the disease is transmitted by the leaf hopper, control of this insect will lower the incidence of the stunt disease. Dipterex, Sevin, Diazinon or other insecticides must be used in repeated applications seven to ten days apart until control is maintained.

Soil insects are another serious problem on corn and have been found on all corn crops produced on Project farms. Soil insecticides such as Aldrin or Dieldrin were used and were effective.

The fall armyworm attacks when the corn is very small. A good larvacide carefully applied by a ground sprayer is required. On corn over 12 inches tall a granulated insecticide dropped into the whorl is effective.

Cutworms are a problem but this insect is controlled by bait broadcast on the soil near cut plants (insecticide Endrin mixed with sawdust and molasses was used for control on Project farms).

The corn earworm must be controlled when the larva is seen on the corn-silk - once it enters the ear, it is impossible to control.

The earliness and severity of insect attack may require repeated spraying when the corn is young. This may be a spray program of weekly applications after the plants are two inches tall and until they are 18 inches tall.

Weed Control

Corn grows rapidly and quickly shades the soil preventing weed growth. Weed control when the corn plants are small is important. The rotary hoe or spike-tooth harrow is useful for corn until it is about six inches tall. One or two cultivations are usually sufficient.

Chemical control of weeds is widely used and can often be cheaper and more effective than mechanical weed control. Atrazine and 2, 4-D have been widely used with good results. Both chemicals are available in Nicaragua.

Irrigation

Tall corn can present a problem when using a sprinkler irrigation. Corn should never be stressed for moisture. The soil profile to five feet should be at field capacity at planting time. Crop irrigations should be adjusted to replace the soil moisture as the plants grow. A crop of corn will use about 20 inches of water.

Harvest

Harvest for "Chilote" should start as soon as the cob is about four inches long. Harvest for "elote" can start when the kernels are in the soft dough to hard dough stage of development. Harvest for grain can start when the seeds are at 30% moisture without yield loss. The seed moisture needs to be at about 22% for shelling. For storage, the seed moisture must be below 14%. The harvest of corn can be done either by hand or by machine.

Average yields of improved varieties is about 5,000 pounds per manzana (2,900 lbs/acre). Yields in the range of 9,000 to 10,000 pounds (5, 150-5, 715 lbs/acre) have been reported by a few individuals.

Corn fits the year-around cropping program primarily because it can be grown in the wet season. Yields of 2,900 pounds per acre are not enough to make money except when corn prices are forced up to an abnormal level.

Costs of production and management skills are greater for corn than for grain sorghum. Large acreage increases will force most of the corn into feed markets resulting in lower prices.

Corn will become a crop for widespread use when varieties and management can produce 6,000 to 8,000 pounds per acre and when more land has been leveled for furrow irrigation.

4.84 - Cowpeas (Vigna sinensis)

Cowpeas, an annual, is very well adapted to the Project area. The varieties tested have been free of disease problems and have had no special insect problem.

The cowpea can be used for human consumption, for hay and silage and as a green manure crop. The cowpea seed is a popular food in the Southern United States and in many parts of the world. The fresh pod may be eaten but usually the immature seed or the dry seed is used. Cowpea makes a good forage crop and sometimes is grown with corn for ensilage.

This crop is not recommended as a large scale cash crop for irrigated lands in Nicaragua. There is no sizeable local market and little if any identified export market. Harvest is a special problem since the mature seed cracks easily. Farmers equipped to grow other beans may grow cowpeas, but by themselves, cowpeas won't justify the special equipment needed.

As a green manure, cowpeas provide real advantages for the Project area. They could be planted with the first rains of May and plowed under before the cotton or other crop is planted in July or August. Seed for planting would be best produced during the dry season on irrigated farms. This green manure crop would smother out weeds; at the same time protect the soil from erosion of heavy rainstorms and baking of the soil by the hot tropical sun.

Cowpeas grow equally well on sandy, loam or clay soils. Fair growth can be expected on soils where other crops often do poorly.

Varieties

Cowpea varieties range in plant type from viny to semi-erect to bush. Cowpeas have an indeterminate growth habit and will continue to flower until stopped by adverse environmental conditions.

The variety, Mississippi Silver, makes an early seed set. The reddish brown seed is excellent for either a green or dry bean which might provide a substitute for the expensive red bean.

The variety, Whippoorwill, makes rapid and lush plant growth with a good seed yield. The seed is small and requires fewer pounds of seed for planting. The seeds are mottled in color. They are edible but this variety will probably be most useful as a green manure crop.

Arauca has a reddish brown seed excellent for eating. In the Project area, this variety made rapid vine growth but set little seed during the longer days of May to August. It appears to need a short day for initiating flowers. This could be an advantage for use as a green manure crop from May to July. Seed production is not wanted with a green manure crop since it can present a volunteer plant problem.

Short season varieties such as California #5 were not tested.

4.85 - Peanuts (Arachis hypogaea)

Peanuts are considered an important crop in the projected irrigated acreage of Nicaragua. They can be grown on large blocks of land and lend themselves to mechanization. The two qualifications other than continuity of market are:

1) They should be grown during the dry season so that the mature crop is not caught in the fields during periods of continuous heavy rains.

2) Specialized equipment must be available for digging and threshing. Hand harvesting experience in Project Adelante was so time consuming, inefficient and expensive, that a large percentage of the crop was lost. The part that was harvested was done so at an exorbitant cost.

The large market in Nicaragua is for use in processing into oil. As with other oil crops, farmers are advised to identify their market and have a contract prior to planting. Production should be limited to coarser textured soils of the area. Special planting equipment is required but adapters are available for corn planters.

Varieties are grouped into four classes: (1) Runner, (2) Virginia, (3) Spanish, and (4) Valencia.

The runner types have prostrate plants and usually have medium sized pods and long seeds. Recommended varieties - Early Runner, Virginia Bunch 67, and Florunner.

The Virginia types have prostrate plants with large pods and long seeds. Recommended varieties - Florigiant and NC 2.

The Spanish type have early maturing erect plants with small pods and seeds. Recommended varieties - Starr and Argentine.

Pest Control

Soil insects (wireworms, lesser cornstalk borer, corn rootworm, cutworms, etc.) are very serious pests on the seedlings and the pegs. Most fields in the Project area have some soil insects. Although peanuts were grown successfully on Project farms without treatment, it may be necessary to use a soil insecticide before or at time of planting for insurance.

A wide variety of leaf insects will attack peanuts but can all be controlled by Sevin, Dipterex or Diazinon.

Disease problems haven't been serious in the Project area. A trash-free seedbed and good weed control will help prevent many peanut diseases. Avoid mechanical injury or throwing soil onto the plant when cultivating or weeding. This will help prevent conditions favoring disease problems.

4.86 - Safflower (Carthamus tinctorius L.)

This is a new crop to Nicaragua which was introduced by Project Adelante and was first grown in the Project area near Leon in 1968. Safflower is a member of the thistle family and is grown for the seed from which a high quality edible oil is produced. It is being grown as a crop in the United States, Mexico, Spain, Middle East countries, India and Australia. It is best adapted to a hot dry climate and can be surface irrigated in well-drained soils.

The oil is widely used in paint because of its high drying and non-yellowing quality. In recent years, safflower oil has found a growing market as a cooking oil. Medical research in the United States reports that oils high in linoleic acid tend to reduce the cholesterol content of the blood serum which helps prevent atherosclerosis, a circulatory system disease. Safflower has the highest linoleic acid percentage of all the vegetable oils. The local oilseed processors are interested in safflower oil for blending with cottonseed oil to improve its quality and improve the overall efficiency of the plant operation.

All of the improved varieties have an oil content of 40 percent or over. Under the conditions of Project Adelante the variety S-208, developed by Pacific Oilseeds, Inc., is recommended. This variety has high resistance to Alternaria leaf spot as well as rust and Phytophthora root rot.

With other improved varieties such as Gila and US-10, irrigation is quite hazardous because of the root rot effects. Therefore, based on experience in the Project, S-208 is recommended.

Safflower is grown under complete mechanization and can be used on extremely large areas of the irrigated zone. It is a low management crop and marketing investigations by Project personnel indicates good reception. Although processing facilities are available in Nicaragua to extract the oil, contracts will be required prior to planting to assure marketing at harvest time.

This crop along with peanuts and castorbeans provides important industrial oil crops to expand the marketing base of irrigated agriculture.

Pest Control

Soil insects, especially cutworms, can be a problem but experience so far indicates no serious damage. Many insects can cause plant damage, but fields grown in the Leon area have been relatively free of damaging insects. Root rot is the most serious disease and can be controlled by resistant varieties and by providing good drainage.

Safflower cannot tolerate rain or high humidity after flowering because of Botrytis head rot. This disease can completely destroy all of the seed heads and is the reason for growing safflower only during the period without rain from December to May.

Alternaria leaf spot is also a destructive disease found on safflower grown in areas with high humidity. Large brown spots develop on the leaves and the seed is discolored. S-208 is most tolerant of the varieties.

Bacteria blight may be found on safflower after rains and in fields where sprinkler irrigation is used. The symptoms on the leaves are reddish-brown necrotic spots with a light color on the circumference of the spot. There may be severe necrosis of the growing point.

Safflower rust can be expected when the crop is grown with irrigation. This disease causes a girdling of the young plant just below the soil surface often resulting in plant death. Control consists of using rust-free seed and crop rotation. Seed treatment of a fungicide is helpful in the control of rust as well as the use of variety S-208.

Weed Control

A rotary hoe can be used on safflower before it is four inches tall and is especially useful where narrow rows are planted. Several herbicides give effective weed control in safflower. One of the best is Treflan.

Irrigation

Safflower roots will extract moisture from a depth of three meters. A field with a high water table permits growing safflower without irrigation after planting. Some areas in the Project have the water table at one or two meters below the surface which would be excellent for safflower. Also some areas in the Project could be sub-irrigated which is satisfactory for safflower.

Either irrigation by sprinkler or gravity in furrows (never use flooding) can be used successfully if recommended practices are followed.

1. Wet the soil with a pre-irrigation to the expected rooting depth.
2. Plant on raised beds.
3. Use root rot resistant varieties.
4. On beds, wet through rapidly with furrow irrigation, irrigate alternate rows or increase spacing between furrows.
5. Do not stress plants for moisture before irrigating - stressed plants are more susceptible to root rot.
6. Do not over-irrigate - carefully check soil moisture conditions.
7. Avoid standing water or prolonged irrigation - the surface soil must have drained within two days after start of the irrigation.
8. Provide a drain ditch at the lower end of field.
9. Avoid serious problems by continuously checking the soil moisture, the plant roots and general growth conditions.
10. Ask for assistance from technicians who have had experience with irrigated safflower.

A good crop of safflower will require about 20 manzana inches of water. Safflower forms spines on the leaves and heads after flowering - irrigators will need the protection of leather or rubber-coated pants.

Harvest

Harvest is done with a grain combine. Safflower is ready for harvest when the seed has less than eight percent moisture. Combines with rasp bar, angle bar or spike tooth cylinders will satisfactorily thresh safflower. The cylinder speed must be set between 2500 and 3000 feet per minute peripheral speed. To calculate the rpm use the formula:

$$\text{Cylinder rpm} = \frac{\text{Cylinder peripheral speed in feet per minute}}{3.14 \text{ X Cylinder diameter in feet}}$$

The front clearance between cylinder and combine should be 5/8 inch and the back 3/8 inch. On spike tooth cylinder, the overlap of the cylinder and concave teeth should be 1/4 to 1/2. For estimating seed loss during harvest, each seed per square foot equals about seven pounds loss per manzana. Safflower yields in the Project area with good production methods should be over 4,000 pounds per manzana.

4.87 - Beans (Phaseolus vulgares)

Results with beans, both red and black, were unsatisfactory in the Project.

California red bean seed was imported and compared with local varieties. Plant growth of all the varieties lacked vigor and resulted in poor production. Diseases of roots and tops were so serious that the entire crop had to be taken out.

Until varieties are developed which are better adapted to the area and more resistant to diseases, beans are not recommended in irrigated cropping programs.

4.88 - Millet

Foxtail Millet (Setaria italica)

Foxtail millet appears to be very well adapted to the Project area. This crop has characteristics which could make it the basic grain crop for this area. The feed value is equal to grain sorghum and can be produced in as short a period as 60 70 days. The yields can be as high as 2-1/2 tons per acre. There was no insect damage or disease. The timing may have just been fortunate but there was no bird damage.

This crop was introduced to Nicaragua by the Project. Two hundred and six selections from six countries were screened at La Leona farm. These were planted on October 31, 1968 and half the selections were ready for harvest in 60 days. A detailed report is available in Volume 2 report, December 1968, of the monthly report series.

Proso Millet (Panicum miliacium)

A planting of Proso millet was made on April 15, 1969 at the Fonseca farm. This crop appeared to be completely unsuited to the conditions. Heads developed before the plants had made sufficient growth. This particular millet has been set aside as not being well adapted to the area.

Pearl Millet (Pennisetum glaucum)

Two varieties of this crop, Gahi and Pearlex, were introduced into Nicaragua by the Project. This is an annual crop closely related to elephant or Napier grass (Pennisetum purpureum) which is well known as a forage crop.

Pearlex appears to be the most uniform variety and therefore recommended over Gahi.

This crop can be very important to the area for both forage and grain. It will produce more feed per acre in the shortest time from seeding than any other known crop.

Parakeets are especially fond of the seed and stripped a small isolated field near Villa Salvadorita in two days.

The crop gets extremely high (7 - 8 feet) and this becomes a problem with sprinkler irrigation. The height also complicates combine harvesting.

In summarizing millets, it is clear that Foxtail and Pearl types are well suited to the area and can be important field crops. Further testing and field plantings of Foxtail may support the present opinions that Foxtail is a more adaptable grain crop than Pearl Millet. Proso Millet should be discarded as a potential crop.

4.89 - Soybeans (Glycine max)

Test work was carried out with soybeans using Hardee, Improved Pelican and Mandarin varieties. Improved Pelican made the best vegetative growth and yields but only produced one ton per manzana for the highest replication.

Soybean varieties are not available which are adapted to the short day conditions of Nicaragua. Until these varieties have been developed the crop should not be considered in an irrigated cropping plan.

4.891 - Yuca (Manihot Utilissima Pohl.)

Yuca has been grown primarily as a subsistence crop with little management and care and a resulting low yield. This crop can be grown under intensive conditions including irrigation. The crop could be used in the production of starch and cattle feed.

In order to justify the costs of intensive production, yields will have to be raised to 32 to 36 tons per acre (55-63 tons/manzana).

Pruning at a height of 3-1/2 to 4 feet may be advantageous in furrow irrigation but will be a requirement under sprinkler irrigation. Dry season irrigation may not be needed as often as with other crops. Indications are that eighteen-day intervals between irrigations may be as effective as nine-day intervals.

Mechanization will be required if yuca is grown on a large scale. Hand work should be limited to operation of the transplanter and hand pruning.

Insufficient information resulted from the irrigated yuca at the Pineda farm to identify optimum plant population and fertilizer requirements.

With changes in cultural techniques yuca would be an important industrial crop for large areas of irrigated land.

4.892 - Yautia - Quequisque (Xanthosoma sp.)

The Project carried out field-size trials of this crop under irrigation at Site No. 8, Pineda farm. This crop is commonly used as food. A major expansion would require that new markets be developed.

The roots, which are the edible portion of the plant, require seven to ten months to mature, but unlike yuca, can be stored after harvest. The crop does respond to irrigation and can be used in the cropping program. Germination and sprouting of the seed pieces takes over one month. It is important that the planting piece be placed fairly deep so that moisture can be maintained. Prior to crop emergence, weeds can become well established. A general contact oil spray should be applied as needed to eliminate this but must be done prior to crop emergence.

Markets may be limited for this crop so test work should be initiated on arrow root (Marantha arundinacea L.) for arrowroot flour.

4.9 - Crop Rotation

4.91 - Project Area Factors to Consider

From the experience gained from Project Adelante it has been possible to identify the factors which must be considered in developing year-around cropping programs and alternatives. These factors are:

1. Weather
   a. dry season
   b. wet season
   c. period of very heavy rains
   d. Canícula (dry period in the wet season)

2. Bird seasons
   a. migratory birds (Rice birds)
   b. local birds (Parakeets)

3. Crops
   a. length of growing season
   b. tolerant to wet weather

4. Prices
   a. normal trends and yearly fluctuations
   b. period of highs and lows

Except for the last point on prices, these are all physical factors and it is this group of factors which will be discussed in the selection and planning of crops for year-around irrigation programs.

4.92 - Building a Cropping Program

It is possible to develop an annual calendar which shows how these factors fit. With this the crops with their different lengths of seasons and requirements can be superimposed. The dates used are close enough to be guides but are likely to shift from year to year.

Weather - Rains start and stop on different dates from year to year. In 1968 the wet season was dry and irrigation was necessary. In 1969, the wet season was very heavy and continued into December. In general the dates can be shown as follows:

Dry season - November 15 to May 15
Wet season - May 15 to November 15
Heavy rains - June and October
Light rains (Canícula) - July and August

Birds - Rice birds can be expected in March and April and again in August and September. Parakeets may be a problem in any month. The months indicated in Figure 4-1 are based on 1968-69 experience only, and are subject to modification with further observation of bird habits.

Crops

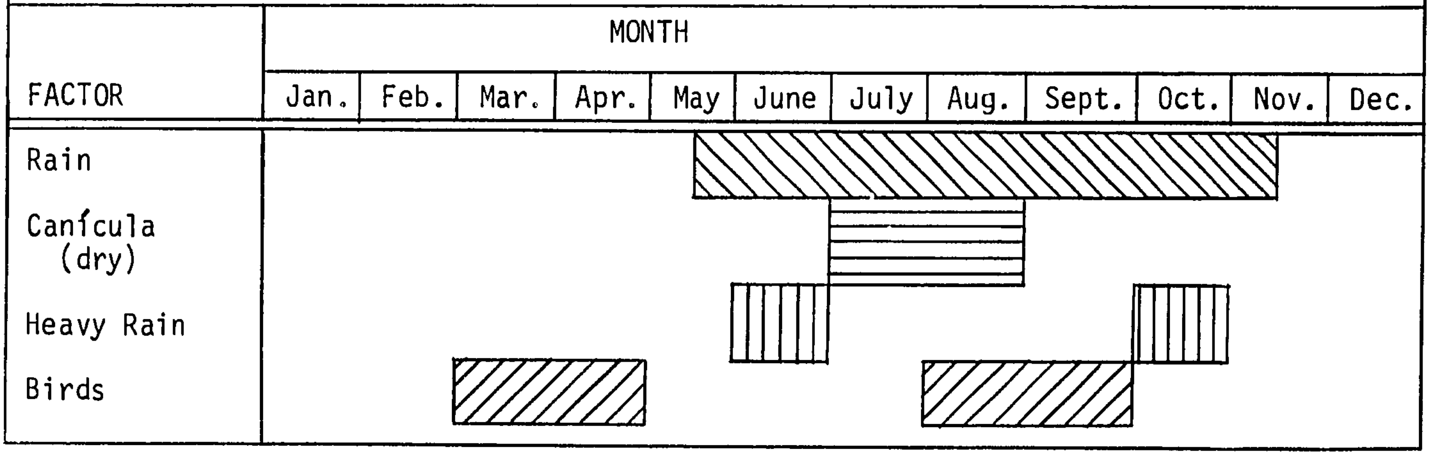
Name	Length of Growing Season, Days	Season Restrictions
Grain sorghum	90 - 120	Maturity in dry weather
Ratoon sorghum	90 - 100	Maturity in dry weather
Corn	120	
Elote	70	
Chilote	50	
Castorbeans	150	(Crops must set in dry weather)
Ratoon Castors	100 - 120	
Safflower	120	(Crop must be grown in dry weather)
Foxtail Millet	75	(Crop must mature to escape birds)
Pearl Millet	90	
Peanuts	90 - 105	
Vegetables		
Okra	165	
Peppers	165	
Melons	165	
Tomatoes	165	
Watermelons	165	
Beans	90	
Soybeans	90	
Yuca	300	
Quequisque	210 - 300	

These three factors plus the comments about season restrictions provide bench marks and guides which may be used to set up alternative programs.

FIGURE 4-1

GUIDE FOR USE IN ESTABLISHING CROPPING PROGRAMS

IN THE PROJECT ADELANTE AREA



With these bench marks, crops can be distributed using the qualifications which have been identified. These qualifications are guides, not inflexible rules. For example, June and October can be very heavy rain months - normally planting and harvesting should not be scheduled for either of these months. The following are examples of how to fit crops to the conditions.

I - Safflower - 120 days - flower and mature during the dry season. Plant into fully wet profile of soil. Be sure it matures in the dry season, November 15 to March 15, leaving a short dry period. A crop of corn is a good following crop. Part may be sold early as elote (60 to 70 days).

II - Castorbeans - A first crop and a ratoon crop takes about 250 to 270 days. The crop cannot set any seeds during high humidity or moisture or capsule mold will cause them to rot. The crop can be planted on September 15 and harvested February 15, and the ratoon crop harvested about June 1 to 15. If only one crop is grown and the crop planted on September 15, it may be followed by -

Millet (care must be taken to miss severe bird migration period of March and April) - a March 1 planting date would be satisfactory.

Grain sorghum - Use a shorter season crop to miss the early rain and perhaps AKS 614 for protection from late birds.

Corn - As outlined following safflower, yuca and quequisque. (If the first crop of Castorbeans is planted November 15, the following crop should be corn, yuca or quequisque.)

III - Peanuts - If a crop can be planted in September or early October, two crops may be grown in the dry season. Otherwise plan on a November 15 planting followed by the same crop following the single Castorbean crop.

IV - Grain sorghum - A crop may be planted before the end of the rains but it is hazardous. If the rains continue through November the crop may suffer serious damage. If planted November 15, the first crop will just beat the March-April migratory birds (if they stick to a schedule) and the ratoon crop may be off before rains.

A second crop in place of a ratoon sorghum crop may be sweet corn, millet, field corn, yuca or quequisque.

4.93 - Wet Season Crops

There is less choice of crops during the wet season than in the dry. Crops are limited to corn, yuca and quequisque. Others may be grown but the risk is greater. If forage crops are a part of the program, millets may be grown throughout the year.

Chapter 5

IRRIGATION ENGINEERING FOR PROJECT

Chapter 5

IRRIGATION ENGINEERING FOR PROJECT

5.0 - SOURCES OF IRRIGATION WATER

5.01 - General

All cooperator irrigation water supplies except one were obtained from wells. That exception, the supply for Site No. 4 (Vaca), was obtained by pumping from a nearby spring. Hence all supplies actually came from ground water sources, as a spring is a natural phenomena occurring when the ground water table is forced by adjacent geologic formations to intersect the ground surface.

Section 3 of this report explains the very limited availability of surface water supplies in the area, and the widespread occurrence of ground water of good quality, within reasonable pumping lifts. Four new wells were drilled by cooperators for project work, and all proved to be good sources of irrigation water. One cooperator already had a well drilled on his property about two years previously, but had not installed a pump.

Table 5-1 summarizes the supply sources and their principal features. Site No. 62, Quintanilla, is included because the well was drilled and developed under project auspices, even though cropping programs could not be executed.

5.02 - Well Logs and Yields

Logs, showing graphically the different formations encountered in drilling each of the five project wells, as compiled by the drillers, are presented in Figures 5-1 through 5-5.

Site locations are shown in Figure 1-1. The profile which includes Site Nos. 13 and 50 (Figure 3-1) reveals the volcanic barrier between the ground water in the Nicaraguan Depression and that in the Leon-Chinandega Coastal Plain, while Figure 3-6 shows general ground water zones.

Comments on the yields of the various ground water sources follow. (Laboratory analyses of water quality are presented in a subsequent section.)

Site No. 4, Vaca: The spring flow varies from a high of about 1500 gpm at the beginning of the dry season, to a low of 300 gpm near the end of the season. Both temperature and quality of the water seem to be influenced appreciably by nearby volcanic activities. The temperature averages around 32°C (90°F), while the conductivity (measure of salinity) of from 1400 to 1800 micromhos per centimeter was the highest of any of the irrigation sources encountered. It is not suitable for salt-sensitive crops, but is satisfactory for many irrigated crops.

Site No. 8 Pineda: This well yields high quality water, at low pumping lifts, the present static water level being only 10 feet below ground surface. The present yield of 300 gpm probably could be increased to 900 to 1000 gpm with a drawdown of 85 to 100 feet, if a larger pump were to be installed; perhaps more. The specific capacity, of 15 gpm of yield for each foot of drawdown, is good.

Table 5-1

PRINCIPAL FEATURES OF COOPERATOR WATER SUPPLY SOURCES

Site No.	Owner	Supply Source	Total Depth	Well Diameter		Depth to Water Level		Drawdown	Yield gpm	Specific Capacity gpm/ft	Total Dynamic Head	Horsepower	Cost in Cordobas			
				Hole	Casing	Static	Pumping						Well	Pump	Electrical Connection (2	Total
4	R. Vaca S.	Spring	5'	N.A.	10"	5'	5'	0	300 to 750 (1	N.A.	50' (3	13	-	-	Diesel	9,500
8	R. Pineda F.	Well	160'	18"	12"	10'	30'	20'	300	15	204'	20	20,000	21,350	8,220	49,570
13	O. Galo	Well (5	248'	10"	10"	170'	175'	5'	330	66	340'	40	16,500	38,500	15,000	70,000
50	J. Fonseca L.	Well (3	258'	16"	12"	25'	57'	32'	1370	43	90'	40	28,400 (4	22,850	16,000	67,250
		(Booster)	-	-	-	-	-	-	300	N.A.	150'	15	-	5,960	-	5,960
62	G.Quintanilla	Well	200'	16"	8 1/2"	34'	76'	42'	300	7	250'	25	20,000	26,000	15,630	61,630
86	R. Escobar L.	Well	240'	20"	12"	127'	152'	25'	600	24	320'	60	24,600	43,900	13,590	82,090

Notes:

1. Spring Yield varies from 300 to 1500 gpm, depending upon time of year.
2. All power, except for Site No. 4, is 220 volt, 3 phase, 60-cycle A.C.
3. Site No. 50, Fonseca, well does not provide total head required for sprinkler irrigation, since major portion of land is gravity-irrigated. All Site No. 4, Vaca, gravity-irrigated.
4. Well of Site No. 50, Fonseca, dug pre-project by Civic Action Program of G.O.N. National Guard. Cost shown is estimated 1968-69 cost.
5. All wells except that at Site No. 13, Galo, have gravel-packs.

PROYECTO ADELANTE

Sitio (Site) Nº 8

INFORME DE PERFORADORES DE POZOS

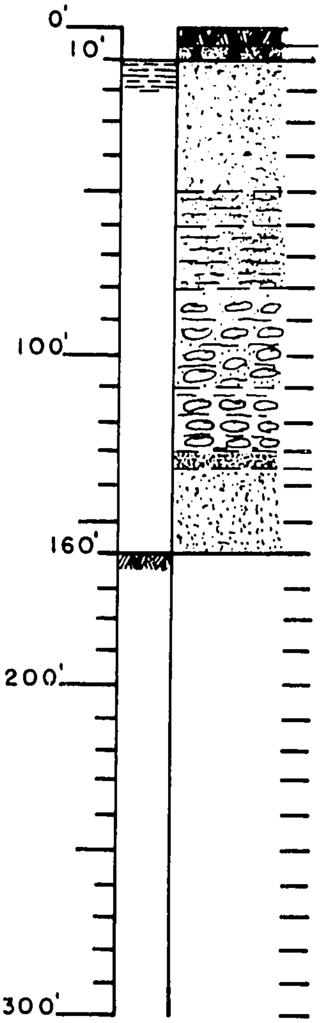
Pozo (Well) Nº 1

(12) Registro del pozo (Well log)

Profundidad Total: (Total Depth) 160 pies.

Formación: Describir el color, carácter, tamaño del material y estructura.

Formation: Describe color, character, & structure of material



5'	Tierra vegetal franco arcillosa.	Clay loam
10'	Arenas finas con pocos limos semicompactos.	Fine sands; semi compact
	Arenas finas y medias color negro suaves.	Fine & medium sands, color black
50'		
60'	Arenas con limos, suaves.	Sands with few fines
80'		
	Limos, arenas, sedimentos y pómez, suaves.	Loams, sands, volcanic sediments & pumice
110'		
	Limos con pómez y pocas arenas.	Loams with pumice & sands
130'		
135'	Arenas con pocos limos semicompactos.	Sands with few fines, semicompact
160'	Arenas finas semicompactas, suaves.	Fine sands, semicompact.

FIGURA (FIGURE) 5-1

PROYECTO ADELANTE

Sitio (Site) Nº 13
Pozo (Well) Nº 1

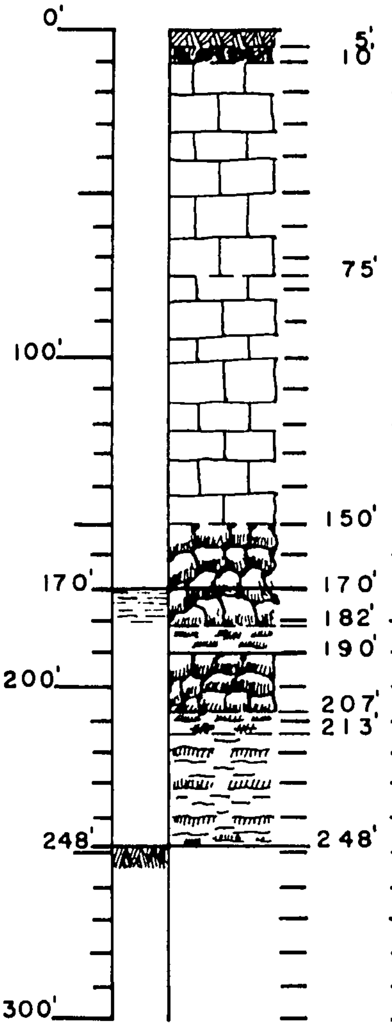
INFORME DE PERFORADORES DE POZOS

(12) Registro del pozo. (Well log)

Profundidad Total: (Total Depth) 248 pies.

Formación: Describir el color, carácter, tamaño del material y estructura.

Formation: Describe color, character, & estructure of material



Tierra Vegetal.	Plant soil cover
Barro Arenoso.	Sandy clay
Cantera Medio Dura.	Moderately hard tuff
Cantera Dura.	Hard tuff
Lava Volcánica Dura.	Hard volcanic lava
Roca Colorada.	Red rock
Escoria y Lava Volcánica.	Volcanic lava & cinders
Roca Colorada.	Red rock
Roca Azul Dura.	Hard blue rock

FIGURA (FIGURE) 5-2

PROYECTO ADELANTE

Sitio (Site) Nº 50
Pozo (Well) Nº I

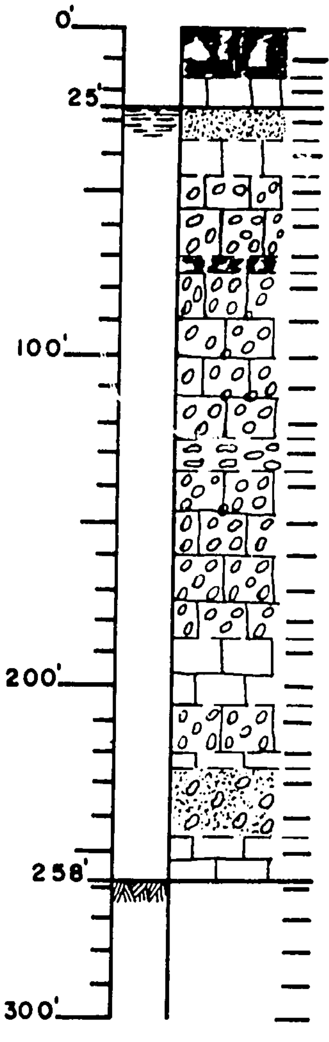
INFORME DE PERFORADORES DE POZOS

(12) Registro del pozo (Well log)

Profundidad Total: (Total Depth) 258' pies.

Formación: Describir el color, carácter, tamaño del material y estructura.

Formation: Describe color, character, & structure of material



15'	Arcilla con cantera.	Clay & tuff
25'	Cantera blanca dura.	White, hard tuff
35'	Arena fina.	Fine sand
45'	Cantera blanca suave.	White tuff, soft
55'	Cantera negra gravosa.	Gravelly tuff, black
	Cantera amarilla gravosa.	Gravelly tuff, yellow
75'	Cantera negra gravosa.	Gravelly tuff, black
	Arcilla azul.	Blue clay
	Formación de cantera y grava.	Tuff & gravel formation
125'		
135'	Piedra pómez.	Pumice rock
	Cantera suave y gravosa.	Soft gravelly tuff
185'	Cantera negra dura.	Hard tuff, black
205'		
225'	Cantera negra suave y gravosa.	Soft, gravelly tuff, black
	Cantera negra dura.	Hard tuff, black
245'	Arena gravosa.	Gravelly sand
	Cantera colorada dura.	Hard tuff, red
258'		

FIGURA (FIGURE) 5-3

PROYECTO ADELANTE

Sitio (Site) Nº 62

INFORME DE PERFORADORES DE POZOS

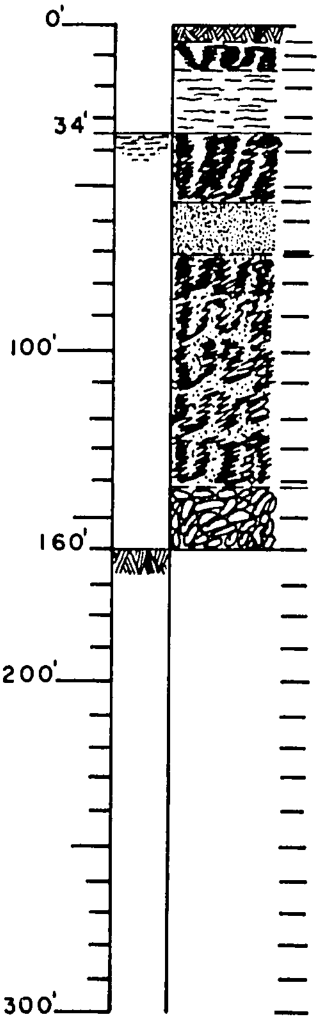
Pozo (Well) Nº 1

(12) Registro del pozo (Well log)

Profundidad Total: (Total Depth) 160' pies

Formación: Describir el color, carácter, tamaño del material y estructura.

Formation: Describe color, character, & structure of material.



4'	Tierra vegetal.	Plant soil cover
15'	Arcilla.	Clay
34'	Limos semi-compactos.	Semi-compact loam
54'	Arcilla.	Clay
71'	Arenas finas (buen acuífero)	Fine sand (good aquifer)
142'	Arcilla con poco arena (acuífero pobre)	Clay with some sand (poor aquifer)
160'	Cascajo.	Broken hard pan

FIGURA (FIGURE) 5-4

PROYECTO ADELANTE

Sitio (Site) Nº 86

INFORME DE PERFORADORES DE POZOS

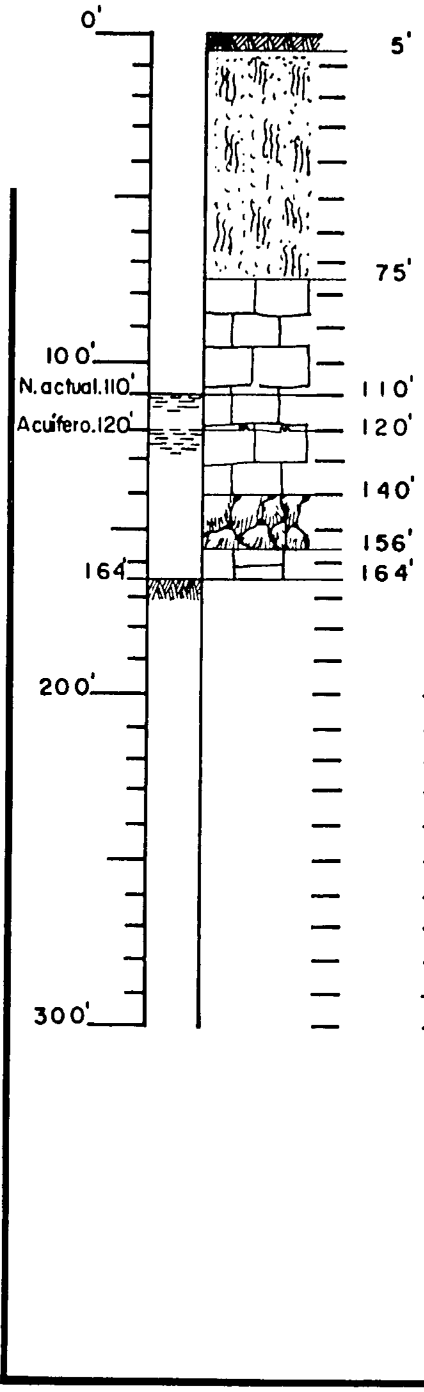
Pozo (Well) Nº 1

(12) Registro del pozo. (Well log)

Profundidad Total: (Total Depth) 164' pies.

Formación: Describir el color, carácter, tamaño del material y estructura.

Formation: Describe color, character, & structure of material



Suelo vegetal.	Plant soil cover
Talpetate arenoso.	Sandstone
Roca mediana colorada.	Small size rock, red
Roca volcánica partida.	Fractured volcanic rock
Roca azul dura	Hard rock, blue

FIGURA (FIGURE) 5-5

Site No. 13, Galo: This well has an exceptionally high specific capacity of 66 gpm/ft. When tested initially it yielded 300 gpm with only 2 feet of drawdown. Consequently the rate of flow could be increased considerably by the installation of a larger pump. Since this well is the only one of five that does not have a gravel pack, the high yield indicates very porous, or fractured, underground formations. Water conductivity was from 860 to 1000 micromhos/cm. Although this is considered high salinity, the water is suitable for irrigation of a wide variety of crops; especially if proper irrigation management is practised.

While this well has proven to be very satisfactory, drillers consider the chances to be poor of developing a good well in the general area around Malpaisillo where it is located. Several dry holes have been drilled, and the water sometimes has been reported to be corrosive to pumping equipment when water is found. Nevertheless, the Galo well demonstrates that ground water supplies are available in the area, although the total extent of the good aquifers, and the quantity of water which can be extracted annually, are yet to be established.

Although the pumping lift of 175' is the greatest of any of the project wells, this lift is not excessive, and can be characterized as "moderate".

Site No. 50, Fonseca: With both a high specific capacity (43 gpm/ft) and a high yield of almost 1400 gpm, this is the largest of the cooperator wells. The well itself was completed prior to the commencement of Project Adelante, under the Civic Action Program of the Nicaraguan National Guard. Several wells were drilled in the Leon-Chinandega area under that program, but pumping units were not installed in all. The pumping lift of 57' is low. Water quality is very good.

Because 40 of the 52.5 manzanas are under gravity irrigation, the well pump was selected only to provide dynamic head to discharge water into the canals, with some reserve capacity. A booster pump was used to provide the head needed for the sprinkler system.

Site No. 62, Quintanilla: The yield of this well, 300 gpm, is fair, inasmuch as the casing diameter is the smallest among the project wells. Chemical quality is good, and the pumping lift of 76' is low to moderate. Data on this well indicates that a well with larger casing and greater drawdown would yield considerably more.

Site No. 86, Escobar: Located on the upper reaches (Fig. 3-1) of the divide between the coast and the interior depression, on the Pacific Ocean side, this is a good well with a yield of 600 gpm. Drawdown is about 25'. Water conductivity tested at 590 micromhos/cm, which puts it in the medium salinity category. Additional evidence and tests are needed on the present well before the possibility of increased yields by installation of a larger pump, or even of maintaining present production, can be projected safely. Available data is not complete enough for projections. New pumping tests are required.

5.03 - Water Quality

The results of standard chemical tests for irrigation water quality are summarized in Table 5-2. All but one of these tests were performed in Nicaragua; the exception being one of the samples for Site No. 4. Because of the fairly high salinity of the spring water source at that site, four samples were tested.

All waters tested were suitable for irrigation, although more care needs to be taken in the use of those at Sites 4, 13, and possibly 86, to avoid any buildup of salt concentrations near germinating seeds or emerging plants, or in the

TABLE (CUADRO) 5-2

PROYECTO ADELANTE
NICARAGUA

Water Analyses — — — RESUMEN DE ANALISIS DE AGUA 4/12/68

SITIO N° (SITE N°)	CATIONES (CATIONS)	ANIONES (ANIONS)	CONDUCTIVIDAD EC X 10^6 (CONDUCTIVITY)	SÓLIDOS DISUELTOS (PPM) (DISSOLVED SOLIDS)	BORO (PPM) BORON (PPM)	(MILIGRAMOS EQUIVALENTES POR LITRO) (MILLIEQUIVALENTS PER LITER) CATIONES (CATIONS +)				ANIONES (ANIONS -)						SSP	SAR	(RESIDUOS (RESIDUAL Na_2CO_3	EC X 10^6 / CATIONES (CATIONS)	SD / EC X 10^6	SD / CATIONES (CATIONS)
						CA	MG	NA	K	CO_3	HCO_3	SO_4	CL	F	NO_3						
4	14.31	14.37	1400	834	0.10	1.10	7.00	5.65	0.56	0.50	10.10	0.85	2.53	0.01	0.38	40	2.82	2.50	98	.60	58
4A	17.74	17.75	1900	1202	0.25	4.80	7.60	4.70	0.64	0.00	13.60	0.65	3.40	T	0.09	27	1.89	1.20	100	.67	68
4B	17.65	17.01	1500	1115	0.30	6.00	6.30	4.80	0.56		13.84	0.98	2.14	*0.05	--	27	1.94	1.54	85	.74	63
4C	17.99	17.96	1640	--	0.46	6.19	5.42	5.83	0.55	0.00	13.16	2.49	2.31	--	--	33	2.4	1.55	91	.	--
8	2.21	2.30	220	128	0.00	0.80	0.60	0.57	0.24	0.00	1.20	0.10	1.00	T	T	26	0.68	0.00	100	.58	58
13A	10.20	10.25	1000	668	0.70	3.50	4.80	1.52	0.38	0.00	9.40	0.06	0.68	T	0.11	15	0.75	1.10	100	.68	65
13B	11.15	10.05	860	618	0.12	6.00	3.40	1.52	0.23	--	9.60	0.14	0.26	*0.05	--	14	0.69	0.20	73	.72	55
46	3.32	3.39	400	212	0.10	1.50	0.70	0.83	0.29	0	2.10	0.06	1.20	0.02	0.01	25	0.79	0.00	120	.53	64
50	2.39	2.50	200	160	0.10	0.70	1.00	0.48	0.21	0.30	1.70	0.00	0.43	0.00	0.02	20	0.52	0.30	84	.50	42
53	7.61	--	760	--	--	2.80	2.00	2.30	0.51	--	--	--	4.87	--	--	30	1.51	--	--	--	--
60	3.45	3.56	310	216	0.10	1.50	1.40	0.44	0.12	0.10	2.80	0.06	0.53	0.01	0.01	13	0.36	0.00	90	.70	63
62	2.92	3.00	230	200	0.10	1.26	1.00	0.52	0.14	0.00	2.20	0.19	0.58	0.00	0.03	18	0.49	0.00	96	.72	69
74	2.13	2.18	220	180	0.60	0.90	0.60	0.44	0.19	0.00	1.30	T	0.43	T	0.40	21	0.50	0.00	103	.82	84
75	2.31	2.34	220	160	0.60	0.80	0.80	0.48	0.23	0.00	1.90	T	0.33	T	0.06	21	0.54	0.30	95	.73	69
76	2.03	2.11	220	172	0.70	1.00	0.20	0.70	0.13	0.00	1.55	0.21	0.29	T	0.06	34	0.91	0.35	104	.78	84
82	2.32	2.19	245	212	0.01	0.92	0.78	0.56	0.06	0.00	2.08	0.00	0.11	--	--	24	0.61	0.28	103	.86	91
85	5.84	5.85	590	436	0.10	2.90	1.90	0.78	0.26	0.00	4.60	0.13	1.00	0.01	0.11	13	0.5	0	100	.74	75

*FOSFATO
(PHOSPHATES)

general plant root zone. Because of the high annual rainfall, no buildup of salts in the upper soil profile is expected on an annual basis, because the infiltrating rainwater will leach excess salts downward.

Quality Criteria:

In judging suitability of a particular water for irrigation, there are four principal indicators which are studied.

1. Total dissolved salts (solids), or Salinity Hazard.
2. Sodium Hazard, as measured by Sodium Absorption Ratio.
3. Boron Hazard, measured by boron concentration in parts per million.
4. Bicarbonate Ion Hazard, measured by "residual sodium carbonate".

The above items are measured and/or calculated as follows:

1. Salinity ---- Electrical Conductivity (micro or millimhos).
2. Sodium ------ $SAR = \frac{Na}{\sqrt{\frac{Ca+Mg}{2}}}$, where Na, Ca, Mg are ion concentrations in milliequivalents per liter.
3. Boron ------- parts per million boron.
4. Residual Sodium Carbonate ---- $(CO_3+HCO_3)-(Ca+Mg)$, where all constituents are expressed in milliequivalents per liter.

Using data from Table 5-2, the four indicators for Sample 13A are as follows.

1. Salinity Conductivity = 1000 micromhos/cm ($ECX10^6$) at 25°C
2. Sodium SAR = 0.75
3. Boron Bn = 0.70 ppm
4. Res. Sodium Carbonate = 1.10 meq/l.

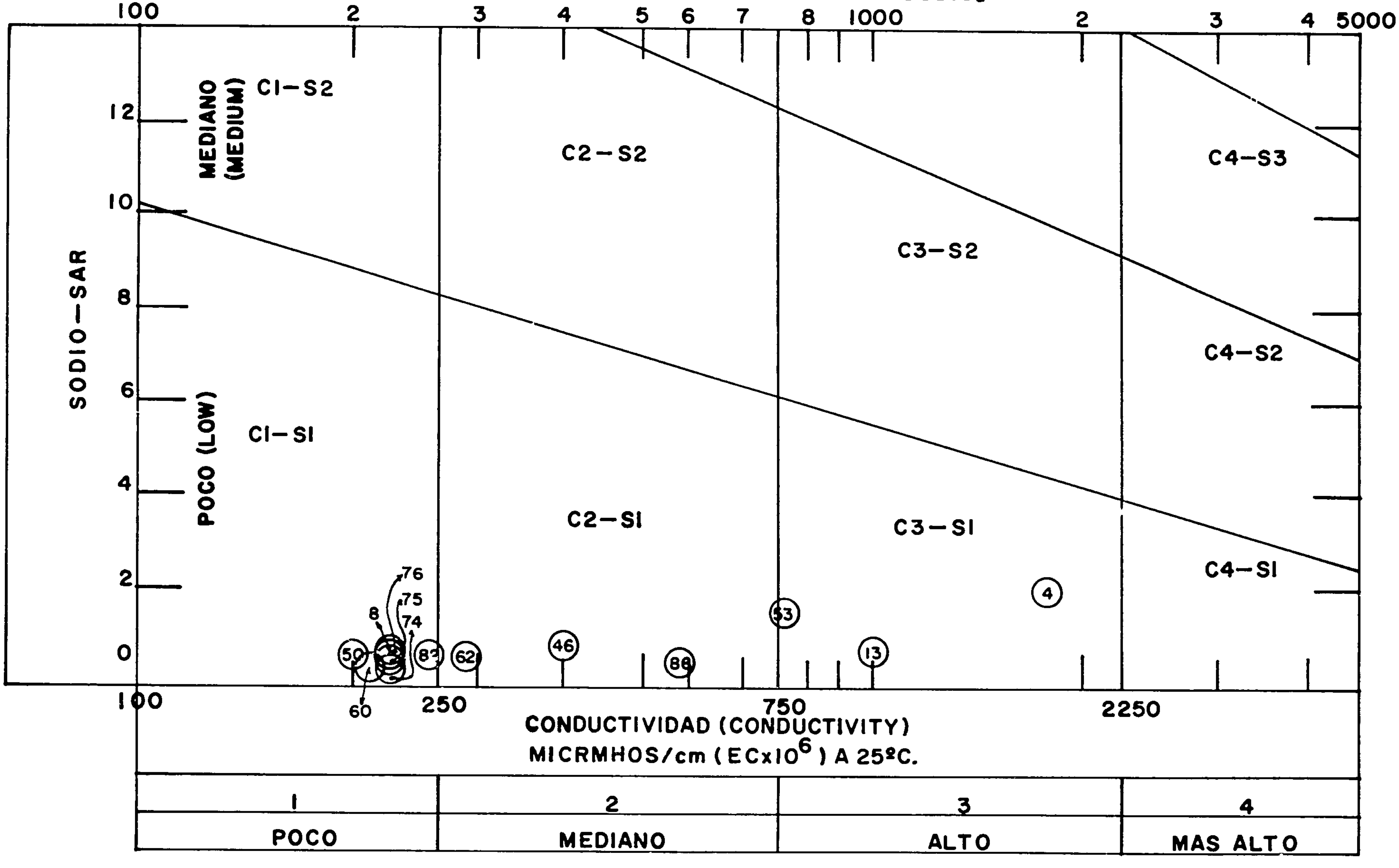
One of the better explanations of the effects, together with recommended permissible limits, of the various chemicals which may be present in irrigation water, may be found in Agriculture Handbook No. 60, U.S. Department of Agriculture, 1954. The first two indicators, Conductivity and SAR, are normally studied together by plotting the data on a chart such as Fig. 5-6. All the Adelante tests are shown plotted on this figure. It will be noted that the sodium hazard is small in all cases. Salinity is classed as high in 3 cases, and as moderate in three other instances.

With high salinity water, more should be applied during the dry season than for a low salinity water. The excess water is needed to leach some of the excess salts below the root zone to keep the soil moisture concentration within permissible limits for the crop grown.

Cooperator No. 4 initially was interested in growing cucumbers. The water analysis revealed high salinity, and since cucumbers are very salt-sensitive, the plan had to be dropped until a better quality water can be found. Also, problems in controlling salt buildup were experienced in applying this water during seed germination. Such a water requires very careful management, but can be used.

NICARAGUA

CUADRO PARCIAL DE DETERMIÑACION DE CALIDAD DE AGUA
SEGUN SU SALINIDAD Y CONTENIDO DE SODIO.



USD A. HANDBOOK—60

FIGURA (FIGURE) 5-6

Table 5-3 summarizes recommended limits for Boron and Residual Sodium Carbonate.

Table 5-3

RECOMMENDED LIMITS FOR BORON AND RESIDUAL SODIUM CARBONATE

(A) Boron

Boron Class	Sensitive Crops ppm	Semitolerant Crops ppm	Tolerant Crops ppm
1	<0.33	<0.67	<1.00
2	0.33-0.66	0.67-1.32	1.00-1.99
3	0.67-0.99	1.33-1.99	2.00-2.99
4	1.00-1.25	2.00-2.50	3.00-3.75
5	>1.25	>2.50	>3.75

(B) Residual Sodium Carbonate

	meq/l.
Probably Safe	<1.25
Marginal	1.25-2.5
Not Suitable	>2.5

Use of a water with constituents higher than recommended does not necessarily mean the crop will die. It usually means a reduction in yield, the reduction being somewhat proportional to the excess concentration remaining in the soil moisture, and depends greatly upon---

The particular crop.
The soil.
The available drainage.
The irrigation practices used.

Summary: Project Adelante experience revealed that although most area ground waters are very suitable for irrigation, there are areas where the water may be high in salinity, boron, or residual carbonate, and hence may be unsuitable for certain crops. Furthermore, higher salinity waters must be applied in greater total quantities to control salt-building, and the best irrigation practices are required to get good crop yields.

5.1 - WELL CONSTRUCTION

5.11 - Available Equipment and Crews

During 1968 to mid-1970 when Project Adelante was in its initial 2-year operating period, there were four companies known to be in the business of drilling irrigation wells and supplying pumping equipment. Both cable tool and rotary rigs are used, and at least one contractor has a reverse-circulation rotary drill rig capable of drilling holes up to 42" in diameter.

Equipment is good and the crews and supervisory personnel, for the most part, appear to be well-trained and knowledgeable in their art. However, they have had limited experience in development of wells under adverse conditions and engineered development specifications.

Electric well logs are known and used, but the limitations of such logs may not be realized. Unless such a log is interpreted by a specially-trained professional geologist, in an area where numerous such logs exist or can be obtained, their usefulness is minimal, and the extra cost to the owner normally is not justified. If such logs are taken by qualified persons as part of an overall research program, the information then revealed can be very helpful. Such a program was beyond the scope of Project Adelante, and the normal "drillers log" of visual observation of strata encountered was considered satisfactory.

Drillers are able to drill smaller diameter pilot holes (i.e. 4 5/8" dia.) initially which then can be reamed to a larger diameter for an actual well if the drillers log and electric log (if used) indicate that a producing well can be developed. This is a good procedure, as the cost of such a pilot hole is considerably less than for a large hole, and minimizes costs in the event that the location proves to be unsuitable.

Contracts for well drilling and pump installation were made directly by the cooperators and the private drilling companies. While project staff had sample contract drafts and specifications available, these were not utilized.

5.12 - Typical Well Characteristics

Depths, diameters, yields, and other performance data for project wells have been summarized previously in Table 5-1. All were of gravel-pack construction, with the exception of that at Site No. 13, Galo. Complete data on each well was obtained from the drilling companies, and are in Project Adelante files. A typical summary sheet for Site No. 8, Pineda, is shown as Table 5-4.

For this well, a cable-tool rig drilled an 18" diameter hole 160' deep. A 12" diameter steel casing, 3/16" thick, was installed in 20' sections, welded together. Casing perforations approximately 1/8" wide and 6" long were cut by oxyacetylene torch, providing a hydraulic area of no less than 10 percent of the casing area where perforated between depths 40' and 60', and 80' and 160'. Slot spacings were about 1". The space between the outside of the hole and the casing was backfilled with about 7 cubic meters of 1/4" to 1/2" graded gravel.

Pump tests were conducted for 5 1/2 to 8 hours, at a rate of 650 gpm. Information on other pump tests confirmed that most development and test pumping is limited to 24 hours or less (usually 12 hours or less), and to rates not greatly above the desired pumping capacity. Consequently the full capability of the wells is not proven. Longer tests, at greater discharges are needed in many instances.

The construction of other project wells was similar. Two of the casings were of 1/8" thickness.

Table 5-4

PROYECTO ADELANTE
INFORME DE PERFORADORES DE POZOS

Sitio No. 5
Pozo No. 1

(1) PROPIETARIO:
Nombre: Ramón Pineda F
Dirección: León

(2) LOCALIZACION DEL POZO:
Departamento: León
Municipio: León

(3) TIPO DE TRABAJO:
Pozo nuevo ☒ Profundidad ☐
Reconoic. ☐ Abandono ☐
Si se trata de abandono, describir material y procedimiento en el inciso (12)

(4) USO PROPUESTO
Domest. ☐ Indust ☐
Munic. ☐ Riego ☒
Prueba ☐ Otro ☐

(5) EQUIPO
Rotativo ☐
Cable ☒
Excavado ☐

(6) REVESTIMIENTO:
Simple ☒ Doble ☐

De pies	a pies	Diam.	Espesor
0	160	12"	3/16

Tipo y tamaño del anillo del pozo

Describir unión: Soldadura

Si se tiene empaque de grava

Diametro de gujero	De pies	A pies
18"	0	160

Tamaño de grava: Entre 1/4" y 1/2"
7 mts³ en total.

(7) PERFORACIONES:
Tipo de perforador usado Oxiacetileno
Tamaño de perfs. 6 pulgs. long. por 1/8"

De pies	a pies	Perf. por fila	Filas por
40	60	Area hidráulica: 10%	
80	160		

(8) CONSTRUCCION:
Se puso sello sanitario Si ☐ No ☒
A que profundidad? ______ pies
Se selló algún estrato contra polución?
Si ☐ o No ☒
Si es sí anote la prof. del estrato

De	Pies a	Pies

Método de sellado:

(9) NIVELES DE AGUA:
Prof. a que se encontró agua 10 pies
Nivel estático antes de perforar 10 pies
" " desp. " " 10

(10) PRUEBAS DE POZO:
Se efectuó prueba de bombeo? Si ☒ No ☐
Quién la efectuó? McGregor
Rendimiento 650 G.P.M. con 25 pies
de rebajamiento depués de 5 1/2-6 horas
Temperatura del agua ______ °F° ______ C°
Análisis Químico Si ☒ No ☐
Registro eléctrico Si ☐ No ☒

(11) DESARROLLO DEL POZO:
Métodos: Pistones (8 hrs)
Verificados por: McGregor

5.13 - Well Costs

Costs of well-construction as reported by contractors for Project Adelante, and in general, are shown in Table 5-5.

The general practice of drilling companies is to give the client only a total price for his work including the well, test pumping, pump and equipment. Special requests had to be presented by project staff to obtain approximate allocations of these costs.

Costs of poles and transmission line to transmit electric power to pumps must be considered also. These varied from slightly over 8,000 cordobas for Site No. 8 which was 140 meters from a main highway and near ENALUF power lines, to 16,000 cordobas for Site No. 50 which was 3,500 meters from ENALUF lines. All power supplied was 220 volts, 60-cycle, 3-phase, a.c.

Table 5-5

WELL DEVELOPMENT COSTS IN NICARAGUA

1968-69

	Diameter (in inches)		Gravel Packed	Costs per foot of well depth	
	Casing	Hole		Cordobas	U.S. $
General Drilling Contractor Estimates	6"	6"	No	$ 40	$ 5.70
	8	8	No	45	6.40
	10	10	No	50-60	7.10-8.60
	12	18	Yes	150	21.50
	14	24	Yes	165-180	23-26
Adelante	10	10	No	67	9.60
	8 1/2	16	Yes	100	14.30
	12	18	Yes	125	18
(This figure believed low)	12	20	Yes	(105)	15

5.14 - Large Capacity Wells Elsewhere in Area

In a previous chapter it was reported that wells with capacities up to 2000 gpm had been developed for the sugar cane plantation at Ingenio San Antonio. A reliable Nicaraguan driller advised project staff of several wells with which he was acquainted in the area.

A 36" diameter well at Site No. 53, La Queserita, was reported to be 190' deep and a yield of 3,500 gpm. Drawdown was 36' from a static water level of 9'.

Two wells at El Guanacaste were reported to yield 2,000 gpm each.

Wells of this size are mentioned, since irrigation costs are reduced by developing wells of from 1000 gpm-2500 gpm, or more, when possible, rather than small wells which will provide water for only a small area. Widespread irrigation in the area should bring many more larger wells.

5.15 - Delays

One particular weakness of the well-drilling industry in Nicaragua is their reluctance, or inability, to stock pumps and spare parts. A minimum of 8 to 10 weeks is required for delivery from U.S. manufacturers and it usually requires four times this length of time for actual installation. Pump equipment costs generally average 125% of U.S. retail quotations. A second weakness is the reluctance of the equipment dealers to service their equipment. A dealer representative may make nearly daily trips from Managua to the Project Area to sell his product, and once the sale is closed, be hard-pressed to even acquaint his client with the newly acquired equipment. In all fairness, the other side of the picture is not all rosy either. The contractors sometimes believe that the landowner uses every means at his disposal to delay payments. Such delays tie up dealer capital unnecessarily.

Table 5-6 gives the dates of contract signing and other specific data on the delivery dates of pump equipment used on project cooperator sites. Future plans realistically should consider this experience.

Table 5-6

WELL EQUIPMENT DELIVERY AND COMPLETION SCHEDULE

FOR PROJECT ADELANTE, 1968-1969

1 Site No.	2 Contract Date	3 Well Started	4 Well Completed	5 Pump Installed	6 Pump Oper.	7 Loan Approved	8 Total*** Elapsed Time
8	17-7-68	18-7-68	29-7-68	24-1-69	13-2-69	15-2-69	7 Mos.
13		21-8-68	15-10-68	10-6-69	1-8-69	15-1-69	12 Mos.
50	21-8-68	*	*	22-3-69	23-3-69	15-1-69	7 Mos.
62	17-7-68	18-7-68	27-7-68	26-6-69	**	1-6-69	11 Mos.
86	17-2-69	12-6-69	11-7-69	9-1-70	9-1-70		11 Mos.

* - Well completed by Guardia Nacional in 1967.
** - Pump inoperative due to landowner's refusal to pay ENALUF meter deposit.
*** - Total elapsed time = Contract signup to pump operation date. (Column 7 minus Column 2 or 3)

COMMENTS

Site No.	
8	- Seven months elapsed time due primarily to delay in loan approval.
13	- Delay in equipment delivery plus two months, additional elapsed time due to improper voltage for starting motor mechanism.
50	- No particular delays except power line installation.
62	- Loan approval delay was the major factor plus owner final refusal to pay meter deposit.
86	- Equipment delivery delay was major factor in total elapsed time of 11 months.

5.16 - Units of Measurement

Because most of the well and pumping equipment are from U.S.A. manufacturers, U.S. units of measurements, except for land area, are in general use. Gallons per minute, feet and inches are used rather than metric counterparts. The Nicaraguan land area unit, the manzana (equal to 1.74 acres) is used in the area, rather than hectares or acres.

5.2 - IRRIGATION WATER REQUIREMENTS

5.21 - General

There are two principal components of crop water requirements:

1. Consumptive Use (evapotranspiration).
2. On-farm losses due to seepage, deep percolation, and surface runoff.

The general procedure followed in estimating crop water requirements is to first estimate the consumptive use, and then to calculate the total farm delivery requirement by dividing by the efficiency of irrigation water use, where

$$\text{Farm Irrigation Efficiency} = \frac{\text{Consumptive Use}}{\text{Total water delivered}}$$

Farm irrigation efficiency varies with soils, wind, type of irrigation system, and irrigation management. Values recommended for general planning are:

Farm Irrigation Efficiencies

Sprinkler irrigation	- 70 to 75 percent
Surface irrigation	- 50 to 60 percent

For Project Adelante, only the Farm Irrigation Efficiency needs to be considered, since the source of water supply is located on the farm. In large projects involving transmission and distribution canals, the efficiency (or losses) in the canal system also must be taken into account.

5.22 - Consumptive Use, Background

Consumptive use (evapotranspiration) is defined as the unit amount of water lost to the atmosphere from a given area in transpiration, building of plant tissue, and evaporated from adjacent soil, snow or intercepted precipitation in any specified time. Consumptive use may be expressed in volume per unit area, such as acre-inches per acre, manzana-inches per manzana, or in depth, such as inches or millimeters. The unit of time may be per day, month, year, or other period.

Many factors operate singly or in combination to influence the amounts of water consumed by plants. Their effects may differ with locality and water consumption may fluctuate from year to year. Some effects involve the human factor; others are related to the natural influences of the environment and to the growth characteristics of the plants. The more important of the natural influences are climate, water supply, soils and topography. The climatic factors that particularly affect consumptive use are temperature, solar radiation, precipitation, humidity, wind movement, length of growing season, latitude, and sunlight.

Evapotranspiration is increased as crop roughness increases. Taller more uneven vegetation tends to result in greater turbulence and more efficient utilization of radiation in the production of water use. Dark green vegetation produces higher rates of absorption of solar energy. In general the lighter the color of the vegetation the lower the rate of evapotranspiration. Plant diseases or disorders that produce yellowing of the leaves of the plants greatly reduce evapotranspiration. Assuming that factors for crop roughness and crop color are comparable, then evapotranspiration is roughly a function of the degree of crop cover. This relationship would be more exact if it were not for the variability in evaporation from the soil. Under similar climatic conditions there is little difference in the rate of evapotranspiration by various crops or types of vegetative cover provided equal crop cover densities, roughnesses and color of vegetation are compared.

It is not the purpose of this report to go into a detailed study of the various ramifications of the theory of consumptive use, but rather to give indications of water use by the plants grown under irrigation on the project sites. Furthermore, it was never intended for Project Adelante to do basic research during the initial years on crop consumptive use by means of lysimeter or soil-plant-water studies. The Project work was expected to provide a basis for estimating, within reasonable limits, maximum irrigation rates and total crop applications. This has been accomplished by reconciling, and to a limited extent by expanding, basic climatic data on temperature, humidity, and evaporation, and by directing field irrigation so that crop water requirements were met. In the latter instance, efforts were not always successful due to pump breakdowns, and failure of farm workers to irrigate when, and as, directed.

5.23 - Basic Procedure for Estimating Crop Consumptive Use

Several methods are used by agriculturists and hydrologists to estimate consumptive use. Among the better of these methods are those of Blaney-Criddle and of Hargreaves. The latter(1) is believed to be the most applicable, especially for tropical climates, because it considers the integral effect of all of the important influences on crop consumptive use, and yet is fairly simple to apply. The basic premise of the method is that the consumptive use at any time is directly proportional to the evaporation from a U.S. Weather Bureau Class "A" pan, and to a crop consumptive use coefficient which in turn depends upon the stage of growth of the crop. In mathematical form the relationship is as follows:

$$ET = (EVPD)(k)$$

Where ET = Crop consumptive use during period of time (usually one month) in inches or millimeters.

EVPD = Measured evaporation from class A pan, in inches or millimeters.

k = crop consumptive use coefficient for specific month.

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(1) "Consumptive Use Derived from Evaporation Pan Data" by George H. Hargreaves, Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, March 1968, pp. 97-105.

When measured pan evaporation data is not available, it can be estimated from the equations of Christiansen (2). (Calculated evaporation can be designated EVPC, and substituted for EVPD in the basic equation). The Christiansen equation was used together with 1956-68 climatic data (primarily for Chinandega, but with some Managua data for wind and sunshine) to calculate one of the series of pan evaporation points shown on Fig. 3-5(b), p. 3-10 of this report. In this calculation relative humidity data obtained on the project was used, because that reported for Chinandega was for only one early morning reading per day, and did not represent average daily humidity.

Fig. 3-5(b) also shows that pan evaporation at Cooperator Site No. 8, Pineda, generally was higher than the calculated average pan evaporation. For the purposes of estimating average expected crop consumptive use, the measured values were used, except where not available. (Note: The annual average pan evaporation was estimated in December 1969 by Mr. G. H. Hargreaves while on special assignment in Nicaragua with U.S.AID. He used average Chinandega data, but did not have the advantage of project relative humidity data. The annual pan evaporation calculated by Hargreaves was 1954 mm., while the project calculation was 1980 mm.)

Maximum calculated average daily pan evaporation rate was 8.45 mm/day for March. The maximum month recorded during 1-year of project data collection averaged at 9.5 mm/day in April. Maximum daily evaporation rates recorded at the project varied from 7.2 mm/day to 17 mm/day.

Values of k, the crop consumptive use coefficient, are given in Tables 5-7 and 5-8. Most of these were obtained from Hargreaves original article or his report on Project Adelante to U.S.AID. Values for other crops have been estimated by the consultants.

Monthly crop consumptive use requirements, in inches, are presented in Table 5-10 for some of the more important crops. (Inches, rather than millimeters, are used for convenience in conjunction with Nicaraguan dealer U.S. sprinkler irrigation equipment data sheets, which use inch units.) Estimates in this table are for crops grown during a period of time when rainfall is minimal or conversely, when the most irrigation is required. The consistently-warm climate in Nicaragua permits many of these to be planted and harvested at different times of the year. Selection of crop growing period depends upon a great many factors, as outlined in detail in Chapter 4 on Agronomics, and hence there are too many alternative possibilities to calculate and present in a report such as this. The Table 5-10 values can be used as a guide for estimating maximum irrigation costs. For cropping periods other than those shown in Table 5-8, the basic coefficients of Table 5-7 can be used together with monthly evaporation figures to calculate crop evapotranspiration.

(2) "Pan Evaporation and Evapotranspiration from Climatic Data", by Jerald E. Christiansen, Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, June 1968, pp. 243-265.

Table 5-7

COEFFICIENT OF CONSUMPTIVE USE OF CROPS BY PERCENT OF GROWING PERIOD "k"

ET = k(EVPC) or = k(EVPD)

CROP	Percentage of Growing Period of the Crop 0	10	20	30	40	50	60	70	80	90	100%
Beans	0.20	0.30	0.40	0.65	0.85	0.90	0.90	0.80	0.60	0.35	0.20
Corn	0.20	0.30	0.50	0.65	0.80	0.90	0.90	0.85	0.75	0.60	0.50
Cotton	0.10	0.20	0.40	0.55	0.75	0.90	0.90	0.85	0.75	0.55	0.35
Grain Sorghum	0.20	0.35	0.55	0.75	0.85	0.90	0.85	0.70	0.60	0.35	0.15
Spring Grain	0.15	0.20	0.25	0.30	0.40	0.55	0.75	0.85	0.90	0.90	0.30
Winter Grain	0.15	0.25	0.35	0.40	0.50	0.60	0.70	0.80	0.90	0.90	0.30
Watermelon & Melons	0.35	0.35	0.45	0.50	0.60	0.65	0.65	0.60	0.60	0.55	0.55
Nuts (Pecan)	0.35	0.45	0.55	0.75	0.75	0.65	0.50	0.45	0.40	0.35	0.30
Peanuts	0.15	0.25	0.35	0.45	0.55	0.60	0.65	0.65	0.60	0.45	0.30
Potatoes	0.20	0.35	0.45	0.65	0.80	0.90	0.95	0.95	0.95	0.90	0.90
Rice	0.80	0.95	1.05	1.15	1.20	1.30	1.30	1.20	1.10	0.90	0.50
Soybeans	0.15	0.20	0.25	0.30	0.45	0.55	0.70	0.80	0.70	0.60	0.50
Sugar Beets	0.25	0.45	0.60	0.70	0.80	0.85	0.90	0.90	0.90	0.90	0.90
Tomatoes	0.20	0.25	0.40	0.60	0.70	0.75	0.75	0.65	0.55	0.30	0.20
Vegetables, Shallow Roots	0.10	0.20	0.40	0.50	0.60	0.60	0.60	0.55	0.45	0.35	0.30
*Safflower	0.10	0.20	0.30	0.45	0.70	0.90	0.95	0.95	0.80	0.60	0.15
**Yuca & Quequisque	0.20	0.30	0.40	0.60	0.80	0.90	0.90	0.90	0.90	0.90	0.90
*Castor Beans	0.10	0.15	0.35	0.50	0.65	0.80	1.05	1.30	1.20	1.00	0.60

* Value estimated by Uniconsult from Arizona 1950-1964 data.

** Value estimated by Uniconsult, no data. Probably a high estimate, for use until better data obtained.

Other values from articles or reports by G. H. Hargreaves, referenced in body of this report.

ET = Evapotranspiration in inches or mm.
EVPC = Calculated U.S. Weather Bureau Class "A" pan evaporation in inches or mm.
EVPD = Recorded U.S. Weather Bureau Class "A" pan evaporation in inches or mm.

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Table 5-8

MONTHLY COEFFICIENTS OF CONSUMPTIVE USE "k"

ET = k(EVPC) or = k(EVPD)

CROPS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DEC
Alfalfa	0.55	0.65	0.75	0.85	0.95	1.00	0.95	0.90	0.85	0.80	0.70	0.55
Avocado	0.20	0.35	0.45	0.55	0.60	0.65	0.60	0.60	0.60	0.40	0.35	0.25
Citrus	0.50	0.50	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.50	0.50
Dates	0.85	0.85	0.80	0.80	0.75	0.75	0.75	0.80	0.85	0.90	0.90	0.90
Dates, Hard Skin	1.05	1.00	1.00	0.95	0.95	0.95	0.95	1.00	1.00	1.10	1.10	1.10
Orchard Deciduous	0.15	0.20	0.30	0.50	0.70	0.75	0.75	0.65	0.45	0.25	0.15	0.10
Grapes	0.15	0.20	0.25	0.40	0.55	0.60	0.60	0.60	0.50	0.40	0.25	0.20
Orchard with Cover	0.50	0.55	0.65	0.75	0.85	0.90	0.85	0.85	0.75	0.70	0.60	0.50
Oranges & Lemons	0.45	0.40	0.35	0.35	0.35	0.35	0.40	0.45	0.50	0.55	0.55	0.50
Pasture	0.40	0.45	0.55	0.65	0.70	0.70	0.70	0.70	0.70	0.60	0.50	0.45
Pasture (Bahia)	0.65	0.70	0.75	0.70	0.75	0.70	0.70	0.60	0.60	0.60	0.65	0.65
Pasture (Bermuda)	0.75	0.70	0.75	0.80	0.70	0.70	0.70	0.70	0.75	0.75	0.80	0.75
Pasture (Pangola)	1.15	1.05	0.80	1.00	0.90	1.20	1.10	0.95	0.80	0.60	1.00	1.05
Pasture (Trenza)	0.80	0.80	0.90	1.20	1.30	1.60	1.20	1.45	0.80	0.95	1.20	1.30
Banana	0.80	0.90	1.10	0.85	0.85	0.70	0.70	0.75	0.85	1.00	1.10	0.95
Sugar Cane	0.75	0.70	0.50	0.50	0.55	0.55	0.60	0.75	0.85	0.85	0.90	0.85
Beans, Castor	0.50	0.85	1.20	0.80	-	-	-	-	-	-	-	0.18
Beans, Dry	-	0.45	0.90	0.60	-	-	-	-	-	-	-	-
Corn	0.75	0.90	0.65	-	-	-	-	-	-	-	-	0.35
Cotton	0.70	0.45	-	-	-	-	-	0.20	0.50	0.75	0.90	0.80
Melons	0.38	0.50	0.65	0.60	0.55	-	-	-	-	-	-	0.35
Millet (Pearl)	0.20	0.60	0.60	-	-	-	-	-	-	-	-	-
Safflower	0.25	0.65	0.95	0.50	-	-	-	-	-	-	-	-
Sorghum, Grain	0.40	0.80	0.85	0.55	-	-	-	-	-	-	-	-
Soybeans	-	0.25	0.60	0.65	-	-	-	-	-	-	-	-
Vegetables, Shallow-roots	0.50	0.60	0.55	0.35	-	-	-	-	-	-	-	0.20
Vegetables, Deep roots	0.50	0.65	0.60	0.55	-	-	-	-	-	-	-	0.35
Yuca, fresh, 300 days (and 300-day Quequisque)	-	-	0.30	0.40	0.60	0.80	0.90	0.90	0.90	0.90	0.90	0.90

Notes: 1. Data above dashed line provided by G. H. Hargreaves (See text). Data below estimated by Uniconsult
2. Sugar cane planting in March with harvest in April following year.
3. Cropping periods for most annual crops can vary considerably. Those shown selected to calculate representative irrigation requirements.

5.24 - Crop Irrigation Requirements

If rainfall occurs during a crop growing period, part of it (termed "effective" rainfall) will satisfy consumptive use requirements. The remaining demand must be satisfied by irrigation. To determine the amount of water which must be pumped to supply such a differential, the difference is divided by the far irrigation efficiency to obtain the farm irrigation requirement.

$$IR = \frac{ET - r_e}{E}$$

Where
ET = Consumptive Use (Evapotranspiration)
E = Irrigation Efficiency
IR = Irrigation Requirement (Farm Delivery)
r_e = Effective rainfall

r_e, effective rainfall, is that portion of the precipitation which does not runoff over the surface of the ground or percolate beyond the root zone, but which remains in the root zone and is available to meet crop evapotranspiration needs.

Average monthly precipitation was taken from Table 3-1 for Chinandega. Minimum monthly precipitation is appreciably less, and a farmer with an irrigation system will be able to add supplemental water when required during times of below-normal rainfall. See Table 5-9.

Table 5-9

AVERAGE PAN EVAPORATION AND PRECIPITATION VALUES USED IN ESTIMATING IRRIGATION REQUIREMENTS - PROJECT ADELANTE AREA

(All Values in Inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Ago	Sep	Oct	Nov	Dec	Tota
Average Monthly Evaporation	10.1	10.1	9.3	11.2	9.7	7.6	6.2	7.1	6.3	4.5	5.4	7.8	95.3
Average Daily Evaporation	0.33	0.36	0.30	0.37	0.31	0.25	0.20	0.23	0.21	0.15	0.18	0.25	
Average Monthly Rainfall	0	0.1	0.2	1.1	5.9	16.0	9.0	7.9	15.4	20.1	4.0	0.2	79.9
Minimum Monthly Rainfall	0	0	0	0	0	6.5	2.7	2.4	11.1	10.0	1.2	0	

Table 5-10

REPRESENTATIVE ANNUAL IRRIGATION REQUIREMENTS FOR VARIOUS CROPS PROJECT ADELANTE, NICARAGUA

(All Values in Inches)

Crop	Consumptive Use ET		Irrigation Requirement IR	
	Peak Month	Annual	70% Efficiency	50% Efficiency
Cotton	7.1	31	28	39
Beans, dry	8.4	20	27	38
Castor Beans	11.2	36	50	70
Corn	9.1	26	36	50
Cucumbers	6.6	24	33	46
Eggplant	6.1	22	29	41
Grain Sorghum	8.0	26	38	53
Melon & Watermelon	6.7	27	33	46
Millet (Pearl)	6.0	14	20	28
Pasture (Pangola)	11.6	96	82	115
Pasture (Bermuda)	9.0	70	56	78
Peanuts	6.0	19	26	36
Pepper, bell	6.1	22	30	42
Quequisque	7.0	53	25	35
Safflower	8.8	24	33	46
Squash	6.0	21	26	36
Sweet Potato	6.6	24	33	46
Tomato	7.0	24	33	46
Yuca, fresh	7.0	53	25	35

Note: Values shown generally represent expected requirements for crops grown in dry months during average years. Cotton, however, estimated on typical 1968-69 area practice. Crops such as yuca, quequisque, and cotton extend thru rainy season.

5.3 - REQUIRED SYSTEM DELIVERY CAPACITIES

5.31 - System Capacity Requirements

The delivery capacity of the irrigation system, whether a sprinkler or surface system, depends upon the peak period use of the crop being irrigated, the irrigation efficiency, and the number of hours per day during which irrigation is performed. The required capacity is calculated from the following equation:

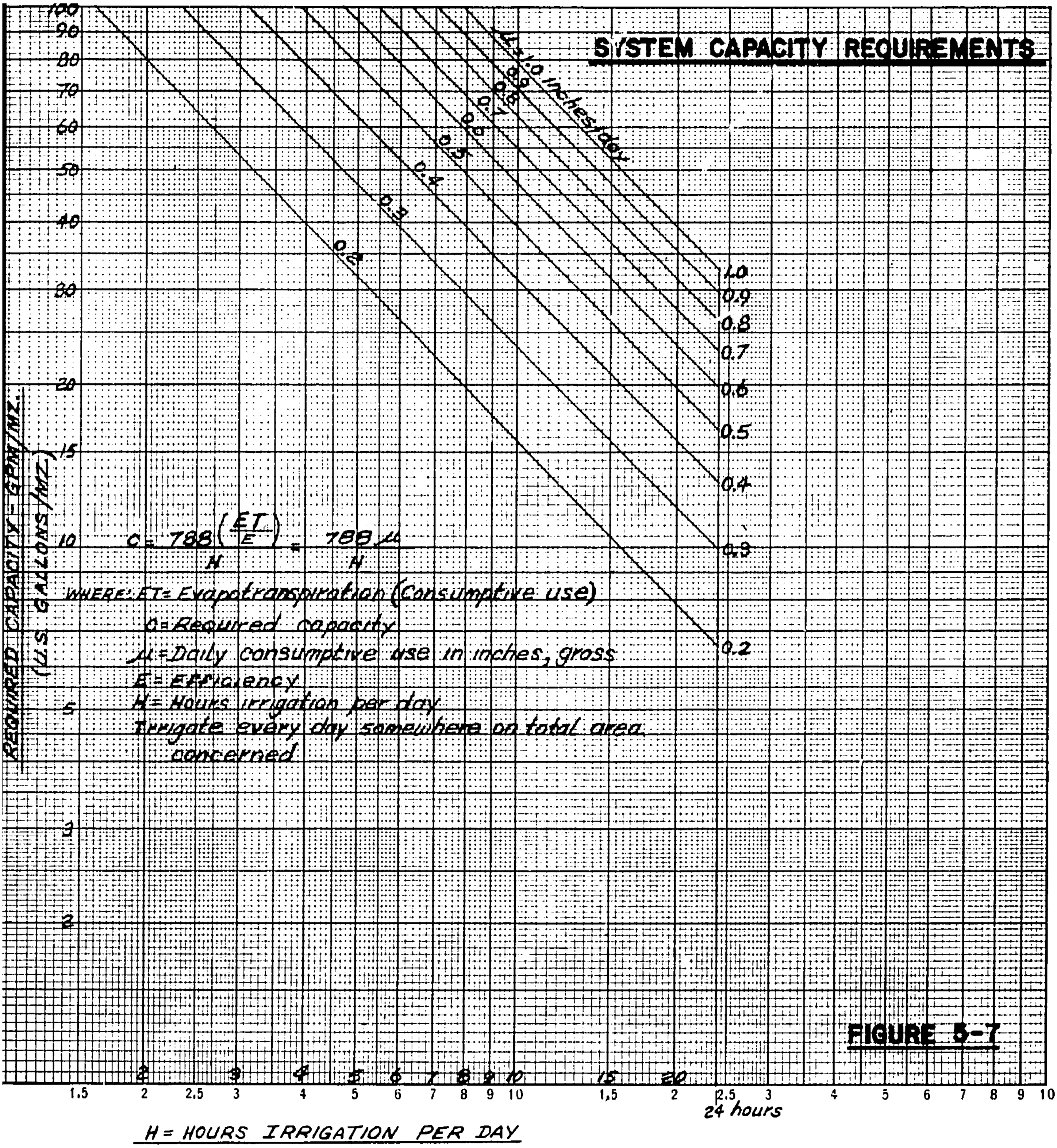
$$\text{Required Capacity in gallons per minute per manzana} = \frac{ET}{\text{Efficiency}} \times \frac{788}{H}$$

where

ET = Evapotranspiration Rate in inches per day

Efficiency = Irrigation Efficiency

H = Number of Hours of Irrigation per Day



SYSTEM CAPACITY REQUIREMENTS

$$C = \frac{788\left(\frac{ET}{E}\right)}{H} = \frac{788\,\mu}{H}$$

WHERE: ET = Evapotranspiration (Consumptive use)
C = Required capacity
μ = Daily consumptive use in inches, gross
E = Efficiency
H = Hours irrigation per day
Irrigate every day somewhere on total area concerned

FIGURE 5-7

CONSUMPTIVE USE-IRRIGATION APPLICATION REQUIREMENTS

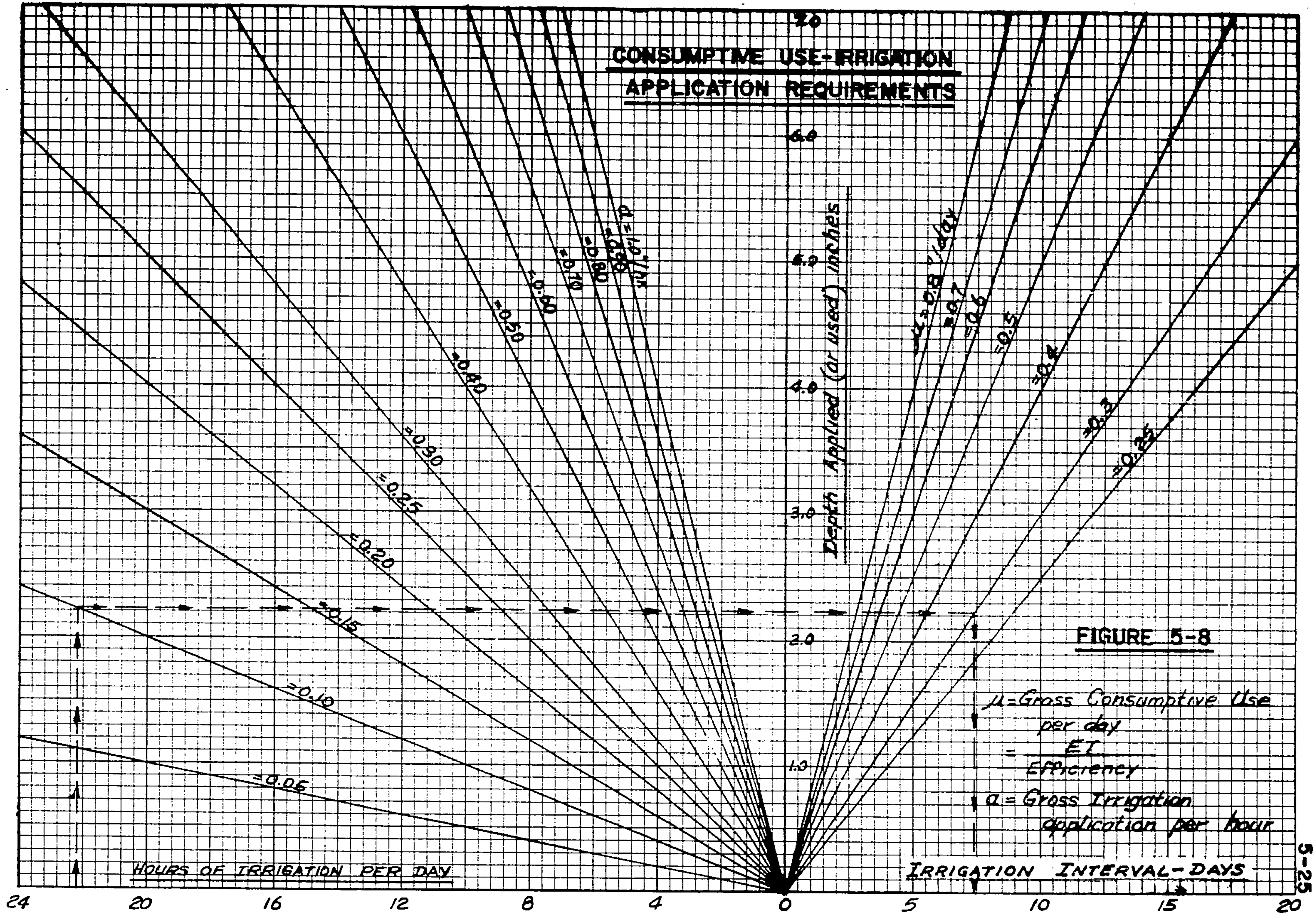
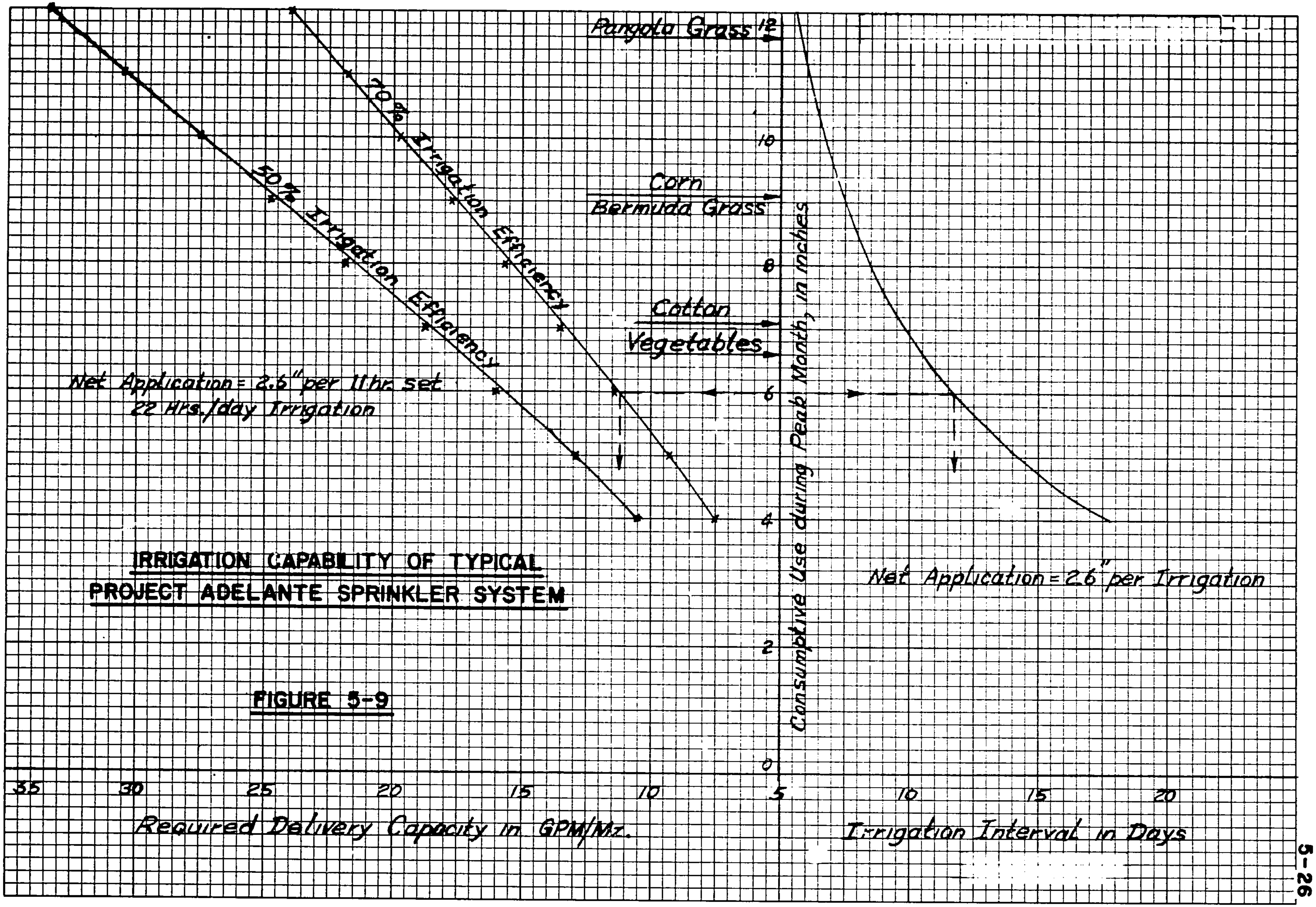


FIGURE 5-8

μ = Gross Consumptive Use per day = $\frac{ET}{Efficiency}$

a = Gross Irrigation application per hour



IRRIGATION CAPABILITY OF TYPICAL PROJECT ADELANTE SPRINKLER SYSTEM

FIGURE 5-9

The relationship is shown graphically as Figure 5-7. The capacities shown, for various hours of operation per day, are the capacities needed every day during the peak irrigation season.

This does not mean that the entire farm is under sprinkler irrigation every day, but that some area is irrigated daily. The capacity for the area sprinkled each day normally is greater. For example, if a farm has a gross peak daily use of 0.5"/day, and sprinkling is to be done only 11 hours each day, the required farm capacity is 35.3 gpm/mz. If the farmers system is arranged so that he irrigates 1/4 of the farm each day, the delivery rate to each tract will be 4 times as much, or 141.2 gpm/mz., but only for the area actually sprinkled. The farm delivery rate remains at 35.3 gpm/mz. for the total area irrigated in 4 days.

If irrigation is not performed daily somewhere on the farm, then the required capacity is increased. In the example preceding, if irrigation is performed for four consecutive days, and then no irrigation occurs for another 4 days, the required capacity is then 70.6 gpm/mz. or twice as much.

If the farm has irrigation for 22 hours every day, then the required capacity is only one-half as much, or 17.6 gpm/mz. for a daily irrigation schedule.

For a 20-manzana area, the following total daily delivery capacities are required.

Hours Irrigation per Day	Required Capacity
11-hour irrigation daily	706 gallons per minute
22-hour irrigation daily	353 gallons per minute

5.32 - Application Rates

Application rates must not exceed the intake rates of the soil, whether by flood or sprinkler irrigation. The left side of Figure 5-8 shows the governing relationship.

For example, if 3.7 gross inches of water are to be applied in 22 hours, the soil must have an average intake capacity over that period of time of about 0.17 inches/hour. Also, the water must be applied at that rate. If the intake capacity is greater, the system will work. If the intake rate is less, then less total water can be applied per day.

5.33 - Irrigation Interval

The irrigation interval, or time between irrigations on the same plot of ground, depends upon the peak rate at which water is used and the amount of water available in the root zone to supply the evapotranspiration demand.

Using the same figures as in the preceding two examples, a 3.7 gross inch application and a gross use per day of 0.5", the graph on the right-hand side of Figure 5-8 shows that the time between irrigations must not exceed 7.4 days.

It should be noted that the irrigation interval depends upon the total amount of water applied and the gross daily use, and is independent of both the system capacity and the infiltration rate.

At the same time, system capacity is independent of the amount applied per irrigation and of the irrigation interval.

All charts are applicable to all irrigation practices, whether by sprinkler, surface, or subsurface methods.

5.34 - Capacity Design and/or Operation

The selection of a properly-sized irrigation system then, requires simultaneous resolution of the three principal relationships just discussed, plus consideration of available equipment and methods.

The typical Project Adelante sprinkler irrigation system has the following characteristics,

Gross application rate = 0.335 inches/hour
11-hour application = 3.7 inches
22-hour application = 7.4 inches

The available total water delivery capacity depends upon the well or pump at a particular farm. The larger the capacity, the more land that can be irrigated.

The amount of land which can be irrigated properly once a given system is available, depends upon the crops grown, and the management and planning skill of the farmer.

First, he should plan his cropping program so that it will utilize his system capacity to the maximum, but will not exceed the capacity. If it exceeds it, under-irrigation will occur. If it is under-utilized his costs will be higher, but at least his crop yields will not be depressed because of lack of water.

Second, he needs to know about when the next irrigation is due, and to irrigate before plants begin to show stress. For a given irrigation system, it is the interval between irrigations which must vary, and which the good farmer will manage. For a crop which uses much water, the irrigation interval will be smaller. Hot weather also will shorten the required interval. The farmer should not perform his irrigations on the same interval throughout the year. If this is done, there will be under-irrigation at times, with depressed yields, or over-irrigation and wasted pumping costs, and possibly depressed yields on crops sensitive to excess water.

Figure 5-9 has been prepared as an example for the Adelante sprinkler systems, based on 22 hours of irrigation every day, and 11-hour irrigation sets on each plot of land. Use of the 22 hours gives one hour at the end of each irrigation set for movement of equipment to the next set. Each set would apply 3.7 inches gross of water during the 11-hour period.

The figure shows how the delivery capacity must be increased, and the irrigation interval shortened, as the crop water use per month increases. Table 5-10 gives peak month consumptive use rates. A few of the values also are indicated on Figure 5-9.

Pangola grass, with a maximum monthly use of 11.6 inches (net) is about the heaviest water using crop under consideration in the area. A 20-manzana field of pangola grass requires 23.2 gpm/mz., or 464 gpm for proper sprinkler irrigation during the peak month, and must be irrigated every 5.8 days, according to the Figure.

Cotton requires 13.5 gpm/mz., or 1,350 gpm for a 100-manzana field. The irrigation interval during the peak month is 9.7 days.

5.35 - Importance of Evapotranspiration Value on Required System Capacity

It should be pointed out that the variable with the greatest uncertainty as to its true value, and which in addition can vary from year to year in magnitude, and which directly affects required capacity, is maximum monthly evapotranspiration. It has been indicated in Section 5.23 of this report that the estimates are based on

1. The pan evaporation.
2. A monthly consumptive use coefficient.

The pan evaporation data used for the estimates of this report were those measured by the project. They are believed reliable for the location and time recorded, and are relatively consistent within themselves. For cotton, the maximum month was January. The reliability of the coefficient can always be questioned, but, until data to the contrary is obtained, the Hargreaves values are believed to be reasonably correct.

The remainder of the construction of Figure 5-9 primarily is mathematical, and straightforward. The left-hand side is a variation of Figure 5-7, and the right-hand side is a direct inverse mathematical relationship, modified only by increases in consumptive use per day during the peak month over the average use during that month.

The consultants have found on several occasions that required system capacities are undersized because the peak month needs have not been given the attention they deserve. Use of the three charts in this Section may help minimize future such results.

At the same time it should be recognized that an irrigated farm with several crops will not have the peak monthly use for all crops occurring at the same time. Hence the usual case is that the monthly demand for design is a weighted composite. Such a composite should be estimated for each farm crop program for the coming year, as part of good planning.

Thus both the peak crop use, and the overall farm peak use, should be estimated, and the irrigation system operated accordingly.

5.4 - COOPERATOR IRRIGATION SYSTEMS

5.41 - Basic Sprinkler Irrigation System Design

At the time the irrigation equipment had to be ordered in the Spring of 1968, it was not possible to tailor the system design to each specific cooperator site. In fact, not all cooperator sites were yet chosen, and therefore a basic design was selected as follows:

From review of available weather data and reports from a reliable irrigation engineer in the area, a basic application rate of 0.3 to 0.35 inches per hour was considered adequate. Due to the wide range of crops likely to be grown (vegetable, row crops and pasture) it was considered necessary to restrict the irrigation cycle to 10 days maximum. The strong winds of the dry season made it prudent that the sprinkler spacing be limited to 30 feet on the lateral and a maximum of 50 feet between laterals. Also because of the windy conditions a single-nozzle sprinkler head was chosen over the two-jet type. The single jet produces less fine water droplets (spray) and is less affected by drift due to wind. The size of nozzle selected was 5/32-inch, and with an average nozzle pressure of 50 pound per square inch (psi), will deliver 5 gallons per minute. At 55 psi the discharge is 5.22 gpm. With the 30 x 50 foot spacing, a 55 psi pressure gives a gross application rate of 0.335 inches per hour. An eleven hour set results in a gross application of 3.7 inches of water. If irrigation efficiency is 75 percent, a net application of 2.77 inches of water results; with a 70 percent efficiency net application is 2.6 inches. The 70 percent efficiency estimate is considered the more appropriate for planning and design purposes.

Soil infiltration tests at several sites indicated that these application rates would be satisfactory. Copies of the test results may be found at the end of this chapter.

The sprinkler system layout was selected to cover a maximum area with a minimum of equipment. The maximum length of 3-inch laterals was 900 feet, to limit the pressure drop between the lateral inlet and end to no more than 20 percent of inlet pressure. The most economically-shaped field for sprinkler irrigation would be rectangular, with the well and pump located at, or near, the center of the tract. Following this general criterion resulted in the selection of 20 manzanas (34.8 acres), in a rectangular-shape, with field dimensions of about 900 feet in width and 1,800 feet in length. The rotation of the laterals would be made in such a way that a minimum of 450 feet of 4-inch main line would serve this entire 20-manzana tract. Further, assuming nominal well lifts to give a total dynamic head of less than 200 feet, this would put the pump horsepower in the range of a 20 Hp. electric motor or 25 Hp. diesel unit, for a total delivery of 300 gpm.

Capital costs for a basic sprinkler system are summarized in Table 5-11. (Capital Costs for wells and pumps are presented in Table 5-1).

Table 5-11

REPRESENTATIVE CAPITAL COSTS FOR SPRINKLER EQUIPMENT

BASIC PROJECT ADELANTE PILOT FARM OF 20 MANZANAS

Item	Quantity	Cost in Cordobas
4-inch diameter aluminum mainline pipe	900 feet	$ 7,200
3-inch diameter aluminum lateral pipe, with 5/32-inch nozzle sprinkler heads at 30-feet spacing	1800 feet	18,000
Miscellaneous fittings (elbows, tees, etc.)	--	2,000
Total		$27,200

Total Capital Cost/Manzana = $1,360

Sufficient equipment is included to provide a wide range of flexibility in operation. For example, there are included extra connections to permit lateral line locations at various intermediate positions. There is sufficient additional mainline tubing (450 feet extra) to permit the location of the well other than in the exact center of the design area.

Should the design area be increased to that of a more economic unit (say 75 to 100 manzanas) then per unit cost could be expected to be reduced to about $1,200.00 per manzana.

Actual system costs for each of the full cooperator farms are summarized later in Tables 7-1 and 7-2, pp. 7-5 and 7-6. The range of per manzana costs varies from $1,278 to $2,508. The higher unit cost occurred in a situation where fewer manzanas were actually farmed (12.5 mz.) than the 20 manzanas which the system was capable of irrigating.

5.42 - Cooperator Irrigation Layouts

Basic layouts for each of the full cooperator systems are shown on the farm layouts in Chapter Six. (pp. 6-13, 6-24, 6-32, 6-38, 6-42). While the layout was based on 30' spacings between sprinkler heads and 50' lateral spacings (30' x 50), the layouts for Site No. 8, Pineda, and Site No. 86, Escobar, show a 30x60 layout. Actually, since both 20' and 30' lengths of 4-inch mainline pipe were provided, either layout can be used. However, with the 30x60 layout gross application drops to 0.28 inch/hour and 2.97 inches during an 11-hour set. This may be sufficient for many crops during much of the year, but is not considered to be as desirable as the 30x50 spacing recommended. The greater spacing requires either longer sets to give a good irrigation which more fully utilizes the moisture-holding capacity of the area soils, or reduced intervals between irrigations. Furthermore, under windy conditions water distribution will not be as good, the overall efficiency thereby reduced, and irrigation costs increased. The most common result is that parts of the field, between laterals, will not be irrigated sufficiently, and the crop yields are reduced in those areas.

5.43 - Gated-Pipe System

A surface irrigation system using gated aluminum pipe was installed at Site No. 4, Vaca. (See p. 6-38). The cost for that system (excluding power and pump) was $36,390, or $3,308/mz., considering only the 11 manzanas actually irrigated. The higher per manzana cost again reflected the fact that the pipe was not fully-utilized on this small an area, having the capability of serving a larger area.

Although Project Adelante was originally conceived to be primarily sprinkler irrigation during the initial years, the need to evaluate and demonstrate surface irrigation methods is well recognized. Site No. 4 was chosen to demonstrate surface irrigation because it had a large spring for a water source and the well-drained, deep, soil lay nearly uniform in slope to permit water application with a minimum amount of leveling work.

5.5 - SURFACE IRRIGATION

Undoubtedly much of the project area can be irrigated by surface irrigation methods. The reasons for selection of sprinklers initially for cooperator farms were set forth previously in Section 1.12. Primarily these were that proper land-leveling equipment and operators were not available in Nicaragua, that the cost of providing same would be too high for a pilot program, and the time required to train operators and perform the work would be excessive, when compared to the time and costs required, and relative ease of securing sprinkler irrigation equipment and placing it in operation. This is not to say that the sprinkler equipment and wells could be furnished immediately, for as set forth previously in this chapter, delays were anticipated and did occur even for the path chosen. The more important objective of the initial project years was to obtain agronomic and economic data, and farmer experience, for irrigated crops, as soon as possible, and at minimum cost. Whether the supplemental moisture is applied by surface, subsurface, or sprinkler methods, the crop cultivation practices and costs, the yields, and the marketing problems are essentially the same. The irrigation practices, however, do differ.

Where the land is not unduly undulating, land-levelling, which is absolutely essential for surface irrigation, does not cost as much as sprinkler irrigation equipment. In addition, pumping power costs are reduced greatly. Where the land topography is suitable, surface irrigation (also termed gravity, or flood, irrigation) is more economical, and should be considered.

In Chapter 7, pp. 7-16 to 7-18, an economic comparison is presented between sprinkler and surface irrigation for a 20-manzana plot of land with a net application of 52 inches of water per year. The summary comparison is repeated here.

	Irrigation Method	
	Sprinklers	Surface
Investment per Manzana	$ 4,785	$ 3,285
Annual Cost per Manzana	$ 1,334	$ 838
Cost per Manzana-inch of water	$ 25.6	$ 16.1

Since it is extremely important to reduce farm production costs, and the capital required to enter irrigation farming, additional serious consideration should be given to the use of surface irrigation methods rather than sprinkler irrigation methods. There will be areas for which surface irrigation is the more economical (Some of the cooperator sites were in this category), and other areas where sprinkler irrigation is better. The type of crops and soils also enter into the total picture.

5.6 - COSTS OF IRRIGATION

Further details of capital and annual costs for both surface and sprinkler irrigation are presented in Chapter 7, Economic Evaluation, pp. 7-4 through 7-18. These details include an intensive analysis of pumping power costs, and charges for depreciation, interest, labor, repairs, and special irrigation operations.

5.7 - CROP IRRIGATION PRACTICES

5.71 - General

While irrigation practices must be executed by farm managers and farm labor, and hence very much are types of farming practice, many of these involve engineering and hydrologic principles and applications. It is therefore proper to include in this chapter comments on several such practices and principles, which should be understood by those most directly concerned with introducing, or helping with, irrigation in Nicaragua. Irrigation practices for specific crops are covered in Chapter 4 and 6, and only mentioned as examples in this section.

5.72 - Land Leveling for Sprinkler Irrigation

One basic premise of a sprinkler irrigation system is that little or no land preparation work is required. This, of course, depends upon the state of the land being developed for irrigation. If it be virgin land then of course clearing and rough smoothing would be required to permit tillage equipment operation. It should be pointed out, however, that undulating lands do not permit precision planting, cultivation and harvest operations and thus adversely affect yields. In irrigated agriculture the emphasis is on maximum yields, in order to not only justify amortization of the original investment, but also to provide increased returns to the owner for the added labor and management required.

Hence even sprinkler irrigation requires that periodic levelling and floating operations be carried out. Normally these activities are identified and charged as part of cultural practices, rather than being tagged as an irrigation cost. There is good justification for this procedure, inasmuch as such practices should be performed even for purely rain-supplied plant water, to provide for good water infiltration and retention, elimination of surface pondage, reduction of soil erosion, better seed germination, and more uniform soil moisture distribution.

5.73 - Pre-Irrigation

This is the term used to describe the application of water either prior to land preparation or before the seeding or planting of a crop. The purpose of this practice is to refill the full root zone for potential crops with water. This provides a reservoir of water which encourages new plant roots to penetrate the full strata or rooting depth. The soil moisture previously in the root zone may have been depleted by a preceding crop. More frequently, the land preparation work of discing, floating, etc. to prepare a seed bed causes the surface moisture to evaporate and this requires at least a light application to restore the moisture necessary for good seed germination.

Pre-irrigation plays a very important role in the establishment of uniform disease-free stand which helps the plant quickly move beyond the vulnerable seedling stage of growth. Also, a good pre-irrigation helps the plant pass through extremely hot periods when the irrigation system or the irrigators may not be able to replace the evapotranspiration as rapidly as desired.

Furthermore, a pre-irrigation is not water "lost." A good deep pre-irrigation will reduce the amount of irrigation water needed subsequently.

5.74 - When to Add Water (Replacement)

This is simply the addition of water to the soil to replace that used by the plant in the various stages of growth. At first, it will be recognized that the plant requires very little water, or water only in the upper soil layers. As the roots penetrate deeper into the soil profile the plant extracts water at an ever-increasing rate and depth. The ideal application of water is to resupply this extraction at the rate it is being withdrawn. In a practical sense this is not possible. Taking advantage of the ability of the soil to act as a reservoir, it is possible to add water before the plants begin to show physical signs of stress. This is done by observing the moisture content of the soil with the aid of a steel rod probe, tensiometers, or by "feel" of the soil in accordance with well-known guidelines, and irrigating accordingly.

5.75 - Special Moisture Control

In addition to the above there are special conditions to be considered in the matter of water application. In all crops there are certain periods in the growth pattern, where the addition to or withholding of water affect yield, seed set, flowering and certainly quality. Such is the case for a large number of the fruit crops.

For example, in corn there are three distinct periods of growth when adequate moisture is required. These periods are: 1) initial rapid growth period, 2) initial tassel stage, 3) silking stage.

Other examples may include the withholding of moisture to induce maturation, or sugar-type conversion, in the case of sugar cane. Another example is the fact that the application of water during periods of flowering may cause a poor seed set and reduction of final yield.

5.8 - DRAINAGE

5.81 - Importance of Drainage

Very little has been mentioned heretofore in this report of the vital importance of drainage to successful, sustained, irrigated agriculture. This is due partly to the conditions in most of the project area, which permits both surface and subsurface drainage waters to be disposed of rather efficiently; in most instances by natural channels and flow paths which do not need a great deal of special attention from the farmer. Drainage also was not a major problem on cooperator farms because of the very small size of the irrigated area in relation to the rest of the farm and surrounding area.

As long as excess soil moisture, whether from rainfall, flooding, or rising underground water tables, is removed fairly quickly from the plant root zone, by natural means, special drainage works are not required; at least not to any great extent. Because some surface flooding does occur, and because localized areas of poor subsurface drainage exist now, especially near the sea and estuaries, and others may later appear when irrigation in the area becomes more widespread, a few comments on the subject in this chapter are appropriate.

Excess soil moisture produces the following adverse effects on agricultural operations and areas.

1. Public and animal health can be adversely affected by the breeding of disease-carrying insects, especially mosquitoes, in small or large shallow pools of standing water.
2. Poorly-drained soils are colder, which tends to hinder germination and plant growth.
3. Plants are more susceptible to attack and damage from rust, mildew, and other diseases.
4. Poor soil aeration depresses plant growth.
5. Root penetration is reduced, and roots are less healthy. When the water table in the root zone fluctuates, root-rot usually results in many plants.
6. Soil tillage and crop cultivation and harvesting are made more difficult and costly.
7. Poor surface drainage can accelerate or cause soil erosion and gullying.
8. A high water table during the dry season can cause an excess concentration of salts in the root zone, thus depressing crop yields.

Adequate drainage results in early and vigorous plant growth, a longer growing season, larger yields, and decreased production costs.

5.82 - Surface Drainage

By surface drainage is meant the removal of surplus water which tends to collect on the surface of the ground, and the protection against and removal of surface runoff from adjacent lands or from watercourses. Natural surface drainage is provided by depressions, swales, creeks, and rivers, through which the excess water is conveyed to an outlet. Artificial surface drainage is any activity of man performed to supplement the natural drainage.

Artificial drainage includes land leveling or smoothing, terracing to control erosion and re-route natural flow paths, and the construction of new or enlarged surface channels. In the overall sense, construction of levees to prevent flooding is a type of surface drainage activity.

The heavy rains which occur during the rainy season certainly cause surface drainage problems in the area. In most instances modest land-shaping activities can minimize present adverse effects. These activities at the same time, if performed with this objective in mind, can help reduce overall irrigation requirements by conserving soil moisture, and help achieve more uniform water distribution over farm lands.

5.83 - Subsurface Drainage

Subsurface, or subsoil, drainage, refers to the removal of excess subsoil water. It is accomplished by lowering the ground water table by (a) pumping from wells, or (b) by installing open or closed drainage conduits (ditches and/or tile pipe). Actually, subsurface drainage water ultimately must reach some surface drainage channel and be conveyed from the area, or reach some natural disposal area such as the ocean, a lake, or a swamp.

In the project area it is visualized that with ground water pumpage being the primary source of water supply, that this pumpage itself will tend to keep the general water table at a sufficient level beneath the ground surface so that no adverse effects will occur. Perched water tables located over shallow impervious layers may cause some local drainage problems which may require supplemental ditching or tiles. However, the generally excellent permeability of the deep soils, and underlying formations, indicate that most of the area will have few major subsurface drainage problems for many years.

If water levels come within four feet of the ground surface, or are rising several feet per year, special studies should be made immediately to evaluate the situation, and to formulate a plan for preventive action, if needed.

RESULTS OF
REPRESENTATIVE SOIL INFILTRATION TESTS

Site No.

4 & 8
13
50
84 & 60
62
77
78
86

PROYECTO ADELANTE
NICARAGUA

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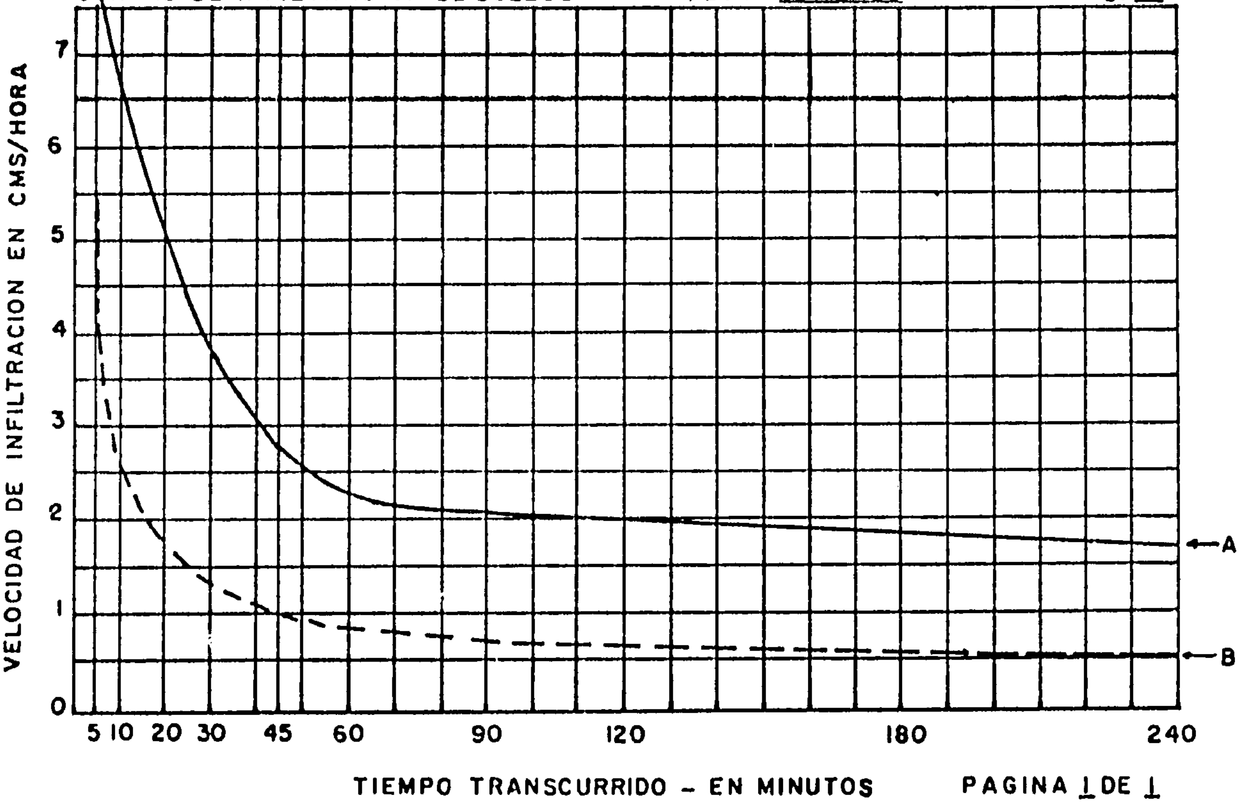

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PROYECTO ADELANTE
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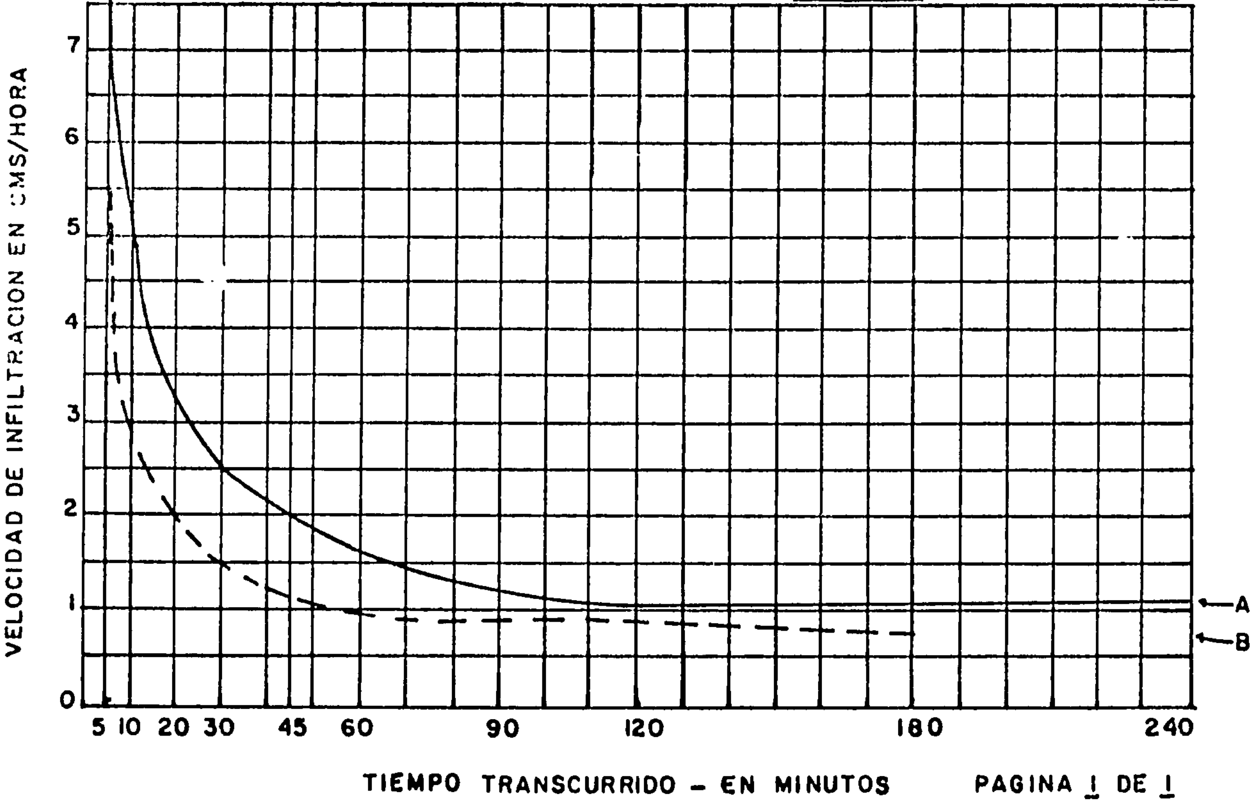

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PROYECTO ADELANTE
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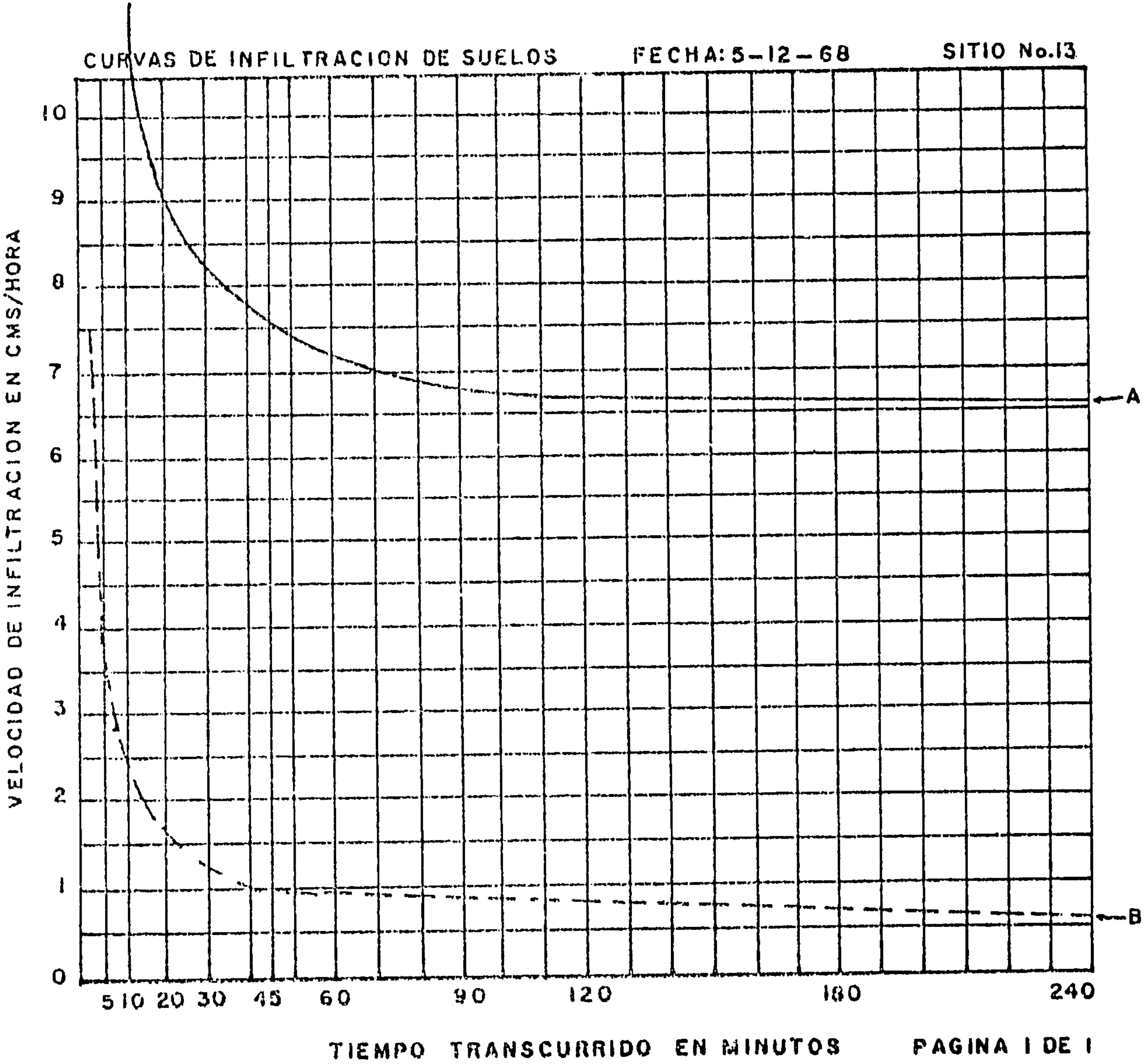
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PROYECTO ADELANTE

NICARAGUA

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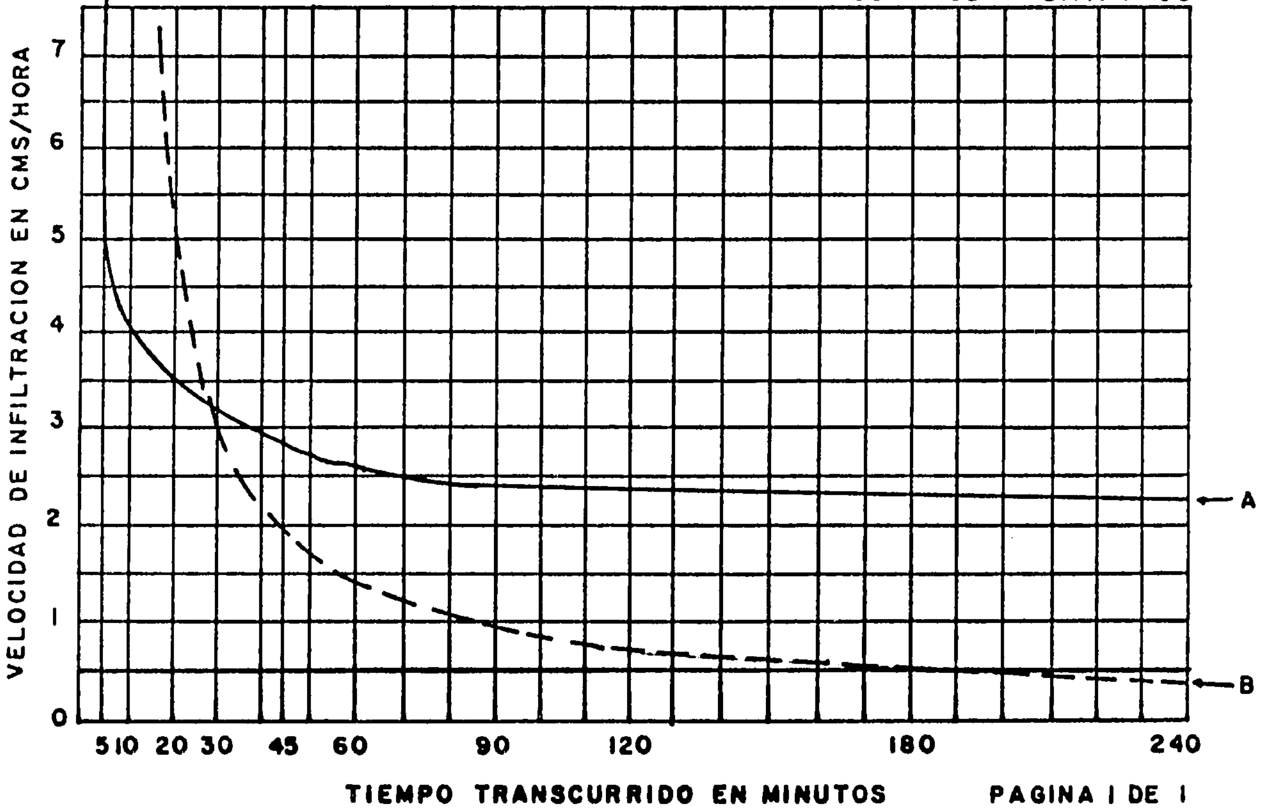

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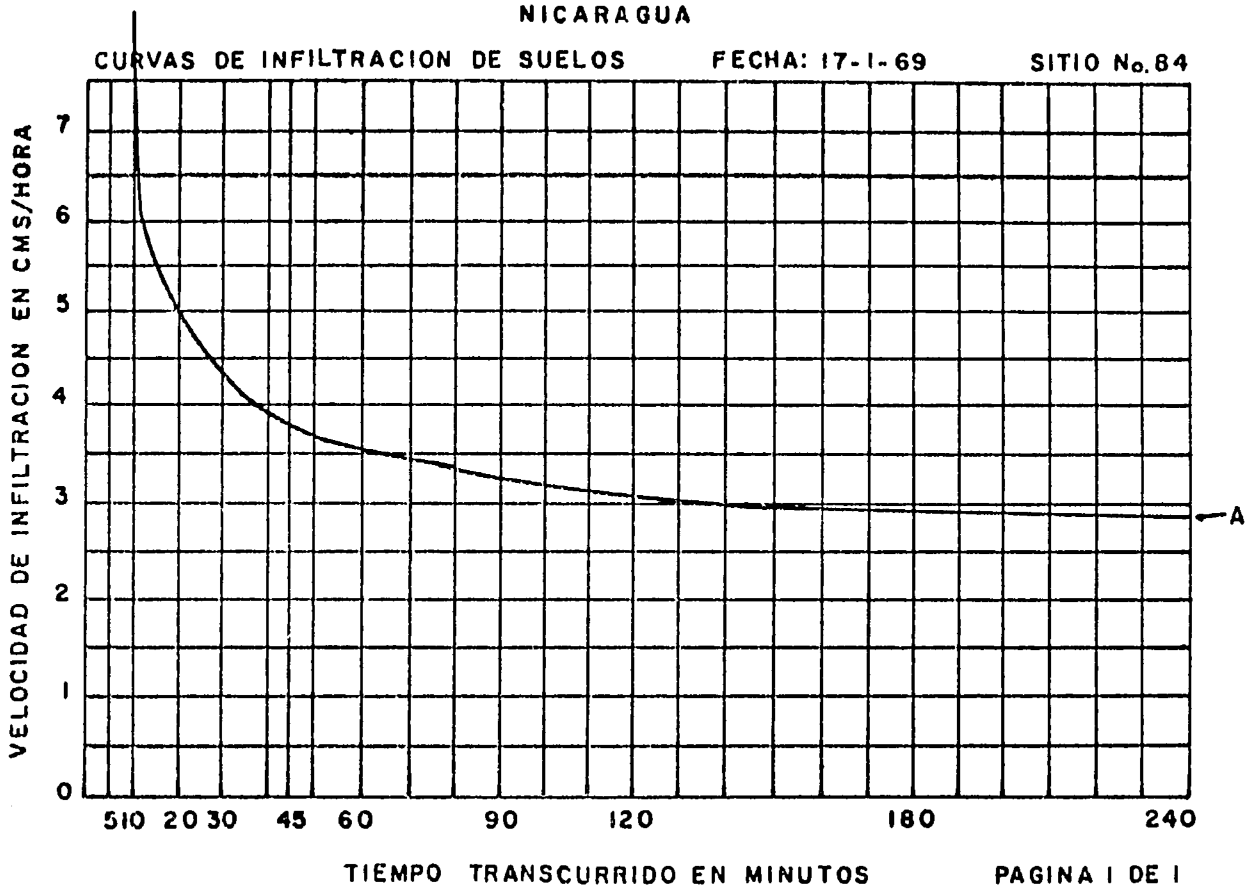

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PROYECTO ADELANTE
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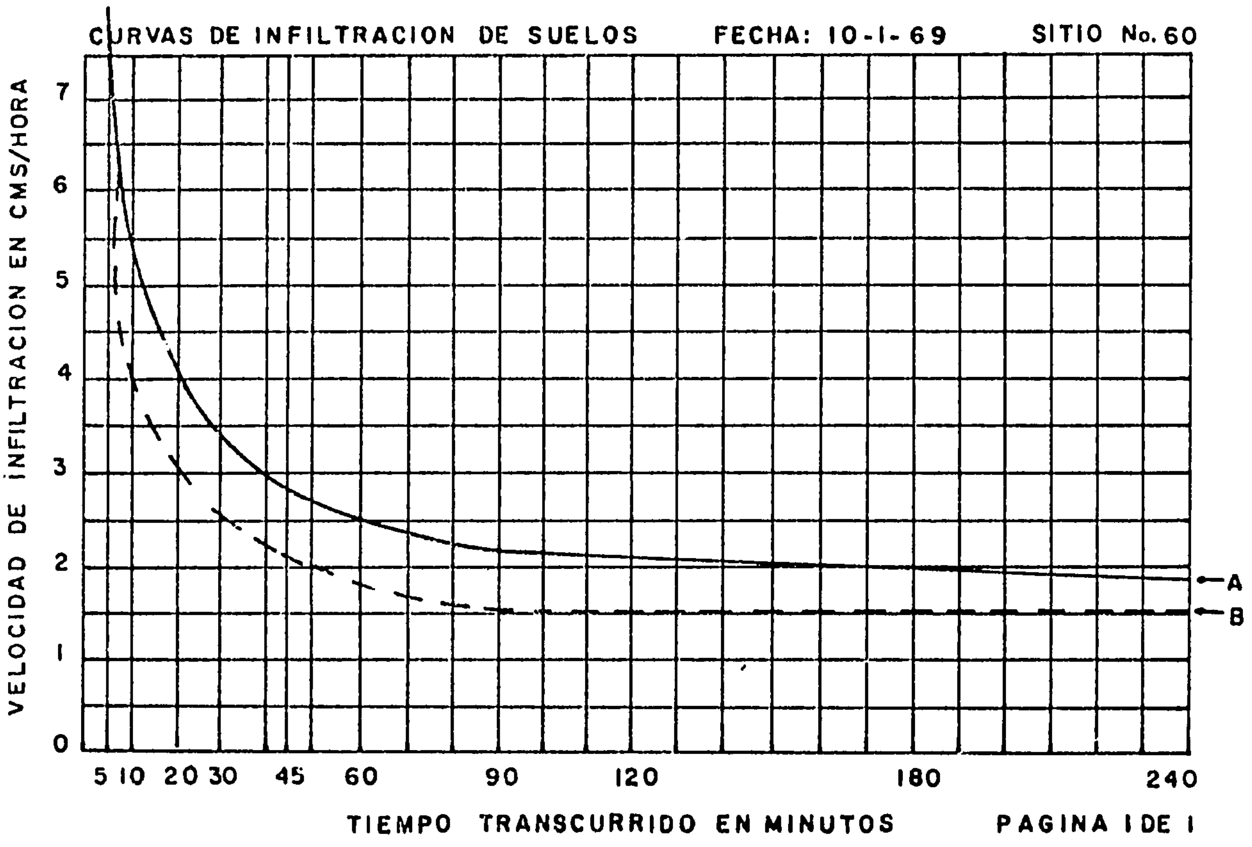

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PROYECTO ADELANTE

NICARAGUA

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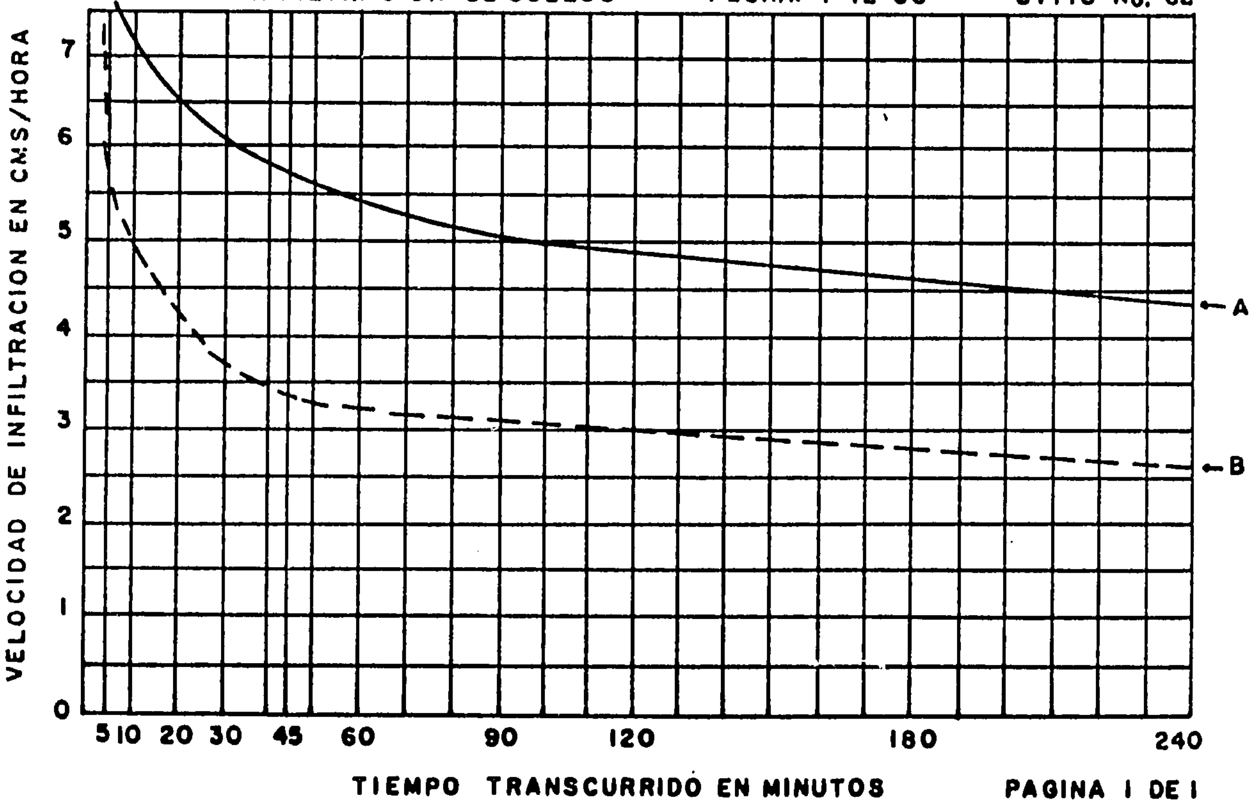

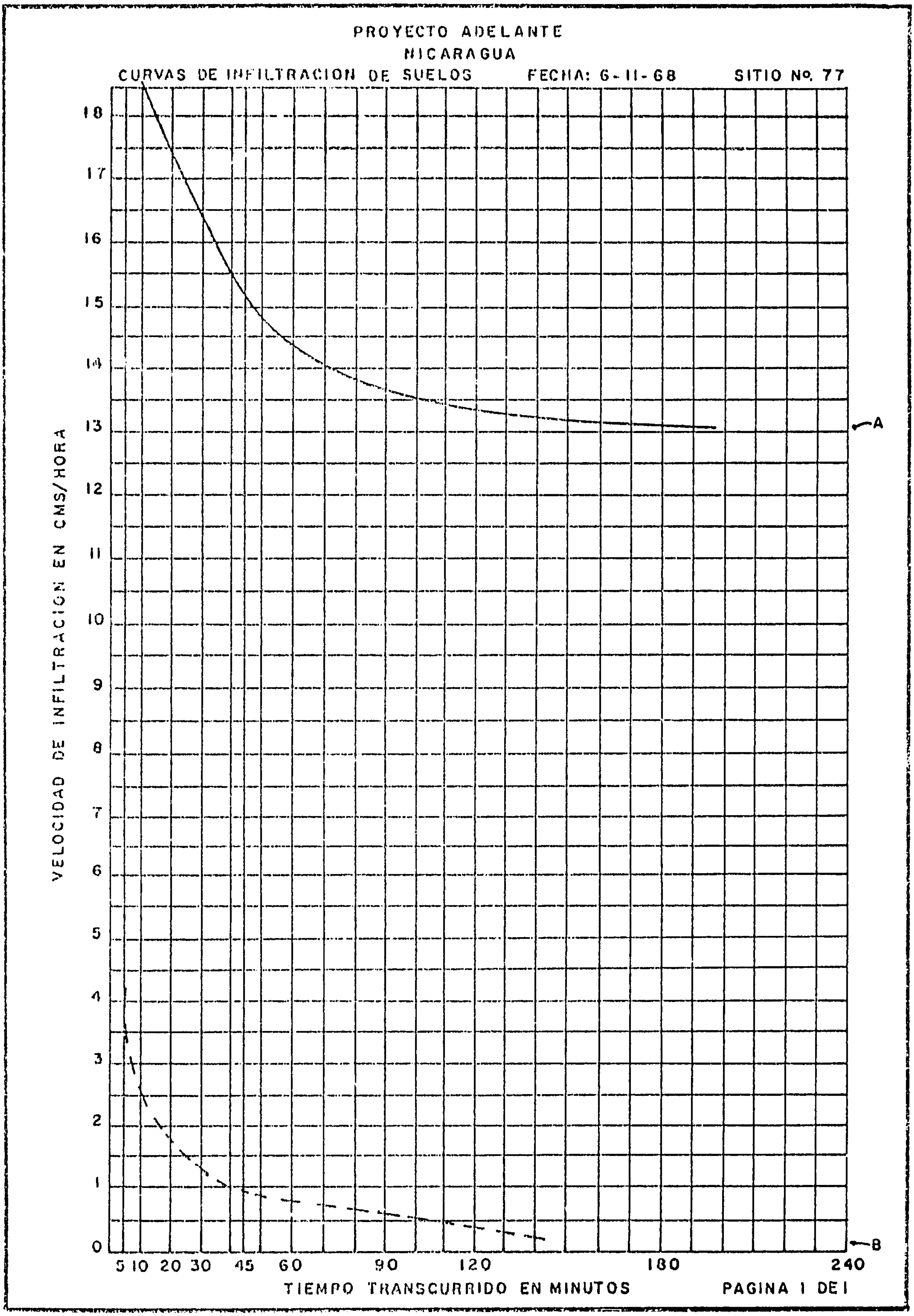
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NICARAGUA
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18
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A
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5 10 20 30 45 60 90 120 180 240
TIEMPO TRANSCURRIDO EN MINUTOS
PAGINA 1 DE 1

PROYECTO ADELANTE
NICARAGUA

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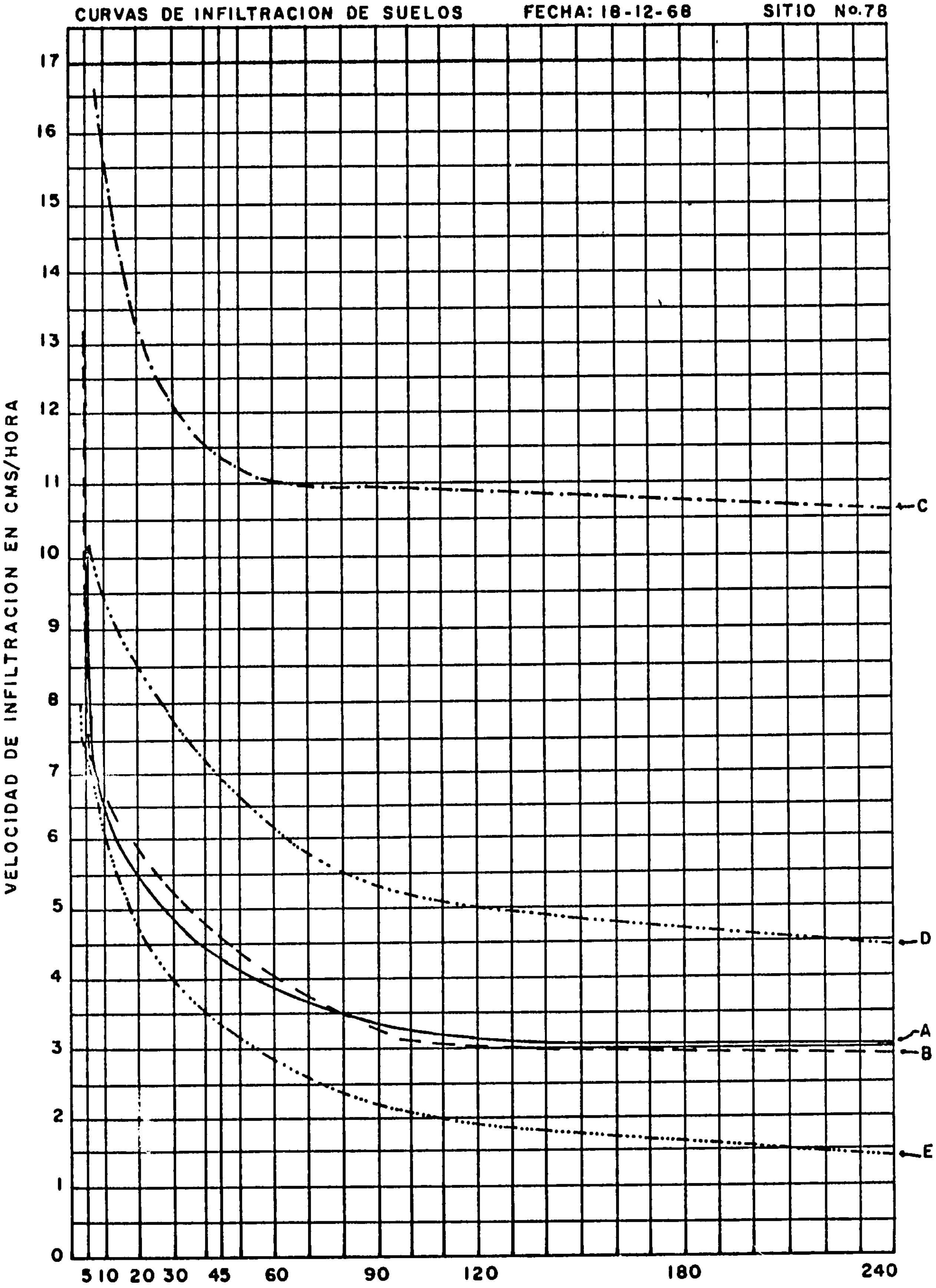

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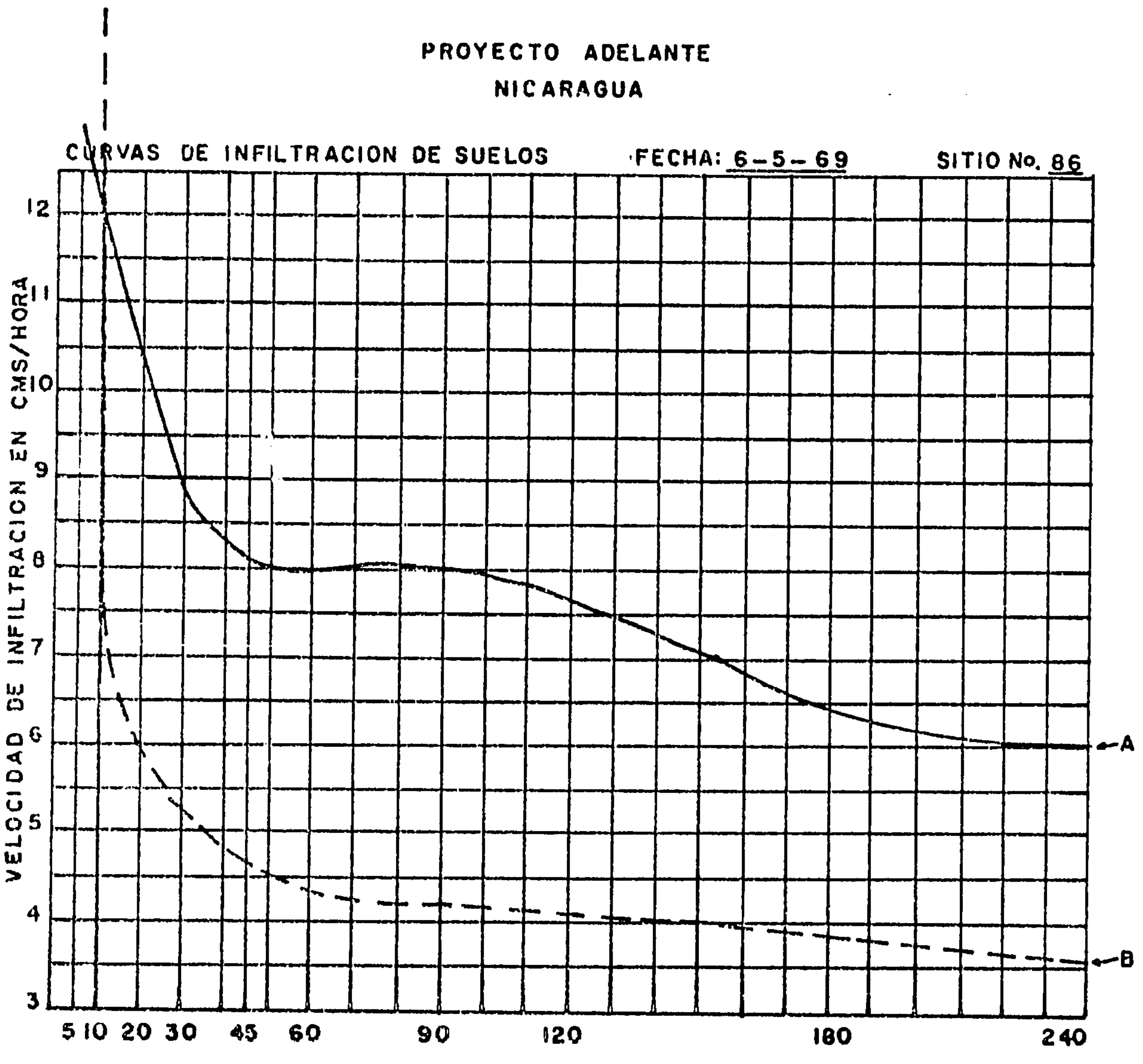

PROYECTO ADELANTE
NICARAGUA

CURVAS DE INFILTRACION DE SUELOS FECHA: 6-5-69 SITIO No. 86

TIEMPO TRANSCURRIDO - EN MINUTOS

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Chapter 6

FARM PLANNING AND DEVELOPMENT

Chapter 6

FARM PLANNING AND DEVELOPMENT

6.0 - INTRODUCTION

In other sections of the report there has been discussion of the site selection procedures which led to the identification of the cooperators for Project Adelante. There were over ninety locations considered and from these came the primary and secondary cooperators. This points out that there are many farms in the area which can fit into an irrigated program.

There was almost no possibility of the farmers making money from the small plots used in this demonstration program. The uneconomic size, coupled with inadequate farm equipment and lack of experience, provided a non-profitable combination. This is to be expected in such a demonstration program, but even so it is a disappointment to the farmers. Most of the cooperators had already suffered from the declining cotton market and additional costs, and project losses, though small, were difficult for the cooperators to accept.

The cooperators had to meet new kinds of problems and at times each was ready to abandon the program. This was not unusual for the initial step in a new program, particularly one which involved so drastic a change as moving from a non-irrigated single crop to irrigated multiple crops.

The cooperators were representative of a large group of farmers in the area. Some made no personal management inputs at all, while one or two made real contributions.

No doubt the major accomplishment of the program was that willing and interested cooperators were located and, in the face of new problems, these farmers remained in the program. It is important to note that with all of the problems of production, the crop irrigation was completely satisfactory and was never a limiting factor. The physical application of the furrow irrigation was not perfect due to unlevel land, but was well within the range of satisfactory performance.

The following is a record and analysis of the programs at the farms of the cooperators. A site map and crop rotation table is included for each cooperator.

6.1 - LA LEONA, SITE #46, SILVIO ARGUELLO C. (ASSOCIATE COOPERATOR)

(Table 6-1 & Fig. 6-1, pp. 6-3,4)

6.11 - General

Crop work couldn't be delayed until wells had been developed, pumps were established and sprinkler systems had been ordered and delivered. Therefore a site was located where crops could be tested and some background of experience in irrigation could be developed. This site was located at the La Leona farm which is at kilometer 79 south of Leon on the main highway. With the cooperation of the owner, Dr. Silvio Arguello C., a piece of land of five manzanas (9 acres) was located where irrigation water could be applied in furrows. Although a makeshift situation, the facilities served the purpose. And it was possible to get the first crops planted on May 29, 1968, within a few months after the project was initiated.

6.12 - Crops, Yields and Cultural Operations

The purpose of these plantings was to get some comparative responses of various crops to begin to evaluate a number of crops for irrigation. Therefore in late May plantings were made of grain sorghum, corn, soybeans, sesame and castorbeans. In addition Meloland grain sorghum and Pajimaca sweet corn were planted for seed increase.

On September 18 all of the grain sorghum varieties were harvested and cut back for a ratoon crop. The yields of these crops by varieties, for the first crop and the ratoon are given in monthly report No. 12, January 1969.

Comparative yields of soybean varieties, Improved Pelican and Hardee, were reported in monthly report No. 9, October 1968. These tests were only two replications, but under luxury fertilizer conditions the yields were a ton per manzana at best (1200 lbs/acre). This was the first strong indication that soybeans had no place in the irrigated program.

The best corn yields were just over one ton per acre (4063 lbs/manzana) for Nicaragua Synthetic 2, and slightly less for Nicarillo (3782 lbs/manzana). The Rocamex H-507 was severely damaged by stunt disease.

Yields were not taken for castorbeans or sesame, but observations were made. From these tests the Lynn variety castorbean was selected over the Baker 296 and Hale based on better growth characteristics.

Nothing new was learned from the sesame trials except to confirm that the Precoz variety had a better seed set than Venezuela 44 and matured three weeks earlier.

A second series of plantings was made the last of October. This planting included corn, safflower, okra, soybeans, tomatoes, cucumber, sesame, millet and grain sorghum. Varieties and location of these crops and the first planting are listed and shown on subsequent pages. The results of the 206 variety planting of Foxtail millet are given in monthly report No. 11, December 1968.

Observations on the corn and cucumbers were included in the same report, as well as in No. 10, November 1968.

Detailed observations were made of the safflower varieties. This plot was made up of selections of safflower from all over the world to determine the degree of incidence of Fusarium and Verticillium Wilt diseases. Neither disease was a limiting factor in this location.

The first plantings at this site should not have needed irrigation, but in addition to a pre-irrigation in April, two irrigations were needed during July because of the lack of rain. The available moisture at this site was restricted because of the shallow root zone. At a zone of 6 to 12 inches there is a layer of sandstone (Cantera). This is quite common in this specific area but the depth of overlying soil varies in the area.

The five varieties of cucumbers were ready for harvest after 45 days. In the order of earliness the varieties were (1) Crusader, (2) S. C. Hybrid III, (3) Pioneers, (4) SMR-58, and (5) Sparton Progress.

The corn variety plot was sprayed unintentionally by a cotton defoliant, which is one of the hazards of working in such close proximity to cotton fields.

Okra and soybean plantings were seriously attacked by Prodenia, the cotton cutworm.

TABLE 6-1

CROP ROTATIONS
FOR
SITE No. 46 - FINCA LA LEONA (DR. SILVIO ARGUELLO C.)
PROYECTO ADELANTE ASSOCIATE COOPERATOR FARM SITE

FIELD No.*	FIELD SIZE (Mz.)**	1968 CROP SCHEDULE***			
		CROP	Date Planted	CROP	Date Planted
1-A	4 Mz.	Castors (Hale, Lynn, Baker)	29 May '68	Sesame (Precoz)	31 Oct. '68
1-B		Sesame (Precoz & Venezuela 44)	"	Sesame (Venezuela 44)	"
2-A		Grain Sorghum (Advance 14)	"	All sorghum varieties cut-back for ratoon crop	18 Sept.'68
2-B		" " (AKS-614)	"		
2-C		" " (U.S. HG-500)	"		
2-D		" " (U.S. HG-700)	"		
2-E		" " (Dekalb C-44-B)	"		
2-F		" " (Dekalb E-57)	"		
2-G		" " (Dekalb F-61)	"		
3		Soybeans (Hardee)	"		
4		Soybeans (Improved Pelican)	"		
5-A		Corn (Rocamex H-507)	"		
5-B		Corn (Nicarillo)	"		
5-C		Corn (Nic. Sin. 2)	"		
6		Grain Sorghum (Meloland)	"	Cut-back for Ratoon Crop	18 Sept.'68
7-A			-----	Corn (Salco)	31 Oct. '68
7-B			-----	Corn (Rocamex H-507)	"
7-C			-----	Corn (Salco)	"
7-D			-----	Corn (Nicarillo)	"
8			-----	Safflower (Several Varieties)	"
9			-----	Okra (Clemson Spineless)	"
10			-----	Soybeans (Improved Pelican)	"
11			-----	Tomatoes (5 Varieties)	"
12			-----	Cucumbers (5 Varieties)	"
13			-----	Millet (Foxtail Varieties)	"
14			-----	Grain Sorghum (Ryer)	"

*See Site Map for location of Field No's.

**Mz. = Manzana = 1.74 acres

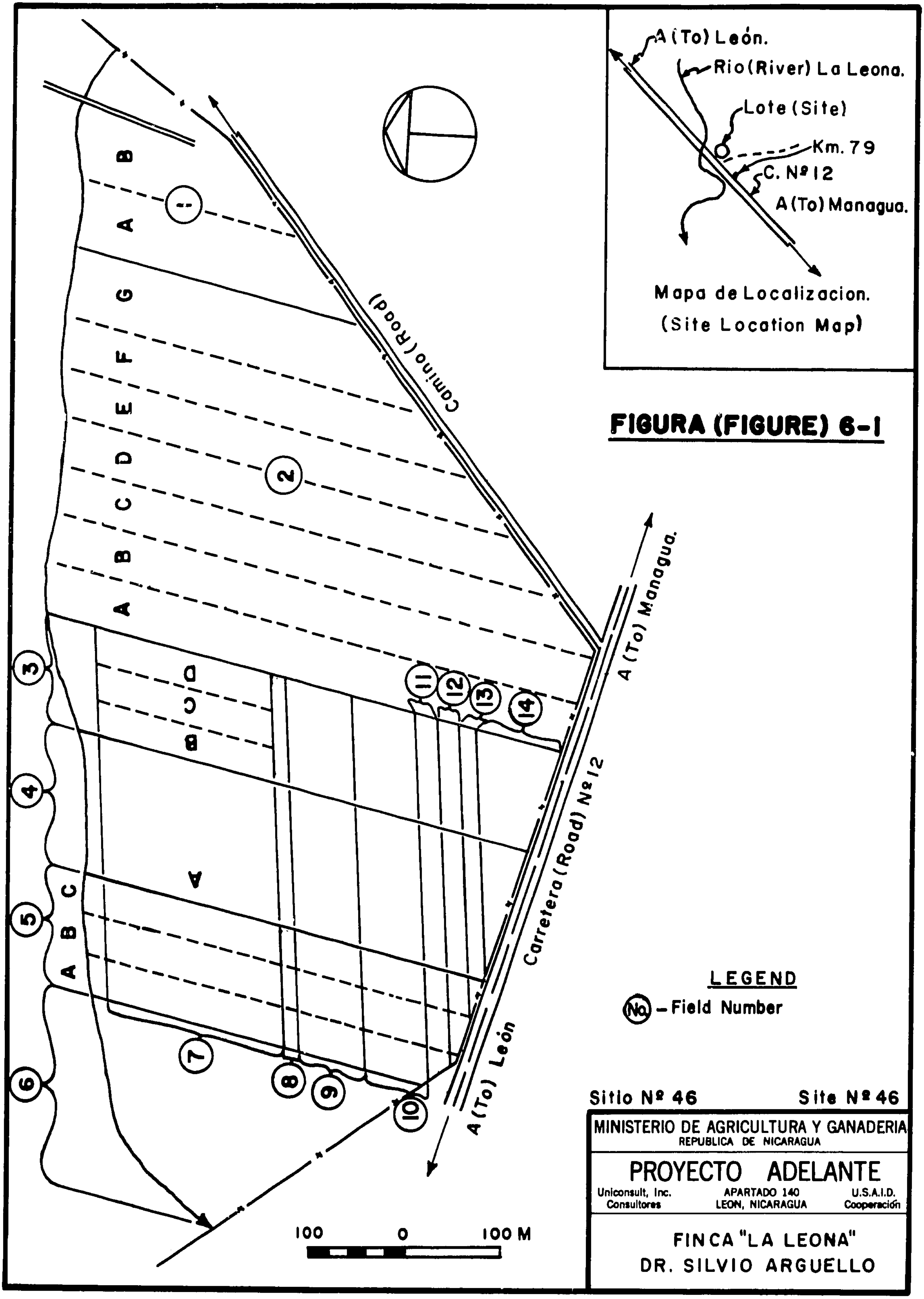

FIGURA (FIGURE) 6-1

Sitio Nº 46 Site Nº 46

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Cooperación

FINCA "LA LEONA"
DR. SILVIO ARGUELLO

At the end of this crop period the work at this site was discontinued and transferred to other cooperator locations where irrigation could be better controlled through sprinklers.

6.2 - EL OLIVO, SITE #62, MAYOR GILBERTO QUINTANILLA, (ASSOCIATE COOPERATOR)

6.21 - General

(Table 6-2 & Fig. 6-2, pp. 6-6,7)

In August of 1968 plantings were made at Site No. 62, the farm of Sr. Gilberto Quintanilla. The well had been dug and tested and arrangements made with the power company ENALUF for the powerline in to the pump. The powerline was installed but water was never available for irrigation because of a change in policy by Banco Nacional.

6.22 - Crops

On August 20 a 19-manzana field of Nicaragua Synthetic 2 was planted and one manzana of soybeans using the varieties Improved Pelican and Hardee.

The entire 19 manzanaswere lost due to inadequate soil moisture,coupled with attacks by Fall armyworm. Beginning on September 5th, replanting began, using graded corn seed to replace the 19 manzanas. This entire field was lost due to lack of rain and lesser stalk borers.

The one manzana previously planted to soybeans was planted to tomatoes, Veranic black beans, red kidney beans and lima beans, plus eight varieties of peanuts, and six cowpea varieties. The cowpeas (especially Mississippi Silvers) and peanuts made excellent growth. The yields from the peanut plots were:

Variety	Yields (lbs/mz)	Yields (lbs/acre)
Runner	3216	1840
Criolla	3009	1720
NAN-4107	2586	1480
Virginia Jumbo	2481	1416
White Spanish	2270	1296
N. C. Runner	2051	1172
Station 2	1885	1080
Spanish	1830	1044

The tomatoes and beans did not survive. The black beans were damaged by virus diseases and the tomatoes died from insufficient moisture for transplants. The red kidneys and limas just made poor growth.

Water was not available from the well,and in fact,was never available.

On October 9, 1968, still hoping for rain and the use of the well, six manzanas of corn were planted. The soil was treated with Dieldrin to control the soil insects and graded seed was used to insure a full stand. Irrigation was not available and the corn died.

Four rows of quequisque were planted and hand-watered but these finally died from inadequate water.

TABLE 6-2

CROP ROTATIONS
FOR
SITE No. 62 - FINCA EL OLIVO (SR. GILBERTO QUINTANILLA)
PROYECTO ADELANTE ASSOCIATE COOPERATOR FARM SITE

FIELD No.*	FIELD SIZE (Mz.)**	1969 CROP SCHEDULE		1970 CROP SCHEDULE	
		CROP	Date Planted	CROP	Date Planted
1-A,B,C	6.0	(Fallow)	--	NOTE: No plantings made on this site in 1970 by Project personnel.	
2-A	1.0	Grain Sorghum (AKS - 614)	3 Feb. '69		
2-B	1.0	Grain Sorghum (Dekalb C-44-B)	"		
2-C	2.0	Soybeans	"		
2-D	0.75	Grain Sorghum (Dekalb F-61)	"		
2-E	0.75	Grain Sorghum (A-14 Advance)	"		
2-F	0.50	Grain Sorghum (Dekalb E-57)	"		
3-A	2.0	Corn (Nic. Sin. 2)	8 Feb. '69		
3-B	2.0				
3-C	2.0				

* See Site Map for location of field No's.

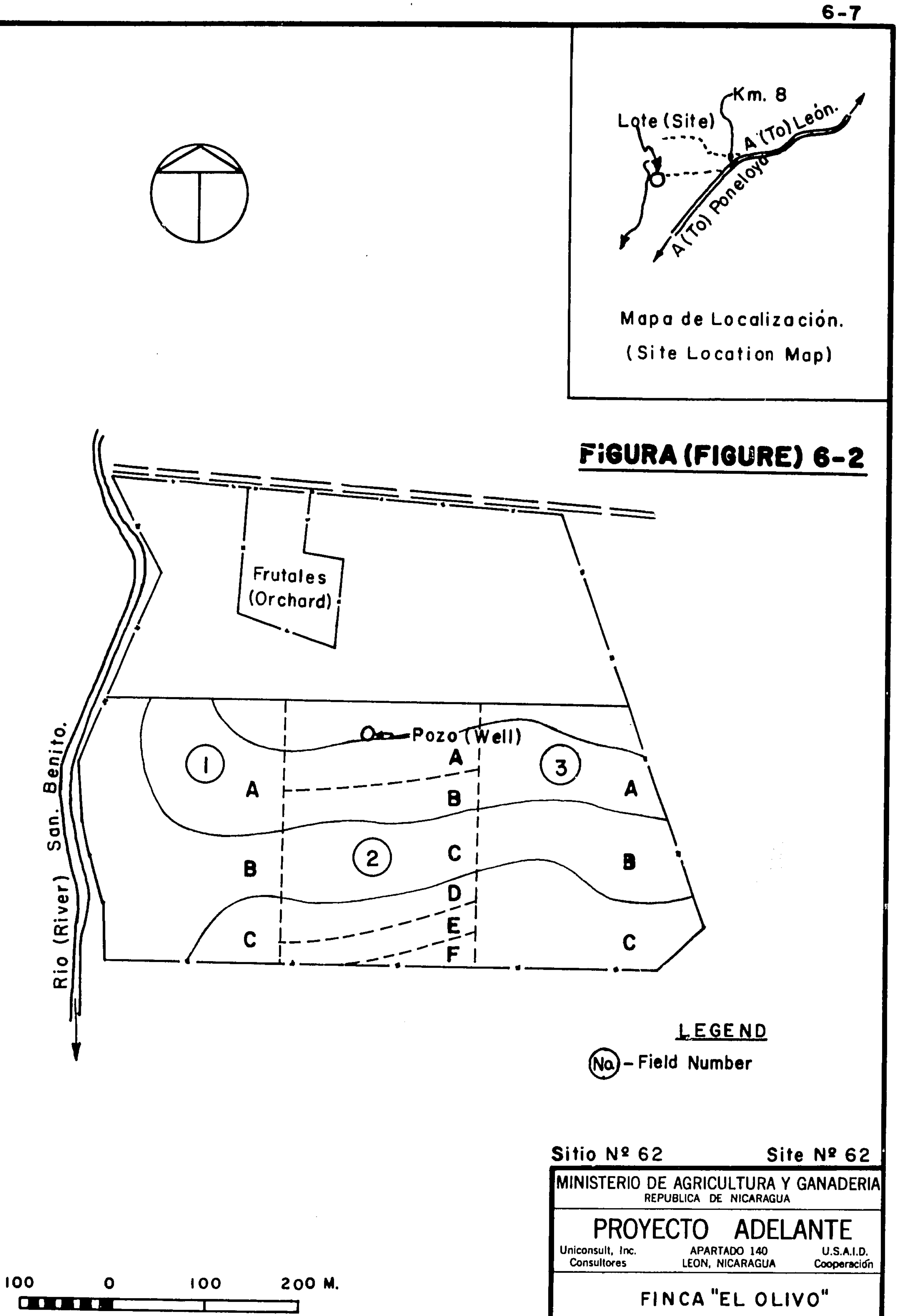

FIGURA (FIGURE) 6-2

Sitio Nº 62 Site Nº 62

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FINCA "EL OLIVO"
SR. GILBERTO QUINTANILLA.

Four manzanas were planted to five varieties of grain sorghum. In spite of very inadequate moisture all of the varieties made a crop. A two-manzana planting of soybeans was lost.

The failure to get irrigation water was unfortunate since the well was very good. A change in Bank policy regarding credit to this cooperator made it impossible for him to continue as a cooperator, which was regrettable since Sr. Quintanilla and the contractor had made a sizeable investment in the well and pump. The Project had devoted a great deal of time and effort which was not all a loss because some information was developed.

6.3 - PENJAMO, SITE #84, ARNOLDO REYES I., (ASSOCIATE COOPERATOR)

6.31 - General

(Table 6-3 & Fig. 6-3, pp. 6-9, 10)

Mr. Reyes became associated with the Project as an associate cooperator and the first commercial planting of safflower was made at his farm on January 16, 1969. This site was located at kilometer 79, south of Leon, almost adjacent to the La Leona farm. The same sandstone layer exists but there is a thicker mantle of overlying soil (one meter) and the soil is somewhat finer-textured than at La Leona.

The sprinkler system in use was the "big gun" type using two giant sprinklers each discharging 200 gallons per minute. The planting dates and plot sizes are shown in Table 6-3.

6.32 - Crops

The most significant work at this site was with safflower. The first part of April the irrigation pump was not functioning and the plants dried earlier than desired. As a result of this and perhaps other problems, the yields were 1936 pounds per manzana (1113 pounds per acre). Under normal growing conditions yields of at least twice this figure can be expected.

Neither the Arauca cowpeas nor the Crioila castorbeans set seed. The Valencia peanuts produced approximately one ton per manzana. All of the crops suffered from the shut-down of the pump but the Project was able to get crop information. The experience with hand harvesting of peanuts at this site again indicated how serious the losses are under these conditions.

The cooperator saved the seed increase from the safflower (variety S-208) and used it for subsequent plantings. This seed was used to supply other interested growers such as Corona (United Fruit) who planted a trial plot in 1969-70.

6.4 - SAN ANTONIO, SITE #8, RAMON PINEDA F., (FULL COOPERATOR)

6.41 - General

(Table 6-4 & Fig. 6-4, pp. 6-12,13)

This site is located on the main highway just south of Leon at kilometer 84. Dr. Pineda was one of the full cooperators who drilled a well, put in a pump and utilized Project sprinkler equipment.

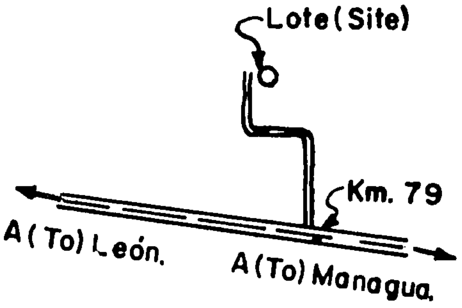
The well was drilled and tested by August 1, 1968, within six months of initiation of the Project. The powerline was installed by ENALUF early in November of 1968, and the pump was installed January 24, 1969.

TABLE 6-3

CROP ROTATIONS
FOR
SITE No. 84 - HACIENDA PENJAMO (SR. ARNOLDO REYES I.)
PROYECTO ADELANTE ASSOCIATE COOPERATOR FARM SITE

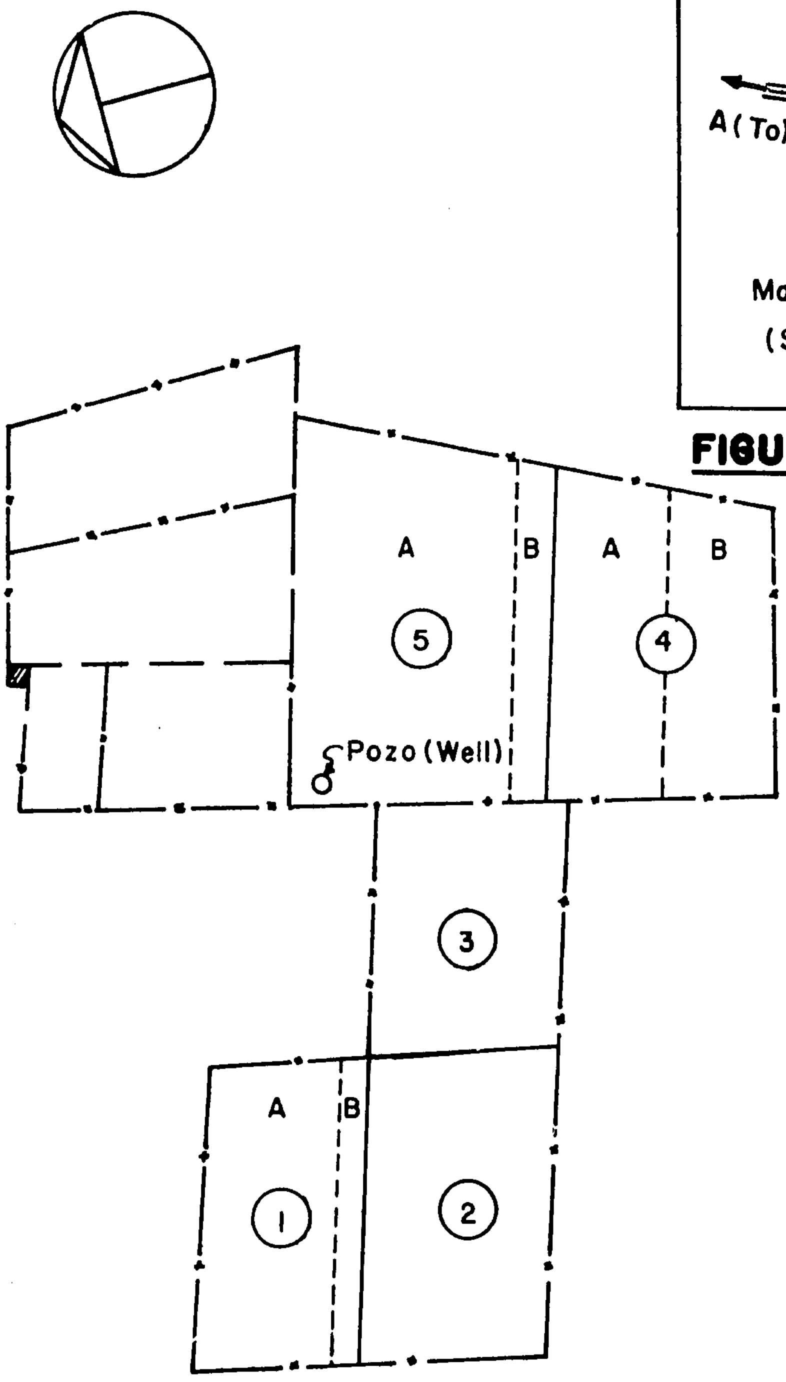
FIELD No.*	FIELD SIZE (Mz.)**	1969 CROP SCHEDULE		1970 CROP SCHEDULE	
		CROP	Date Planted	CROP	Date Planted
1-A	2.00	Black Beans (Veranic)	26 Feb. '69	Note: No plantings made on this site in 1970 by Project personnel.	
1-B	1.00	Cowpeas (Mississippi Silvers)	26 Feb. '69		
2	2.00	Castor Beans (Criolla)	7 Mar. '69		
3	1.90	Grain Sorghum (Dekalb E-57)	14 Mar. '69		
4-A	1.00	Peanuts (Valencia)	7 Mar. '69		
4-B	1.40	Safflower (S-208)	16 Jan. '69		
5-A	3.20	Corn (Nic. Sin. 2)	17 Jan. '69		
5-B	0.50	Okra (Clemson Spineless) & Cowpeas (Arauca)	24 Mar. '69		

*See Site Map for location of field No's.



Mapa de Localización.
(Site Location Map)

FIGURA (FIGURE) 6-3



LEGEND

Ⓝⓞ – Field Number

Sitio Nº 84 Site Nº 84

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FINCA PENJAMO
SR. ARNOLDO REYES Y.

No Project use was made of the land during this entire period inasmuch as there was a growing cotton crop. The residue of this crop was chopped the first of February and the sprinkler system was delivered to the farm. Pre-irrigation was carried out from February 13th to 26th, and the first irrigated crop was seeded on February 27, 1969. Sorghum crops were planted the second week in March which is not good farm planning, but the seed was not available earlier. However, the need to use the dry season period was more important than the possible loss at harvest time from rain. As it turned out rains were heavy, with almost six inches on June 2nd. As pointed out in the June 1969 monthly report No. 17, a two week earlier planting and a timely harvest with the proper equipment would have changed the results from a crop loss to a profit.

6.42 - Field Crops, Yields and Cultural Operations

The following is an analysis of crops grown during the period February to September 1969, for 9 manzanas (15.7 acres):

GRAIN SORGHUM

Cultural Operations - 5 manzanas

Variety: Dekalb F-64 hybrid

Seedbed preparation: February 5 to March 5, chop cotton stalks, pre-irrigate 7.7 inches gross. Rototilled.

Planting date: March 6

Planting rate: 30 pounds of seed per manzana, planted in 34 inch rows

Cultivation: March 22 and April 10

Fertilizer: 200 pounds of 10-40-10 applied preplant per manzana (115 lbs/acre). 200 pounds of Urea per manzana applied by fertilizer attachment on planter.

Spray: April 12 - 250 cc of Azodrin in 15 gallons of water per manzana.

Irrigation: 6 times (total - 22.2 inches gross).

Bird Control: Started May 20 - 4 carbide detonators, June 4 - 11. Fish and Game experts used various methods for bird control.

Harvest: June 10 - 20 (rains and birds caused loss of crop).

Chop stalks: July 10 (delayed 15 days by rain and late harvest).

Analysis of Dekalb F-64 Grain Sorghum

Excellent crop growth and plant population with sufficient moisture and fertilizer.

Armyworm infestation was high before head emergence but there was no observed reduction of flowering or seed set.

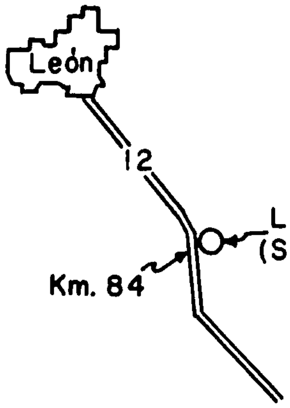
In late May the field had the appearance of a very good crop.

TABLE 6-4

CROP ROTATIONS
FOR
SITE No. 8 - FINCA SAN ANTONIO (DR. RAMON PINEDA F.)
PROYECTO ADELANTE FARM DEMONSTRATION SITE

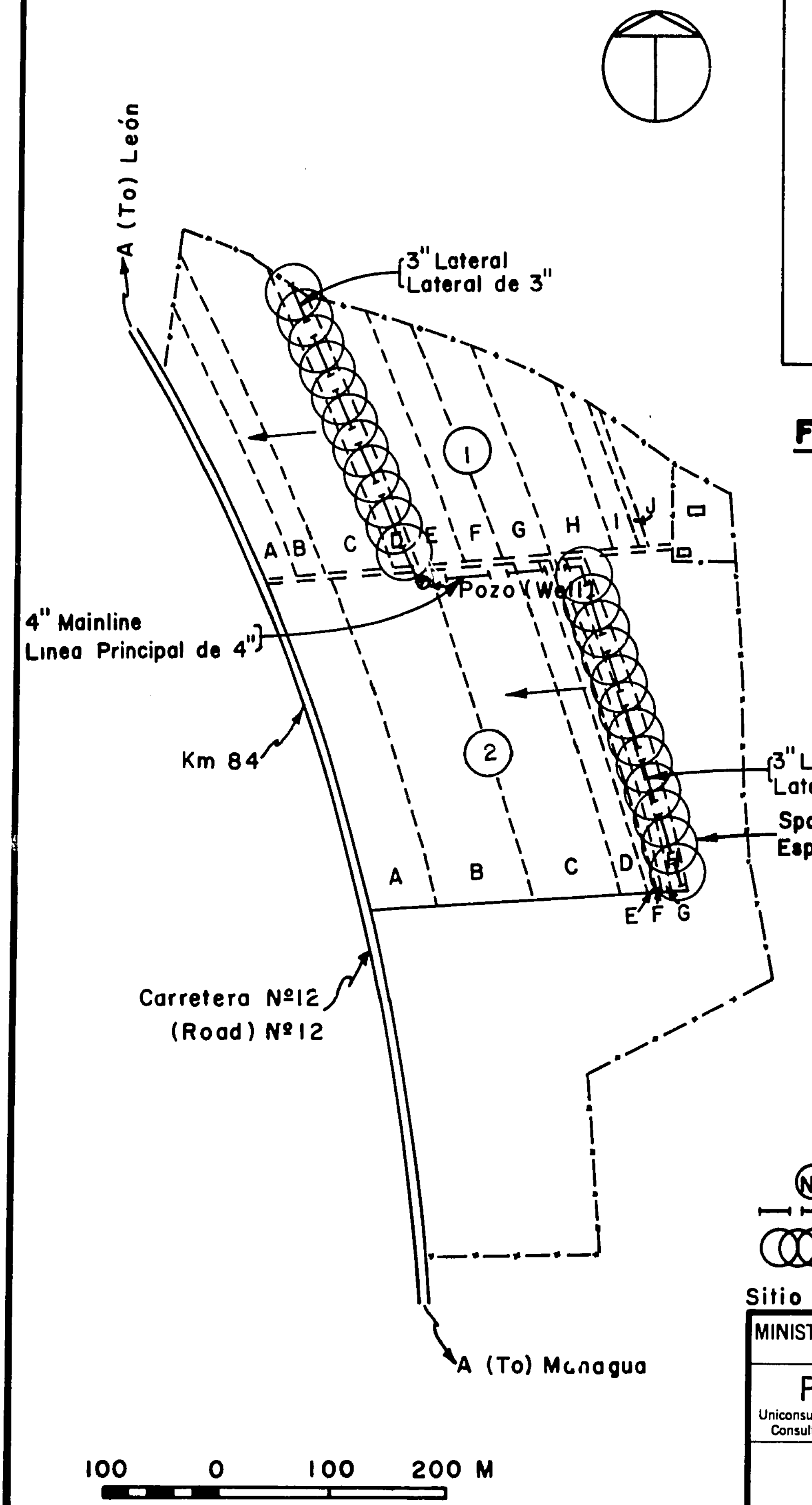
FIELD No.*	FIELD SIZE (Mz.)**	1969 CROP SCHEDULE		1970 CROP SCHEDULE	
		CROP	Date Planted	CROP	Date Planted
1-A	1.00	Peanuts (Several Varieties)	8 Mar. '69	Corn (Pajimaca)	17 Apr. '70
1-B	0.70			Millet (Pearlex)	17 Apr. '70
1-C	1.80			Quequisque	18 Mar. '70
1-D	0.70	Quequisque	8 Mar. '69	Quequisque	8 Mar. '70
1-E	1.10	Yuca (Cubano)	11 Mar. '69	Yuca (Cubano)	27 Jan. '70
1-F	0.65	Castor Beans (Criolla)	27 Feb. '69		
1-G	1.35				
1-H	1.75	Castor Beans (Lynn Dwarf)	14 Mar. '69		
1-I	0.50			Corn (Pajimaca)	17 Apr. '70
1-J	0.03	Pineapple & Papaya	--	Pineapple & Papaya	--
2-A	1.75	Grain Sorghum (Dekalb F-64)	6 Mar. '69	Corn (Nic. Sin. 2)	10 Feb. '70
2-B	3.25			Grain Sorghum (AKS-614)	22 Jan. '70
2-C	3.10	Grain Sorghum (Dekalb E-57)	13 Mar. '69	Corn (Nic. Sin. 2)	10 Feb. '70
2-D	0.90			Grain Sorghum (AKS-614)	22 Jan. '70
2-E	0.35	Okra (Clemson Spineless)	13 Mar. '69		
2-F	0.50	Cowpeas (Arauca)	13 Mar. '69	(Fallow)	
2-G	0.30	Vegetables (Squash, Cukes, Melons)	13 Mar. '69	Safflower (S-208)	27 Jan. '70
2-H	0.50	(Fallow)	--		

*See Site Map for location of Field No's.



Mapa de Localización
(Site Location Map)

FIGURA (FIGURE) 6-4



LEGEND

(No) – Field Number
⊢⊣ ⊢⊣ – Sprinkler Pipe (Tubería)
○○○ – Irrigation System Design / Sistema de Irrigación

Sitio Nº 8 Site Nº 8

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FINCA "SAN ANTONIO"

DR. RAMON PINEDA

The predicted harvest date was July 6, 120 days after planting. This was based on Dekalb F-64 being classed in the latest maturity group of U.S. hybrid varieties. Actual maturity date was June 15, 100 days after planting which is a function of the latitude and the resulting day length.

Parakeets could not be completely controlled and caused severe seed loss. It was estimated some parakeets were coming from as far as 100 kilometers (60 miles) to feed in this field. More extensive plantings of grain crops at this time of the year would help prevent a high concentration of birds in one field. Early control of parakeets in a field will possibly make this bird avoid the same field later on. Other valuable information was developed on bird control and published in a separate report.

Heavy and continuous rain in June caused seeds to germinate in the head.

An estimated seed loss of 2 percent was caused by the sorghum midge (Contarinia sorghicula). Although proper timing is difficult, an insecticide application can reduce the damage from this insect.

A minor loss of seedling plants in this field was caused by the lesser cornstalk borer (Elasmopalpus lignosellus). This pest is present in most fields of the area and can cause serious damage to susceptible crops. A soil insecticide such as dieldrin should be applied at or before planting for control of this insect.

The experience resulting from using a small combine in this heavy crop with a wet soil proved it will be necessary to have better equipment available for harvest. Hand harvest is not practical or economical.

Chopping of grain sorghum stalks for the production of a ratoon crop must be done quickly after the first crop matures. Also important is the use of a rotary chopper with sharp blades to prevent shattering of the basal nodes.

Areas without fertilizer and areas with a double (400 pounds each of 10-40-10 and Urea) fertilizer treatment showed a definite growth response.

Cultural Operation - 4 manzanas - same operations as Dekalb F-64 except:

Variety:	Dekalb E-57 hybrid
Planting date:	March 13
Soil insecticide:	20 pounds of dieldrin (10%) per manzana were applied at time of planting by using the fertilizer attachment on planter.
Fertilizer:	200 pounds of Urea per manzana applied by hand before the last cultivation. (Not a recommended method or time)
Harvest:	June 10 - 20
Chop stalks:	June 23

Analysis: - same as Dekalb F-64

The crop looked almost as good in late May as the field of F-64.

The maturity date was about June 10, or 95 days after planting.

The timely cutting of the stalks shortly after maturity produced a vigorous ratoon crop.

CASTOR BEANS - 4.2 manzanas (7.3 acres)

Cultural Operations

Variety: Criolla (local) seed from Managua.

Seedbed preparation: Febrary 1 - 27, chop cotton stalks, pre-irrigate (7.7 inches gross), rototilled (no plowing or disking).

Planting date: February 27

Planting rate: Planted in 34-inch rows, using a Ferguson inclined plate planter.

Seeding rate: 25 pounds per manzana

Part of the field, 2.2 manzanas, had a poor stand and was disked and replanted March 14 with Lynn castors, a commercial dwarf variety from Texas, using 20 pounds of seed per manzana.

Cultivation: March 21, April 15, hand weed April 29 to May 3, May 7 and May 8 (double cultivation).

Fertilizer: Applied by hand, 200 pounds of 10-40-10 per manzana before first cultivation, 100 pounds of Urea per manzana before last cultivation. (First application was applied too late and improperly due to lack of equipment.)

Irrigation: 6 times (total 22.2 inches)

Harvest: None

Analysis

The Criolla variety made vigorous growth but produced only one flower after four months. Because of this and the extreme height, the variety is not recommended.

The Lynn dwarf variety made normal growth and formed the first flowers on all plants about 45 days after planting.

There was only minor insect problem and no spraying was necessary.

A two-week delay of the second cultivation due to a lack of equipment caused serious competition from weeds. Hand weeding and deep cultivations were needed to bring the weeds under control. This operation caused plant loss and weeds were never fully controlled.

The rains of May and June caused widespread loss of the seed pods by the incidence of capsule mold. For this reason, it is recommended that castors be planted so that seed production will be only during the dry period from December through April.

PEANUTS - 4.3 Manzanas (7.5 acres)

Cultural Operations

Varieties: Criolla, Valencia, Virginia Jumbo, Florigiant, Spanish, White Spanish, Station 2, NAN-4107, N. C. Runner and Runner

Seedbed preparation: February 2 to March 8, chop cotton stalks, pre-irrigation (7.7 inches gross), rototilled.

Planting date: March 8

Planting rate: Planted in 34-inch rows. From 50 to 80 pounds of seed, depending on size, were planted per manzana.

Cultivation: March 23, April 23, handweeded May 6 to 8.

Fertilizer: 200 pounds of 10-40-10 applied before cultivation

Irrigation: 6 times (total - 22.2 inches gross)

Harvest: July 21, chop tops. July 29, plow and start hand harvest.

Analysis:

Excellent plant development with no serious disease or insect problems.

Lack of harvesting equipment was the major factor for not completing the harvest. Hand picking required 20 people for one week to harvest one manzana. The best pickers could get 100 pounds of peanuts each day.

At this rate, more than 150 workers would be required to equal the work of one mechanical harvestor.

A sample yield from the Station 2 variety was 5900 pounds per manzana (3380 lbs acre).

A peanut lifter was made in a local machine shop to attach to the 3-point hitch of a tractor. It would work for a short distance and then become plugged with trash and soil.

A moldboard plow and a disk plow were tried for lifting the peanuts out of the soil. The disk plow was faster and better than the moldboard plow. However, the proper equipment must be available to harvest quickly and efficiently so harvesting was discontinued.

It is recommended that peanuts be planted so that harvest can be carried out during the dry months between December and April.

VEGETABLE AND MISCELLANEOUS CROPS

Small plantings of watermelons, cucumbers, pipian, okra and cowpeas were made on March 13 and 20, 1969.

Analysis

Watermelons - The varieties Sugar Baby and Charleston Grey were planted on March 20, 1969. They made excellent growth and set fruit. A spray schedule using maneb fungicide was started as soon as the rains started. It was impossible to stay ahead of the fungus and the fruit did not develop.

Cucumbers - Five varieties, SMR 58, Pioneer, S. C. Hybrid III, Crusader and Sparton Progress, were planted on March 20, 1969. A general harvest was started 45 days after planting and sold in the local market at $1.50 per dozen. The total yield was equal to about 17 tons per manzana. A spray schedule of maneb fungicide kept the disease problem to a minimum until the heavy rains started in June.

Pipian - This popular squash was planted on March 20, 1969 in the traditional way with the hills of three plants placed about ten feet apart. This plant has good disease resistance and little advantage was noted from the plants which were sprayed with maneb. It did not appear that closer spacing of plants would increase yields.

Okra - An 8-row plot, 900 feet long, of Clemson Spineless was planted on March 13, 1969. The insect problem was severe but kept under control. The plants made good growth with a good pod set. The seed was harvested and sold to a farmer near Chinandega who was encouraged by the planting made by the Project. This farmer drew on Project personnel for technical assistance in growing a 10-manzana field of this crop.

Cowpeas - A 16-row plot, 900 feet long, of the Arauca variety was planted on March 13, 1969 which made extremely vigorous vine growth but never set seed. This variety made a good set of seed when it was planted on another farm in September, which would indicate that it needs a shorter day to initiate flowers. This information makes this variety useful as a green manure crop for planting with the rains of May. Since it would not set seed (seed can create a volunteer problem in the following crop), the variety has an additional advantage as there would be no problem with volunteers in the following crop.

Cropping Program and Analysis for the Period August to December, 1969

YUCA - 1.1 Manzana

Cultural Operations

Variety: Cubano

Planting date: March 11 to 18, 1969

Row spacing: 34 inches

Plant spacing: 30 inches

Cultivation: 2 times with tractor, 1 time by hand

Fertilizer: 200 pounds 10-40-10; 200 pounds 46-0-0 per manzana

The field was pre-irrigated with 7.7 inches gross. A rotavator was used for the seedbed preparation and a four-row corn planter without the seedboxes was used to mark the rows. The yuca stems were cut into pieces 10-12 inches long and pushed into the soil at a 30 to 40 degree angle about eight inches deep. No insect control was necessary. A small area was used for a fertilizer test and a plant population test under the direction of La Calera Experiment Station technicians. Project personnel used a small area to demonstrate the difference in growth of cuttings placed at different angles including perpendicular. Four rows were planted with the cutting horizontal in a furrow and completely covered with soil. In another four rows the cuttings were dipped in a fungicide. On September 26, the plants in two rows were cut back to a height of two feet and four feet, and the plots replicated the length of the field. This was done to observe the effect of cutting the plants back so that the sprinklers could be moved more easily and could operate without interference from tall plants.

Analysis

The yuca cuttings sprouted in three to four days and grew rapidly. After 40 days the yuca was too high for further cultivation. The cuttings which were planted flat and covered with soil took one week for emergency but the top growth quickly caught up with those planted at an angle. No difference of survival was observed between plants dipped in a fungicide at planting time and those untreated.

On October 1, 1969, a sample harvest was made in a selected area of good vigorous plants. A yield was calculated on total root production of 34 tons per manzana. On October 11, 1969, commercial harvest for export to United States started. Total harvest was about eight tons/manzana.

Trimmed plants made excellent regrowth with new branches developing on the lower part of the stem. An added benefit of cutting back is the prevention of lodging which is very common in the tall uncut plants. Pinching back the growing point when the plant is two to three feet tall would cause less shock to the plant than waiting until it is taller. It may be necessary to clip back the growth each month to keep the plant to a reasonable height for sprinkler irrigation.

The hilling of the plants to control weeds increases the amount of soil that the roots must be pulled through at harvest time. Planting on raised beds should make the harvest easier. The use of two, three and four cuttings in a hill type planting does not appear to have any advantage over plants uniformly spaced at 24 to 36 inches in rows 34 inches wide. In fact, many of the four cuttings to a hill were still without well developed roots ten months after planting. There was no difference of the plant or root development among the various angles of the cuttings in the soil.

There was no visual plant response to various fertilizer treatments. Both the test on fertilizer rates and population were lost due to improper supervision during the harvest.

In an area with a plow pan, plant and root development were poor. Actually the roots from this area had a high percentage that were an ideal size (12-15 inches long) for export for fresh market. The large, long roots are undesirable because they are difficult to box for shipping.

There is a tremendous variation in the rooting habits of the Cubano variety and plant selection for yield, root type, quality, and earliness would be beneficial.

QUEQUISQUE - 0.7 Manzana

Cultural Operations

Variety:	Criolla (Purple Tubers)
Planting date:	March 7 to 10, 1969
Row spacing:	34 inches
Plant spacing:	24 inches
Cultivation:	One time with spike tooth harrow, three times with cultivator, two times by hand
Fertilizer:	200 pounds 10-40-10; 100 pounds 46-0-0 per manzana
Harvest:	November 26, 1969

The field was pre-irrigated with 7.7 inches gross. The seedbed was prepared by using a rotavator. The rows and furrows were marked out by using a four-row corn planter without the seedboxes. The planter was set deep, which made a furrow into the soil about four inches deep.

The seed pieces were cut from corms bought in Masaya. Each seed piece had at least two eyes. On an average, each corm would give five seed pieces. Eight rows were planted with corms that had been stored frum the previous year. The other rows were planted with corms from the recent or December harvest. The corms had to have the old roots removed before cutting with a machete.

The seed pieces were dropped into the furrows by hand with the cut side up. In 50 feet of one row, the seed pieces were planted with the cut side down. In another row in a space of 50 feet, the seed pieces were planted on edge. Two rows were planted with the seed pieces spaced at 15 inches in the row. The seed pieces were firmed into the bottom of the furrow by stepping on them. The furrows were covered by using a spike-tooth harrow, and the field was irrigated shortly after planting.

The spike harrow was used to kill the small weed which emerged after the irrigation. The plants began emergence ten days after planting. By the third week there was sufficient emergency so that a cultivation was required for weed control.

Analysis

A man was brought from Masaya who had experience in planting quequisque. He felt strongly that the seed pieces had to be planted ten inches deep, and under conditions where germination depended on rainfall. Deep planting was needed to insure good moisture. Later trials in the following year brought up some serious questions in regard to depth of planting.

This man also insisted on having the seed pieces planted with the eyes downward. The seed pieces planted with eyes up would not produce tubers. The traditional method of planting is to make a deep furrow or hole, planting the seed piece and covering with dry soil. It could take several good rains before there would be sufficient moisture to initiate growth above the seed piece. It is possible that under these conditions the seed piece with the eyes up would eventually grow, but could be a month later than the one with the eyes down. At harvest time, the earlier plant would have developed tubers while the other would have none or much less developed tubers.

Where the seed pieces were purposely planted wrong, they developed as well as the adjacent rows, but it still may be an advantage to plant with the eyes down when planting by hand. The soil is dried considerably during hand planting and pushing the eye side into the soil should help speed the sprouting process. This should not be necessary when using a seed piece planter because the soil is disturbed only momentarily and then the press wheel firms the soil over the seed piece.

The plant spacing of 24 inches in the row appears to be too far apart. It should be reduced to at least 18 inches and possibly as close as 12 inches. It was observed that two or three plants in the same space (about 24 inches) as a single plant, produced 33 percent more total weight of tubers.

Little loss of seed pieces from rot was noted, but it should be a practice to dip the machetes in a fungicide before cutting the seed pieces, preventing the spread of a disease. It would be a good practice to also dip seed pieces in a fungicide solution (experiments are needed for kind and concentration of fungicides). The preparation and planting of seed pieces represents a considerable expense which would warrant the additional cost of applying a fungicide to assure a successful planting.

A sample harvest was made from a selected area on October 1, 1969. The calculated yield of all tubers from this area was 12,000 pounds per manzana. There was some concern in October over the apparent sprouting of the older tubers but this did not become a problem.

The pulling of the quequisque plants when the soil was dry was very difficult, but this problem was eliminated by irrigating to soften the soil.

As in yuca, the mounding of soil over the row during the last cultivation added to the difficulty of pulling the plants. There is no doubt that planting quequisque on raised beds would facilitate the harvest which could be easily done by machine and the tubers are not easily bruised. The tubers do not spread more than 12 inches from the center and can extend 12 inches below the soil surface. This depth would be reduced some by the use of raised beds. It is evident that the root system is not deep since soon after the rains stopped, the plants began showing moisture stress. This indicates that shallow and frequent irrigation is needed.

The slow growth of this plant requires considerable weed control. Work is needed on chemical weed control for the rainy season.

There was some symptoms of leaf disease, but none was serious and no serious insect problem was noted.

The good vigorous growth of this crop indicates its adaptation and the fact it does not exceed six feet in height makes sprinkler irrigation acceptable.

It is possible that quequisque would grow better in sandy soils, but there was no indication of poor growth in clay loam soil.

PAPAYA

Cultural Operations

A small planting of the dwarf type was made at this farm to observe the plant response under irrigation. The planting on June 10, 1969, in a triangular design three meters apart was fertilized and sprayed with Sevin. Death of some of the plants followed a fertilizer application. In October the leaves of the other plants turned yellow and dropped off. Some of the plants were developing fruit. A treatment was made with a foliar fungicide with no results. The problem seemed to be root involved, and nematodes were suspected by some people. Because of the conditions of plow pan and heavy rainfall, it is quite likely that phytothphora was the real cause.

PINEAPPLE

Cultural Operations

A selection of the Criolla variety was planted in two rows 600 feet long. These plants survived but the irrigation system was not designed to provide the frequent light irrigations required. This is a good irrigated crop for the area, but requires an industry approach. Those areas of shallow soil overlying sandstone lend themselves to the production of a shallow rooted crop such as pineapple.

July 1969 - March 1970

At the request of the owner, the volunteer peanuts and ratoon sorghum crops were allowed to mature. It developed that neither of these crops was worth keeping and the crops were removed, but not until December. This resulted in a serious loss of time and money to the grower. New crops were not re-established until January, with many delayed until March. This is too late in the dry season, inasmuch as a large portion of the important season has been lost and the harvest time occurs in the rainy period. But these are things this Project was to demonstrate, even though they are negative.

The yuca and quequisque fields were acceptable for planting at this time of year but there were lessons learned about the establishment and growing of these crops. The details were covered in the Monthly Reports but in summary, these observations may be made.

YUCA

Cultural Operations

-Vertical planting has advantages over horizontal fully covered plantings.
-Mechanical transplanters can be adapted to do this time-consuming job.
-Replanting by hand is needed to fill in the 10% - 15% of the planting which don't grow.
-Rat control using bait will be needed to protect even sizeable plants.
-Planting on beds is recommended both for hand harvest and mechanical harvest.
-Hand sprays or shielded mechanical spraying is necessary for weed control if irrigation is practiced.
-A dust mulch until the plants are established will reduce early weeds.
-Pruning by pinching back terminal buds has advantages particularly under irrigation, either furrow or sprinkler.

QUEQUISQUE

Cultural Operations

Experience with the spring plantings at this site was different from the previous year. Sprouting was delayed as long as forty days and there was a high percentage of seed pieces that rotted. Deeper planting into more uniform moisture may be needed.

Under the above conditions of delayed sprouting, weeds became a serious problem. General contact sprays are recommended (see the section on weeds).

Like yuca, this crop needs to be mechanized. Planting takes far too long under present methods, with accompanying higher costs.

MILLET

Cultural Operations

A crop of Pearlex variety pearl type millet was planted on April 17. Heads were forming in just over thirty days.

In general, the other crops of sorghum and corn were economic losses at the outset because of inadequate fertilizer programs. It is well recognized that crops grown with irrigation must be managed for top yields in order to pay the extra costs of irrigation.

6.5 - EL CARMEN, SITE #50, JULIO FONSECA L., (FULL COOPERATOR)

(Table 6-5, Fig. 6-5, pp. 6-23,24)

6.51 - General

This Project cooperator site located northwest of Leon consists of a combination of 14 manzanas of row crops (sprinkler irrigated) and 50 manzanas of pasture land.

Mr. Fonseca had an existing well that was drilled on his property in 1967 by the civic action unit of the Guardia Nacional. The Project assisted in securing a loan for pumping equipment and arranging for the installation of 3-phase power installation to the well site.

The irrigation system includes a deep well turbine pump with a 40 HP electric motor to lift the 1,370 gallons per minute flow and discharge it into a main canal. At the head works part of this flow (300 gallons per minute) is picked up and boosted to a pressure head of 50 psi for the sprinkler operation using a 15-HP electric motor. The sprinklers cover the 14 manzanas of irrigated row crop land.

The 50 manzanas of pasture is irrigated by gravity flow (controlled flood) or border system. Part of the pasture land is rather smooth and has a fairly heavy soil. This area irrigated rather well with borders spaced at 20-meter intervals. Another portion is rather undulating and is irrigated by a system best described as controlled wild flooding.

Mr. Fonseca's farm equipment consists of two tractors (one 3-point hitch International), the usual type of auxiliary tools such as cultivators, disk plows, disks, planter, etc. The owner has recently acquired a Vee-ditcher unit plus a small blade to remove soil in small levelling jobs.

6.52 - Crops, Yields and Cultural Operations

GRAIN SORGHUM - 8 manzanas (14 acres)

Cultural Operations

Variety: Dekalb E-57

Seedbed preparation: March 17 - April 4. Chop and burn cotton stalks, plow, disk, pre-irrigate (7.7 inches gross) disk and float.

Planting date: April 4

TABLE 6-5

CROP ROTATIONS
FOR
SITE No. 50 - FINCA EL CARMEN (SR. JULIO FONSECA)
PROYECTO ADELANTE FARM DEMONSTRATION SITE

FIELD No.*	FIELD SIZE (Mz.)**	1969 CROP SCHEDULE		1970 CROP SCHEDULE	
		CROP	Date Planted	CROP	Date Planted
1-A	3.00	Grain Sorghum (Dekalb E-57)	4 Apr. '69	Grain Sorghum (AKS-614)	6 Feb. '70
1-B	3.50			Black Beans (Veranic) followed by Corn (Opaco-2)	6 Feb. '70 18 Feb. '70
1-C	0.50			Black Beans (Veranic)	6 Feb. '70
2-A	0.25	Millet (Prosso)	15 Apr. '69	(Fallow)	--
2-B	2.00	Castor Beans (Lynn Dwarf)	13 Apr. '69	Corn (Salco)	12 Feb. '70
2-C	1.50	Peanuts (Valencia)	12 Apr. '69		
2-D	1.14			Red Beans (California Red) followed by Corn (Opaco-2)	12 Feb. '70 18 Apr. '70
2-E	0.50	Pangola Grass (African Star)	14 May '69	Pangola Grass (Nursery)	--

* See Site Map for location of Field No's.

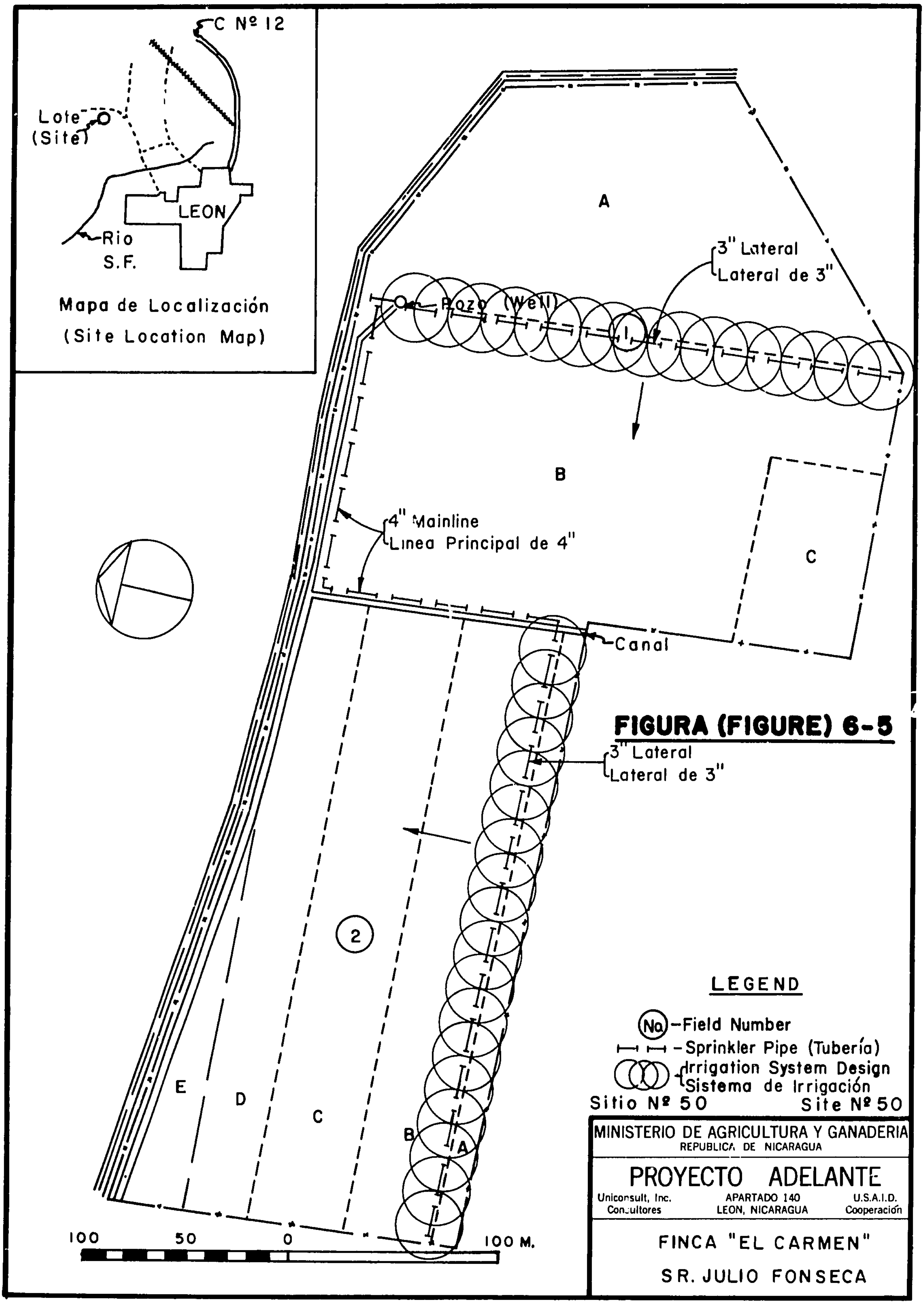

FIGURA (FIGURE) 6-5

Sitio Nº 50 Site Nº 50

MINISTERIO DE AGRICULTURA Y GANADERIA
REPUBLICA DE NICARAGUA

PROYECTO ADELANTE

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LEON, NICARAGUA
U.S.A.I.D. Cooperación

FINCA "EL CARMEN"

SR. JULIO FONSECA

Planting rate: Planted in 34 inch rows using 20 pounds of seed per manzana.

Fertilizer: 200 pounds 10-40-10 and 200 pounds Urea per manzana applied before cultivation.

Spray: April 23 applied 3 pounds of Sevin (80%) per manzana with hand sprayer. June 14 applied 500 cc of Azodrin per manzana by air.

Irrigation: Three times (total - 10 inches gross)

Insect control: The soil insecticide dieldrin (10%) applied at 20 pounds per manzana with the planter-fertilizer attachment at time of planting.

Bird control: June 16-July 3, 4 carbide detonators, 4 boys during the day to scare birds, use of a shotgun, plastic and aluminum foil flags.

Harvest: July 3-22, using small combine.

Analysis

Excellent growth and uniform plant population in this field indicated that there would be a very good yield. However, rain in June caused the seeds to germinate and shatter before it was possible to harvest. The final yield was less than 2000 pounds per manzana (1140 pounds/acre).

Estimated maturity for this variety was 90 days after planting or on July 4. Harvest was started July 3.

An intensive effort to keep the parakeets out of the field was successful. Only minor loss was caused by these birds after June 16. It is also possible that weed seed and other grains were becoming more available which could partially account for having less bird problems in this field. Although the Azodrin spray was applied for insect control, it was hoped it would help control the parakeets, but it had no effect.

The application of Dieldrin as a soil insecticide was successful in controlling the lesser cornstalk borer (Elasmopalpus lignosellus). This was confirmed by planting four rows without Dieldrin in two different parts of the field.

Although the hand applied fertilizer is not efficient and doesn't make possible uniform coverage, it was used because side-dressing equipment was not available. An 8-row strip through the field without fertilizer had less vigorous growth early in the season. More accurate application of fertilizer rates with yield records is needed in this field before a recommended rate can be determined.

The small combine used for harvest needed constant adjustment which caused many delays and additional loss of seed.

PEANUTS - 2.5 manzanas (4.4 acres)

Cultural Operations

Variety: Valencia certified seed treated with inoculant.

Seedbed preparation: March 28 - April 12. Chop and burn cotton stalks, applied 200 pounds of 10-40-10 fertilizer per manzana, pre-irrigate (7.7 inches gross), rototilled.

Planting date: April 12

Planting rate: 70 pounds per manzana in 34 inch rows

Cultivation: Three times and one hand weeding

Spray: One hand spray with 3 pounds of Sevin per manzana

Irrigation: Three times (total - 10 inches gross)

Harvest: August 1 - 28. After chopping the tops, a disk plow was adapted for lifting peanuts. The crop was then harvested by hand. The peanuts were dried in a commercial grain dryer in Leon.

Analysis

This crop made excellent growth with a sample yield of 5000 pounds per manzana (2960 pounds/acre). The daily rains in August (31 inches for the month) prevented a complete harvest. A total of 3100 pounds (1240 pounds/manzana) was harvested and sold to an oilseed processor for 40 cordobas per 100 pounds. Seed germination of the capsules in the soil was the major factor for the low yield. The use of specialized harvesting equipment would have prevented much of this loss.

There were no disease problems and a low infestation of armyworms which were controlled by a single application of the insecticide Sevin.

The application of the peanut inoculant produced a slight increase in nodules near the seed but had no apparent effect on growth. The area planted with seed that was not inoculated formed abundant nodules. The bacteria (Rhizobium sp.) for the legume group that includes peanuts, cowpeas and lima beans appears to be inherent in the soil throughout the Project Area.

The normal time from planting to harvest for the Valencia variety is 90-95 days in Nicaragua. Harvest in this field was started on August 1 which is 110 days after planting. At this time many of the capsules were immature and needed another 7-10 days before reaching the proper maturity for harvest. We have no answer for the cause of delayed maturity other than the prolonged rainy period and wet soil which delayed development of the capsules.

Production of peanuts during this period is justified only in the case of an extremely strong market, no other competitive crop without the same risk, plus the availability of peanut harvest equipment to make a rapid and timely harvest.

CASTOR BEANS - 2.5 manzanas (4.4 acres)

Cultural Operations

Variety: Lynn - Dwarf internode type - open pollinated

Preplant operations were the same as previously given for peanuts.

Planting date: April 13, 1969

Planting rate:	20 pounds per manzana planted in 34 inch rows
Fertilizer:	200 pounds of Urea (46%N) per manzana applied before cultivation.
Spray:	none
Harvest:	on August 1, 1969, the crop was destroyed

Analysis

The plants in this field were exceptionally vigorous and set a good crop of seed.

There was no serious insect problem.

A narrow strip through the field without the 200 pounds of 10-40-10 had reduced growth indicating this field was low in phosphate.

The rains of August caused a severe infestation of capsule mold that made the harvest more expensive than the value of the crop.

MILLET

Cultural Operations

Variety: Proso millet (Panicum miliacium)

On April 15, 1969, this crop was planted in a 0.25 manzana area. The field had been prepared with a rotovator. 30 pounds of millet were broadcast with a hand seeder. A spike tooth harrow was used before seeding and after seeding to kill the small weeds and to cover the seed. The plant emergence was excellent. Within 20 days the plants were six to eight inches tall and forming seedheads. The seedheads were small and the plants never got any taller. It was obvious that day-length is wrong for this crop.

Analysis

Proso millet requires a longer day for vegetative growth. No further work is recommended with this crop.

ALFALFA

Cultural Operations

Variety: Townsville alfalfa (Stylosanthes humilis)

On May 24, 1969, a small area 60 feet by 150 feet was planted to a native legume. This legume is known as Townsville Alfalfa in Australia where it is used in pastures. The legume originally came from Central America but no intensive use has been made of it in the area.

A seedbed was prepared with a rotovator. The seed was mixed with soil and broadcast by hand. The rotovator, set very shallow and at a very slow speed of rotation, was used to cover the seed but even so the plant emergency was very sparse. These plants set seed and were disked lightly on February 8, 1970, in order to stimulate regrowth.

PANGOLA

Cultural Operations

Variety: African Star (Digitaria decumbens)

A small plot of 0.25 manzana was planted to the African Star variety of Pangola on May 14, 1969. This area with sprinkler irrigation was established as a mother block for planting material. This was to be used to replace the Jaragua grass (Hyparrhenia rufa) in the irrigated pastures of this farm.

The vegetative planting material was brought from La Calera. A good seedbed was prepared by plowing and disking. The cut grass was spread over the area and lightly disked in. It had been planned to use the sprinkler for irrigating this immediately after planting. Later it was decided to flood irrigate the area from the irrigation ditch adjacent to the field. The resulting erosion and poor water distribution contributed to a loss of approximately 30 percent of the planting.

One hundred pounds of Urea fertilizer were applied and frequent rains gave the grass a good start. The field was cut back with a field chopper one time for weed control. Once the grass formed roots and initiated growth, it quickly covered the area and even spread to unplanted areas around the edge.

On June 21, 1969, assistance was given to the owner in planting two manzanas of Pangola grass. The seedbed and planting was carried out as it was with the African Star variety. The vegetative material was brought from the Pangola fields of the San Antonio Sugar Mill at Chichigalpa. This small field did not have irrigation available but prior to planting there had been a rain nearly every day. As it happened, there was no rain for several days after planting and the grass cuttings never rooted as a result of the dry seedbed.

August to December, 1969

Because of especially heavy and frequent rains, it was impossible to prepare the land for planting. A volunteer peanut crop had been allowed to mature and the plan was to harvest this crop. However, the set was poor and many of the nuts were moldy from the wet soil conditions. As a result harvest was impossible and the cattle were turned into the peanuts and allowed to graze the crop.

In December, the land was deep plowed. It was in such an unlevel condition after this plowing that the field had to be smoothed with a wooden float. The low spots were filled with dry soil which meant the field had to be pre-irrigated. When the irrigation pump was started a problem developed in the equipment and it took until late January to get the pump back into operation.

It took the Project technicians one week to get a cotton planter converted for planting corn, sorghum and beans. They were unable to get the fertilizer attachment on the planter to work properly, which made it impossible to apply fertilizer at planting time.

BLACK BEANS - 4.0 manzanas

Cultural Operations

Variety: Veranic

Planting date: February 6, 1970

Seeding rate: 50 pounds per manzana

Planting rate: 34 inch rows, 10 seeds per foot

Cultivation: Planting with corn planter plates

The field was prepared by disking and floating. The proposed planting depth was 1-1/2 inches since the field moisture was excellent. As it turned out, the beans were planted from four to six inches deep. Normally, beans will emerge in three to four days, but these took ten days. They never looked healthy and it was soon apparent that a fungus, believed to be Rhizoctonia, was attacking the very long hypocotyl. Frequent, shallow irrigations were applied in an attempt to stimulate the growth of adventitious roots above the zone of fungus attack. Insect attacks were more severe on these stressed plants than on healthy plants. The field was first treated with Diazinon by airplane application at 300 cc per manzana, but due to wind conditions, coverage was not adequate. A later application by ground sprayer was made using the same rate of Diazinon. In spite of irrigations and spraying, the field was lost as a result of the seedling disease.

RED BEANS

Cultural Operations

Variety: California Reds

A broadcast application of 500 pounds of 10-40-10 was made before furrowing out this one-manzana area. A pre-irrigation was applied and a wooden bed shaper, for 34-inch row spacing, was used. On February 12, 1970, the field was planted using 70 pounds of seed which gave a seed spacing in the row of about three inches. A corn planter with modified corn seed plates was used. The planting depth was two inches. Emergence of the beans was good, but there was also a heavy emergency of volunteer peanuts.

The beans were sprayed by air with 300 cc of Diazinon per manzana. They were also sprayed by ground at the same rate on March 12. White fly, leaf hopper and armyworm were the insects noted. The real problem was an attack of the same disease organism which infected the black beans. Although these California Reds were planted at a shallow depth and emerged quickly, the disease destroyed the crop just as it did the black beans.

GRAIN SORGHUM - 3.5 manzanas

Cultural Operations

Variety: AKS-614

Planting date: February 6, 1970

Row spacing: 34 inches

Seeding rate: 20 pounds/manzana

The field was disked and floated and planted, using special seed plates for grain sorghum. They were planted 12 seeds per foot of row, with a planting depth of 1-1/2 inches. On the third day, the plants had begun to emerge and by the fifth day, all of the plants had emerged. The field was sprayed aerially with 300 cc of Diazinon on March 1, 1970. White fly, leafhopper and the fall armyworm were the primary insects. No fertilizer was applied at planting time. The crop was harvested on May 8, 1970, with a yield of 48 quintales/manzana (2800 pounds/acre).

CORN - 5.0 manzana

Cultural Operations

Variety: Salco
Planting date: Feburary 12, 1970
Row spacing 34 inches
Seeding rate: 30 pounds/manzana
Harvest: April 30, 1970

The seed was spaced at three inches in the row and planted at a depth of two inches. The field was sprayed aerially with 300 cc of Diazinon per manzana on March 1, 1970 for control of leafhopper and fall armyworm, followed by a ground application at the same rate and material on March 12.

Part of this crop was harvested as roasting ears (elote). 22,000 ears were harvested and sold to the local market for a gross return of $2210.00 ($330.00 US dollars). The remainder of the crop was harvested as dry corn. The yield of this portion of the crop was not available at the time of this report.

6.6 - LA ESPERANZA, SITE #13, OSCAR GALO, (FULL COOPERATOR)

(Table 6-6 & Fig. 6-6, pp. 6-31,32)

6.61 - General

Sr. Galo's farm is on the main highway to Malpaisillo and San Isidro and is located just west of Malpaisillo. There is a powerline along this highway so it was possible again, because of the assistance from ENALUF, to get electricity to the pump.

The well was started by Percasa on August 21, 1968, and tested on October 15, 1968. It took one year before the pump was installed with the proper electrical system and ready to operate.

First plantings were made in all fields in August of 1969, and the first irrigation was applied in December, 1969.

6.62 - Crops, Yields and Cultural Operations

The farm was divided into three fields as shown on map (p.32) in this section. In one field a crop of open-pollinated Meloland grain sorghum was planted. This crop was harvested on December 3 and a ratoon crop was grown which was harvested March 12, 1970. Contrary to normal experience, the rains continued until the last days of November. Both the first harvest and the ratoon crop produced low yields. The reasons are not known, but in addition to rain damage on the mature heads, nutrition is suspected as the cause of this poor showing. The crops were very impressive in the field, but germination percentage of the first crop was only 44%, and, more importantly, the bushel weight averaged 46 pounds which is ten pounds below normal.

A second field was planted to castor beans and hand harvested in February, 1970. The stalks were cut back for a ratoon crop and allowed to grow for one month at which time it was destroyed by the owner.

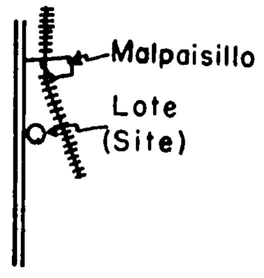
TABLE 6-6

CROP ROTATIONS
FOR
SITE No. 13 - FINCA LA ESPERANZA (DR. OSCAR GALO)
PROYECTO ADELANTE FARM DEMONSTRATION SITE

FIELD No.*	FIELD SIZE (Mz.)**	1969 CROP SCHEDULE		1970 CROP SCHEDULE	
		CROP	Date Planted	CROP	Date Planted
1	3.80	Corn (Rocamex H-507)	21 Aug. '69	Corn (Salco)	28 Jan. '70
2	7.90	Grain Sorghum (Meloland)	22 Aug. '69	Grain Sorghum (Meloland) - Ratoon followed by Corn (Opaco-2)	11 Dec. '69 24 Apr. '70
3	4.40	Castor Beans (Lynn Dwarf)	23 Aug. '69	Castor Beans (Lynn Dwarf) - Ratoon crop	20 Feb. '70

* See Site Map for location of field No's.

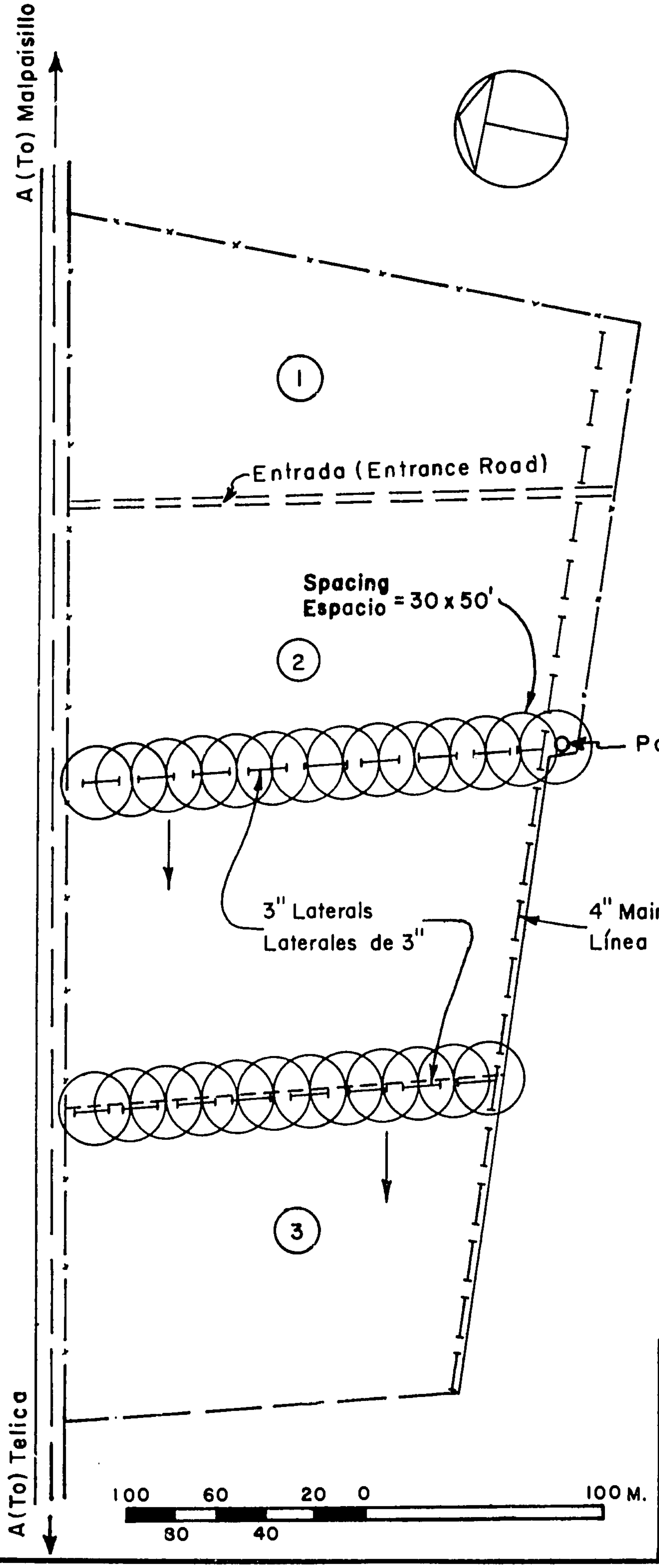
** Mz. = Manzana = 1.74 acres



Mapa de Localizacion

(Site Location Map)

FIGURA (FIGURE) 6-6



LEGEND

Sitio Nº 13 Site Nº 13

MINISTERIO DE AGRICULTURA Y GANADERIA
REPUBLICA DE NICARAGUA

PROYECTO ADELANTE

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"FINCA LA ESPERANZA"

SR. OSCAR GALO

The third field was planted to corn on August 21 which was harvested on December 29. This field was replanted to corn again on January 28, 1970. Roasting ears were harvested the middle of April and the rest of the corn as mature ears in May.

In late Spring - April - the field previously in grain sorghum was planted to corn for a seed crop. In mid-May a small piece was planted to red beans.

GRAIN SORGHUM - 7.9 manzanas

Cultural Operations

Variety: Meloland

Planting date: August 22, 1969

Row spacing: 34 inches

Seeding rate: 25 pounds/manzana

Fertilizer: 200 pounds 18-46-0 per manzana at planting,
200 pounds Urea (46%) per manzana at last cultivation

Cultivation: 2 times

Rainfall: August 22-31, 17"; September, 14.4"; October, 12.1"; November, 4.5"

Harvest: December 3, 1969

Yield: 45 quintales/manzana (2600 pounds/acre)

The planting had been delayed several times because of rain. In order to get the field prepared rapidly, as many as four tractors were working at one time. The Meloland seed was registered seed from the California Crop Improvement Association. The plan was to save the seed from this crop as planting seed since it was isolated from other sorghum plants. The field was rogued three times by pulling tall plants and those with definite plant or head differences.

The stand was excellent and growth was rapid. There were some insects, especially armyworm, but never sufficient to warrant spraying. Flowering started at 45 days. The continuous rain caused rather severe leaf discoloration caused by bacterial blights, helminthosporium leaf blight, anthracnose, rusts and possibly others.

The seed set was excellent and there was no damage from birds. The major problem was a heavy rainstorm during the last days of November. The seeds were nearly dry enough for harvest (16-18 percent moisture). The seeds became swollen indicating the first processes of germination had started.

A fertilizer test was established in this field. The following is the result of this test.

Fertilizer (lbs/mz)				Seed Moisture	Yield*	
N	P	K		Percent	lbs/mz	lbs/A
0	0	0		19.0	4597	2627
128	92	0		14.0	4803	2744
164	184	0		15.0	4720	2697
220	92	0		17.2	4547	2598
			Average	16.3	4667	2667

*Yield adjusted to 14% moisture

The yield for each treatment was taken from eight rows 756 feet in length. There is not sufficient difference in yield to indicate a yield response. There was a distinct plant growth difference in the area with no fertilizer. This area had shorter plants and was slower in heading out. This delay in maturity is borne out by the higher seed moisture at harvest time. The germination test on this seed showed an average of 44 percent and the bushel weight was 46 pounds, or ten pounds below normal. Both of these factors indicated that the seed was abnormal.

Ratoon Grain Sorghum (same field as above)

On December 11, 1969, the sorghum plants were cut with a rotary chopper. The instructions were to cut the stalks at six inches tall with a very sharp blade. (The first 20 rows along the western edge were cut at about two inches tall, this caused a definite delay with regrowth.) After chopping, 100 pounds of Urea per manzana were applied by broadcasting with a spreader mounted on a tractor. This was followed by a light irrigation. There was some problem of getting a uniform application of water. At one time the sprinkler lines were being placed 60 feet apart instead of 50 feet. Blackbirds, crows, and parakeets were eating the seed and a bird patrol had to be established. Insects were never a problem and spraying was not needed. No cultivation was done, no weeds, but volunteer sorghum plants were a problem early in the crop season. These were shaded out by the larger ratoon plants after about six weeks. The crop was ready for harvest the 18th of March or 98 days after cutting back the plants of the first harvest. The ratoon crop yield was only 857 pounds per acre (15 quintales per manzana). Although the appearance of the crop was good, the heads were light and this yield was virtually a crop failure.

CASTOR BEANS - 4.4 manzanas

Cultural Operations

Variety: Lynn Dward

Planting date: August 23, 1969

Row spacing: 34 inches

Seeding rate: 20 pounds per manzana

Fertilizer: 200 pounds 18-46-0 per manzana at first cultivation, 200 pounds Urea (46%) per manzana at last cultivation

Cultivation: 2 times and one hand weeding

Rainfall: August 23-31, 1.6"; September, 14.4"; October, 12.1"; November, 4.5"

Insecticide: 2 times (Parathion)

Harvest: February 20, 1970

Yields: 2700 pounds/acre (47 quintales/manzana)

This planting was made with registered seed from Texas A&M College, College Station, Texas. The plan was to grow this field as a source of future seed for planting.

An inclined plate-type planter was used which was made especially for castor beans and peanut planting and did an excellent job.

The castor beans emerged slowly and plant growth was slow the first month. At 45 days the first flowering was noted. At this time, the plants began to grow rapidly.

The heavy rains caused some stunting of the plants and some died in areas where there was standing water, and because of the wet conditions it was not possible to cultivate as often as was needed. The weeds had to be cleaned out by hand and as usual, this operation caused further loss of plants.

The primary spike, the second set and the third were lost to capsule mold. The continuous rain and high humidity were the cause of this loss.

The harvest was done by hand in March, 1970, after letting the plants dry from soil moisture stress. The workers used gloves and stripped the capsules off the stem and placed the capsules into sacks. The capsules were then spread out in an open space for final air drying of the green capsules.

Ratoon Castor Beans (same field as above)

In March, 1970, the castor bean plants were cut back with machetes. They were cut just above the node on the main stem where the lowest branch had formed (about 18 inches above the soil surface). This was followed with a deep irrigation and an application of 200 pounds of Urea per manzana.

This experience shows that it would be better to keep the plant growing well and use a defoliant for drying the capsules for harvest rather than dry the plants up by moisture stress, the regrowth is much more rapid and the ratoon crop develops more uniformly.

CORN - 3.8 manzanas

Variety:	Rocamex H-507
Planting date:	August 21, 1969
Row spacing:	34 inches
Seeding rate:	31 pounds/manzana
Fertilizer:	200 pounds 16-46-0 per manzana, 100 - 600 pounds Urea
Cultivation:	2 times with tractor, one time by hand
Insecticide:	5 applications
Rainfall:	August 21-31, 1.6"; September, 14.4"; October, 12.1"; November, 4.5"
Harvest:	December 29, 1969
Yield:	2564 pounds/acre (44 quintales/manzana)

This variety of corn was 10 to 12 feet tall with the ears emerging at six to seven feet high by mid-October. A mild wind storm was sufficient to cause lodging of this tall variety. A corn that grows this tall, grown under sprinkler irrigation, would be almost impossible. In addition, this variety is very susceptible to corn stunt disease.

On January 28, 1970, a new crop of corn was planted. This crop was the Salco variety to be harvested for roasting ears. 23,600 ears were harvested in mid-April. The corn that got too mature for sale as roasting ears was harvested as mature corn in May.

This corn was planted at the rate of 30 pounds per manzana but was too shallow. Attempts were made to fill out the planting by hand, but these were too shallow too. Therefore, the entire crop suffered from a poor planting job.

6.7 - MOYOTEPE, SITE #4, ROBERTO VACA S., (FULL COOPERATOR)

6.71 - General

(Table 6-7 & Fig. 6-7, pp. 6-37,38)

This site is located on the northside of the Chinandega Villa Salvadorita highway at kilometer post 159. The deep, well-drained soil lies in a terrace position sloping less than 1% to a northern exposure and is bisected by a diagonally located drainage channel. A large capacity spring, with a flow of about 300 - 400 gallons per minute, is located at the extreme northern edge. The temperature of the water averages 90°F(32.2°C) with a conductivity of 1800 micromhos per cm. at 25°C. The water is high in calcium, and magnesium with relatively high bicarbonate ions. The water is classed as C3-S1 with the following description:

C-3 High Salinity Water - This water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

S-1 Low-Sodium Water - This water can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium. However, crops sensitive to sodium, such as stone-fruit trees and avocados, may accumulate injurious concentrations of sodium.

Sr. Roberto Vaca is a civil engineer, educated in the United States, who worked on the Pan-American Highway and finally settled on his paternal homestead to raise cattle and cotton. He has an average line of farm equipment that is primarily suited to the 39-inch cotton row spacing. Sr. Vaca has no equipment specifically suited to irrigated farming, except for three point hitch tractors.

This site was chosen primarily for its location, soil and available water supply. The spring made the site attractive as a means of demonstrating furrow (gravity flow) irrigation with a minimum of investment in equipment.

The Ames gated pipe system was specifically designed for this site and proved satisfactory for water application.

Preliminary design studies indicated that maximum length of "runs" would be limited to about 100 meters. Water application experience proved this to be entirely too conservative. The current practice of pushing the water the entire length of the furrows (300 meters) in about 20 minutes elapsed time, indicates that all soils don't have high intake rates. There is some difficulty in getting the water to "sub" across the furrows. The tail end of the runs drops off more than desireable and it is going to be necessary to level the area for efficient irrigation.

Electricity is not available at this site, but only a 13 HP diesel powered centrifugal pump was needed for the short lift from the spring to the high point of the field. Since gated pipe is used, the pressure for sprinklers is not required.

The cotton crop on the land was harvested and the stalks were chopped on April 18, 1969. Irrigation equipment and the pump were ready on May 29, 1969. But many things delayed planting: delays in pump testing, low flow in the spring, leveling work and the rains. Planting date was August 26.

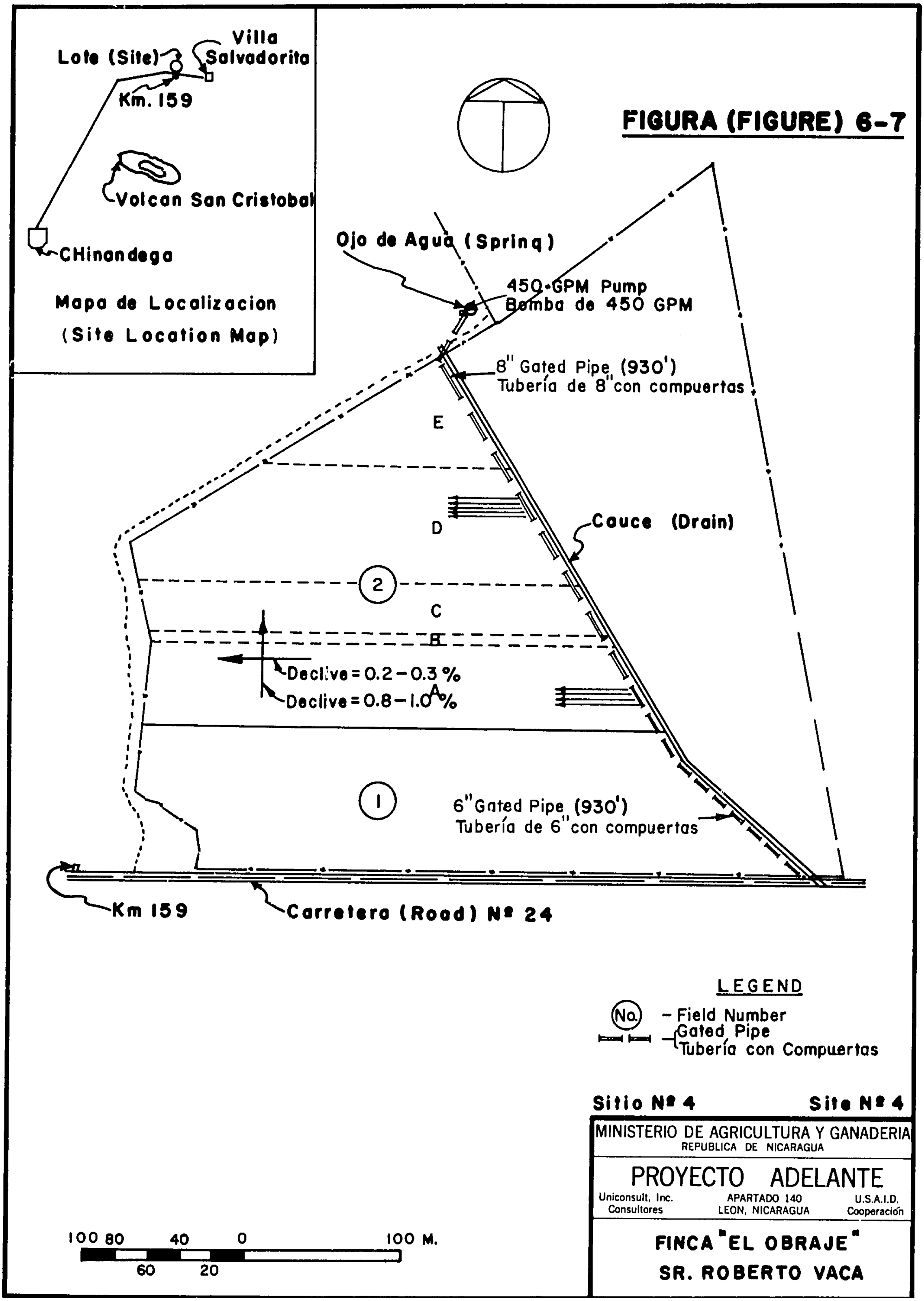
TABLE 6-7
CROP ROTATIONS
FOR
SITE No. 4 - FINCA EL OBRAJE (SR. ROBERTO VACA S.)
PROYECTO ADELANTE FARM DEMONSTRATION SITE

FIELD No.*	FIELD SIZE (Mz.)**	1969 CROP SCHEDULE		1970 CROP SCHEDULE	
		CROP	Date Planted	CROP	Date Planted
1	3.70	Cotton	--	Cotton	--
2-A	2.00	Grain Sorghum (Meloland)	26 Aug. '69	Cowpeas (Mississippi Silvers)	12 Feb. '70
2-B	0.07			Soybeans (Mandarin)	25 Feb. '70
2-C	1.00			Cowpeas (Whippoorwill)	12 Feb. '70
2-D	2.50			Sweet Corn (Pajimaca) - Corn (Salco)	10 Feb. '70 18 Apr. '70
2-E	1.75	Millet (Gahi Hybrid)	27 Aug. '69	Sweet Corn (Pajimaca) intercropped with Yuca	10 Feb. '70

*See Site Map for location of Field No's.

**Mz. - Manzana = 1.74 acres

FIGURA (FIGURE) 6-7



Sitio Nº 4 Site Nº 4

MINISTERIO DE AGRICULTURA Y GANADERIA
REPUBLICA DE NICARAGUA

PROYECTO ADELANTE

Uniconsult, Inc.
Consultores

APARTADO 140
LEON, NICARAGUA

U.S.A.I.D.
Cooperación

FINCA "EL OBRAJE"
SR. ROBERTO VACA

6.72 - Crops, Yields and Cultural Operations

GRAIN SORGHUM

Cultural Operations

Planting date:	August 26, 1969
Seeding rate:	20 pounds/manzana (12 pounds/acre)
Row spacing:	40 inches
Fertilizer:	200 pounds 18-48-0 per manzana at first cultivation, 200 pounds Urea (46%) per manzana at second cultivation
Cultivation:	two times plus one hand weeding
Rainfall:	August 26-31, 1"; September, 11.9"; October, 11.5"; November, 5.8"
Harvest date:	November 28, 1969

This crop was planted in 40-inch rows because the planter, cultivators, fertilizer applicator, etc. were set for this spacing. Some parts of the field had a poor stand, other parts were lost to flooding and there were some insects, but not enough to warrant an insecticide application. The field was rogued for off-types and in general, the plants made good growth and seed set. Only a part of the low yield can be traced to the hand harvest and threshing. As the heads matured, the parakeets moved into the field, so an intensive bird patrol was posted in the field. The loss was as much as 10 percent from birds. The late rains in November caused some loss from shattering and germination of seed in the heads.

Harvesting was done by hand while the seed moisture was about 20 percent. The cut heads were dried in the sun. These heads were threshed by hand flailing.

The low yield can be attributed to an accumulation of problems: 1) poor stand, 2) bird damage, 3) rain at harvest time.

The following data are from a fertilizer test in this field.

Plot No.	Fertilizer (lbs/mz)			Yield (lbs/mz)		Bushel Weight (lbs)	
	N	P	K	Rep I	Rep II	Rep I	Rep II
1	184	0	0	1072	1010	46.6	47.6
2	256	192	0	1084	985	46.0	46.1
3	164	192	0	998	848	48.2	46.6
4	92	0	0	1047	1022	47.6	46.2
5	0	0	0	998	1210	44.9	48.2
		Average		1040	1015	46.7	46.9

The yields are extremely low and inconsistent, and indicate that the other factors limiting the yields offset any response from fertilizer. The normal bushel weight is 56 pounds. A germination test on this seed showed about 50 percent.

Miscellaneous

Millet - On August 27, 1969, a 1.25 manzana area was planted with GAHI Hybrid millet, one of the pearl types. The seed was broadcast with a hand seeder at a rate of 40 pounds per manzana. This field was furrowed out for irrigation when the plants were 12 to 18 inches tall. The plants made rapid growth. Full bloom occurred 35 to 40 days after planting. On October 19, the dickcissell (or rice bird) moved into the field by the thousands and within three days harvested 90 percent of the seed. The estimated time to maturity for this crop was 65 to 70 days from planting.

Soybeans - An eight-row plot of Improved Pelican soybeans was planted the length of the field on August 27, 1969. A poor stand resulted due to low seed germination and the eight rows were replanted on September 10. These were planted at very high seeding rate (about 200 pounds per manzana), but still a good stand was not obtained and was plowed out. Maintaining germination of soybeans is a problem under these climatic conditions particularly with this variety.

Cowpeas - In the area where the soybeans were planted, four rows of Whipporwill and two rows of Mississippi Silver cowpeas were planted on September 20. These made excellent growth. The Mississippi Silver cowpeas were setting seed on November 11 while the Whippoorwill were just starting to flower. The Mississippi Silvers were harvested on January 5, 1970, with a yield of 2180 pounds per manzana. The Whippoorwill were harvested on January 10, 1970, with a yield of 3220 pounds per manzana.

Pajimaca Sweet Corn - On September 20, 1969, two rows of sweet corn, the length of the field (adjacent to the cowpeas), were planted for increase of seed. It took about 100 days to maturity and 100 pounds of seed were obtained. The time for harvesting the corn for the fresh market was about 75 days.

6.8 - SANTA THERESA, SITE #86, RAMIRO ESCOBAR, (FULL COOPERATOR)

(Table 6-8 & Fig. 6-8, pp. 6-41,42)

6.81 - General

This cooperator site is located at kilometer post 105 on the Telica-San Isidro highway, about 15 kilometers north of Leon. The rectangular 38-manzana site is divided one-half to row crops (Project crops) and one-half to pasture (owner operated). The terrain slopes one percent toward the south and is divided into five terraces on the northern portion. The well was drilled as near the center as was practical and the sprinkler system design uses two laterals to cover the design area in 14 days. The sprinkler nozzle spacing is 30 X 60 feet and the gross application amounts to 3.08 inches per eleven-hour setting.

Sr. Escobar is an Agronomist, educated in the United States, having a degree from Mississippi State College of Agronomy. He is a local businessman dealing in the manufacture of furniture and owns a commercial funeral home. Sr. Escobar recently acquired a small herd of dairy cattle that he is pasturing on the lower 20 manzanas. His farm equipment is inadequate for irrigated row-crop farming. The crops have been mediocre for reason of inadequate financing, resulting in late or inadequate applications of fertilizer, etc., and other cultural operations.

TABLE 6-8

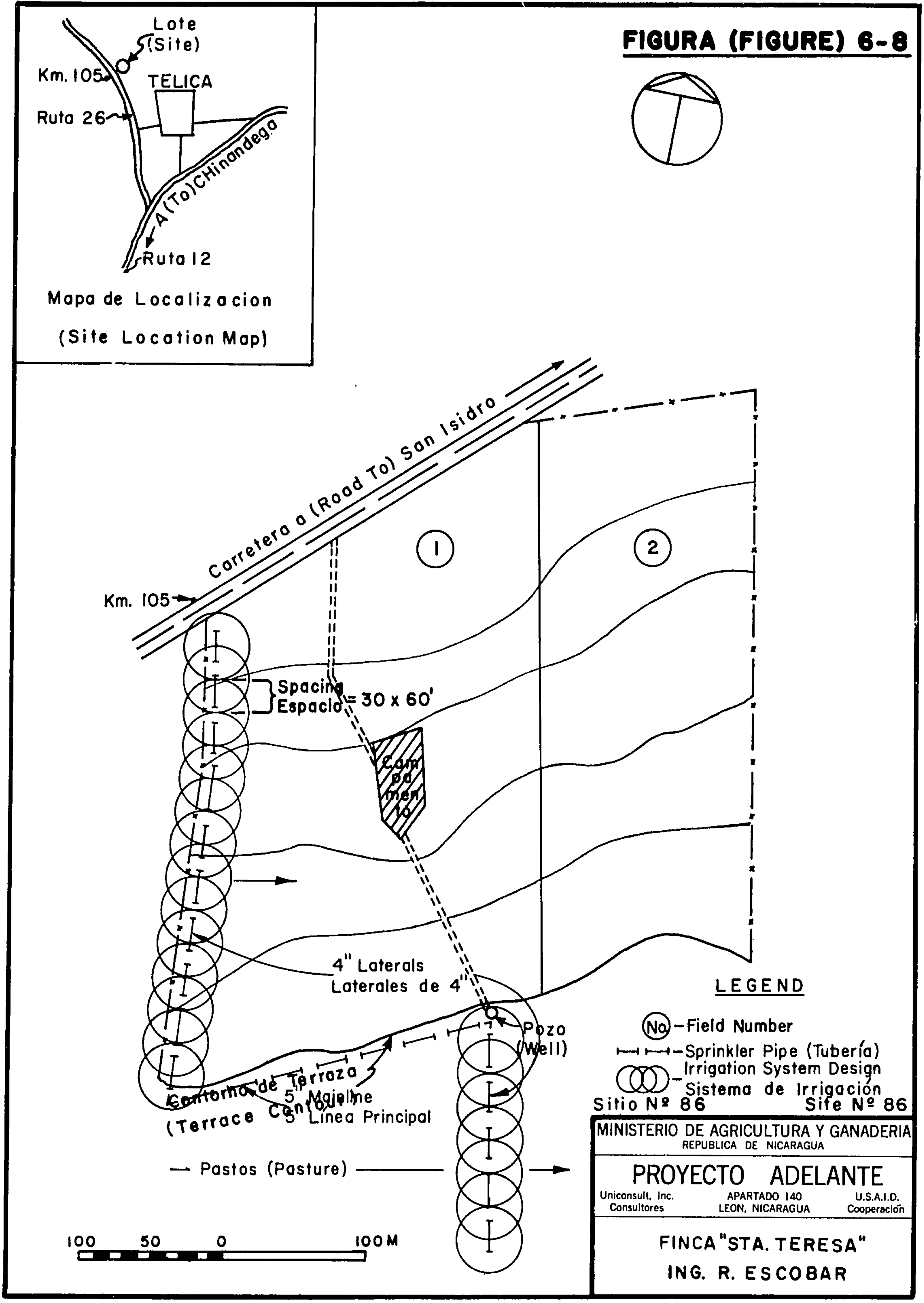
CROP ROTATIONS FOR SITE No. 86 - FINCA SANTA TERESA (ING. RAMIRO ESCOBAR) PROYECTO ADELANTE FARM DEMONSTRATION SITE

FIELD No.*	FIELD SIZE (Mz.)**	1969 CROP SCHEDULE		1970 CROP SCHEDULE	
		CROP	Date Planted	CROP	Date Planted
1	11.50	Grain Sorghum (Meloland)	21 Aug. '69	Corn (Salco)	14 Feb. '70
2	7.60	Castor Beans (Lynn Dwarf)	22 Aug. '69	Castor Beans (Lynn Dwarf) - Ratoon crop	1 Mar. '70

* See Site Map for location of field No's.

** Mz. = Manzana = 1.74 acres

FIGURA (FIGURE) 6-8



Sitio Nº 86 Site Nº 86

MINISTERIO DE AGRICULTURA Y GANADERIA
REPUBLICA DE NICARAGUA

PROYECTO ADELANTE

Uniconsult, Inc. Consultores
APARTADO 140 LEON, NICARAGUA
U.S.A.I.D. Cooperación

FINCA "STA. TERESA"

ING. R. ESCOBAR

6.82 - Crops, Yields and Cultural Operations

GRAIN SORGHUM - 11.5 manzanas

Cultural Operations

Variety:	Meloland
Planting date:	August 21, 1969
Row spacing:	30 inches
Seeding rate:	17 pounds per manzana
Fertilizer:	200 pounds 10-40-10 at first cultivation, 100 pounds Urea at second cultivation
Cultivation:	two times, one time by hand
Rainfall:	August 22-31, 6.5"; September, 12.0"; October, 26.8"; November, 11.0"
Harvest:	December 16, 1969
Yield:	1,000 pounds per manzana

The planting was made with an Allis Chalmers model G tractor with a 2-row Planet Jr. planter. The registered seed was planted at about one inch deep but grew well with the frequent rains. The hard rains did cause some erosion which took the plants out in several areas. Considerable erosion in October left the upper two-thirds between terraces with weak plants. These plants lodged after a windstorm.

Several specific areas in this field were stunted and expressed a chlorosis between the veins of the leaves. The symptoms were typical of zinc deficiency. Zinc was applied as a foliar spray with no results. Leaf samples were sent to a U.S. Soils Laboratory for analysis and the results indicated that the plants had a boron deficiency. By the time the results of this analysis were received, the plants were nearing maturity and too late for corrective measures. This field, although planted a day earlier than Site #13, was slower in flowering and maturity. In addition to the problem of excess erosion and boron deficiency, there were strong indications of nitrogen deficiencies especially in the northern part of the field.

An intensive bird patrol had to be established to keep the parakeets out of the field. There was less than 10% loss of seed from the birds.

The field was rogued of all off-type plants with the idea of possibly saving the seed for planting. Because the plants were lodged, the harvest was slow and difficult with considerable seed loss. The seed was damaged by the harvest and was not useable for planting stock. The attempt to ratoon was not successful because the lodging prevented a good job of chopping. Also the thin stand in areas made ratooning impractical.

CASTOR BEANS - 7.6 manzanas

Cultural Operations

Variety:	Lynn - dwarf internode
Planting date:	August 22, 1969
Row spacing:	34 inches

Seeding rate: 20 pounds per manzana

Fertilizer: 200 pounds 10-40-10 per manzana,
100 pounds Urea (47%) per manzana

Cultivation: two times, one hand weeding

Rainfall: August 22-31, 6.5"; September, 12.0"; October, 26.8"; November, 11.0"

Insect control: hand application of Sevin

Harvest: February 17, 1970

Yield: 2200 pounds/manzana (1260 pounds/acre)

A two-row inclined plate planter was used for planting. A passing rainshower delayed the planting for one day. The seedbed was compacted by the rain and an extra disking and floating were required.

The erosion from the heavy rains caused considerable loss of seed and plants. Otherwise the plants made satisfactory growth. The first spike (raceme) and the first two sets were completely destroyed by capsule mold. The capsules were attacked by Prodenia and the leaves were being eaten by the woolybear caterpillar. The field was sprayed by hand with Sevin.

The harvest was made by hand. Immediately after the harvest the castor stalks were cut at about 18 inches or just above the node with the lowest branch. The field was irrigated to refill the profile. The soil moisture in this field was not at Permanent Wilting Point as was the castor bean field at Site #13. The regrowth after ratooning was much more rapid in this field, supporting the observation that it is best not to deplete the soil moisture if a ratoon crop is planned. As of June 4, 1970, the ratoon crop had not been harvested and it was doubtful if it would be. The Nicaraguan Project Agronomist took samples and calculated a yield of 32 quintales per manzana for this second crop.

CORN - 11.5 manzanas

Cultural Operations

Variety: Salco

Planting date: February 14, 1970

Row spacing: 34 inches

Seeding rate: 30 pounds per manzana

Fertilizer: 150 pounds Urea (46%) per manzana at first cultivation

Weed and insect control were late and inadequate. Pump problems caused the plants to suffer from moisture stress. Fertilizer was applied late and no phosphate was applied at all. There was a good crop of roasting ears in late April, but they were not harvested and marketed in time. The Nicaraguan Project Agronomist took samples from 7,000 square feet and calculated the corn seed yield at 60 quintales/manzana.

NOTE: Aerial photographs of each full-time cooperator's farm are included in Appendix II. The photographs show the farm boundaries, kinds of soils and the Land Capability Classification of each farm.

Chapter 7

ECONOMIC EVALUATION

Chapter 7

ECONOMIC EVALUATION

7.0 - INTRODUCTION

Casual observation would indicate that rainfall is the most economical way of supplying water to crops. Much of the world's intensive agriculture, however, has been developed in areas of sparse rainfall, where water needed by the growing plants must be supplied by irrigation. Agricultural production which depends on rainfall must be adjusted to the rainfall pattern and the farmer must adjust his farming operations to fit this pattern.

However, under irrigated agriculture, with little or no rainfall during the growing season, the farmer can control the time and amount of water application and can coordinate the other operations necessary for production into a program which will produce top yields of high quality products. Where irrigation is a supplement to rainfall, or fills moisture needs independent of rainfall, it is justified only if the income from the additional yields obtained will cover the costs of irrigation.

The agricultural area of western Nicaragua is uniquely suited to irrigation development. Irrigation will allow, essentially, a year-around cropping program which will make maximum use of the land, machinery, labor, management, and other facilities which the farmers have. Irrigation would also contribute to more efficient use of the allied agri-business sector of the Nicaraguan economy, such as implement dealers, fertilizer manufacturers, seed suppliers, marketing channels, transportation facilities, and other businesses involved in supplying farms with their production needs and in marketing agricultural products. Growth in the agricultural sector would be multiplied many times in the total economy, reduce the need for imports of agricultural products, and contribute to a higher standard of living for the Nicaraguan people.

7.1 - IRRIGATION IN THE LEON-CHINANDEGA AREA

In the Leon-Chinandega area, numerous problems are associated with the weather pattern. Most of the rainfall comes during five months of the year. This means that non-irrigated crop production is limited to:

> crops that can be planted at the beginning of the rainy season and harvested after the bulk of the rain is over, and
>
> crops that can be planted and/or harvested during a rainy period.

In either case, there is a period of about six months during the year when the land, equipment, labor, and managerial ability of the farmer is not being used. The limited time periods during which crops can be harvested also means that there are wide fluctuations in prices for most products and particularly for perishables, such as fruits and vegetables. When the bulk of the supply comes on the market, prices are extremely low and increase when the supply is limited.

Introduction of irrigated agriculture into an area such as the Leon-Chinandega farming region has both physical and management requirements.

> From the physical standpoint, there must be a dependable supply of water available to the farmer which will be sufficient to

irrigate his land, and in addition, this water must be of high quality, so it will not harm the crops. It is also necessary to have adequate drainage when irrigation water is applied to an area. This probably will not be a major problem because natural drainageways have developed to take care of the rainfall. Fields must be sufficiently leveled however, so that there will not be low spots where irrigation water can stand.

From a management standpoint, there are two general aspects which must be considered. First, is the technical know-how to develop an irrigation system which will supply water in the correct amount, and at correct intervals so that the crops can be grown during the hot, dry season. On the other hand, irrigated agriculture permits a much higher level of management than is found in most non-irrigated areas. The manager can determine the optimum amount of water to apply and when to apply it. He can coordinate the fertilizer applications, both as to amount and timing. He can establish schedules for spraying, cultivating, weed-control and the other management operations to fit in with the irrigation program. In this way he can maximize yields at the lowest unit cost.

Irrigation offers possibilities for introducing new crops and/or increasing the yield of those crops which have been grown in the area previously. After taking into consideration problems such as keeping the harvest period out of the rainy season and away from periods when birds are present in large numbers, it would be possible to work out a twelve-month cropping program for most of the area.

Development of irrigation in a new area always creates problems in marketing. The marketing structure is not set up to handle the crops at the time they may be harvested under irrigation, or may not be developed to handle the crops that will be grown under irrigation. Farmers going into irrigated agriculture for the first time will have to spend considerable time developing markets for their product, making arrangements with buyers to take the product when it will be available, and establishing a price which will be satisfactory to both the buyer and the seller. Since agriculture under irrigated conditions can be regulated with a fair degree of reliability, it is possible for the grower to contract with the buyer to supply a given quantity of a product at a given time.

Analysis of the potential income and expenses connected with crops that can be grown in the Leon-Chinandega area indicate a definite potential for more vegetable production. Vegetable production requires more management and involves more risk than most of the common field crops. However, there is high potential for economic gain with vegetable crops, and growers who do a good job with production and marketing could find these crops very profitable. In other sections of this report detailed information is given on possible crops for the area and conditions involved with their production, including estimated income and costs.

Marketing channels are essential to not only new crops which have not been grown in the area, but also expanded production of crops which have been produced previously. For some of the non-perishable crops such as grain, storage facilities will be necessary to prepare the grain for such storage. It will also be necessary for new machinery to be developed or introduced into the area since many of the crops will need specialized equipment not now available. Such machinery will include bedding and planting machines, in addition to cultivating, spraying and harvesting equipment.

7.2 - SCOPE OF PROJECT ADELANTE ACTIVITIES

Project Adelante was established for the purpose of demonstrating the feasibility of irrigated agriculture in the Western part of Nicaragua. In order to do this it was necessary to initiate a large number of activities which included:

- development of water supplies
- determining crops which would be profitable in the area
- determining varieties which are adaptable
- establishment of management practices
- obtaining machinery
- training of managers
- finding market outlets
- developing the economic data necessary for evaluating such a project

This section of the report concerns itself with the last activity listed which is the development of economic data to be used in evaluation of Project Adelante. The development of this information was done in the following manner:

> Discussions were carried on with the cooperators concerning the manner in which they carried out farm operations. Detailed information was gathered from them in these discussions by the Ag-Economist. This included: the kind of management that was provided by owner or by some other designated person, the amount of labor that was used in the operation, the various amounts and types of farm equipment owned by the farmer, the kinds of operations this equipment was used for, and the number of hours and costs for these operations.
>
> In addition to these discussions with the cooperators, there were records kept of all of the operations carried on in the cropping programs which included the number of people involved, the equipment used, the number of hours, and the amount of land. Records also included the materials such as seed, fertilizer, water, etc., that were used.

Initially it was hoped that these records could be kept by the farmer or his foreman, but because this was a new experience to most of the cooperators, it soon became apparent that it was necessary for Project personnel to maintain the records of this information by making continual calls on the cooperators and getting the information from the owner or the farm foreman. However, it was not possible for the project staff to maintain daily records of all inputs and revenues. It had been planned to assign a Nicaraguan agricultural economist to this work as a primary task, but one was not available to the project until July 1969. Consequently, it was not possible to accumulate the records as a full-time accountant might do on a large corporate farm.

Furthermore, many of the practices were not performed as or when needed, as described in Chapter 6, for multiple reasons. As a result, the economic data compiled for the various crops is very similar to that collected and evaluated by extension economists in the United States. It is valid, and representative, but, except for a very few cases, it is not the actual experience of any single farm.

7.3 - COSTS OF AGRICULTURAL PRODUCTION

7.31 - Analysis of Irrigation Costs and Machinery Costs

Many of the economic costs faced by farmers are non-cash, at least in the short run. The farmer who owns his own land does not consider rent as an expense, but instead, is interested in the return on the investment he has in the land. Likewise, he does not consider a value on the management he puts into the operation but looks to the profit to reimburse him for his effort. Depreciation on machinery, irrigation systems, and other capital items is a non-cash annual cost, but is a cash cost when the item has to be replaced. Interest on the farmer's investment is not a cash cost unless he has borrowed the money and is paying interest on a loan. We have charged interest on the investment as an economic cost because if the farmer has his own money invested in the operation, he is foregoing investing it in another opportunity and presumably earning a return on that investment.

7.32 - Irrigation Costs

Successful and economical irrigation requires the use of irrigation practices suitable to the soil, the crop being grown, and the climatic conditions of the area. No one method of irrigation will suit all locations and the system must be designed to fit the conditions of the site.

The costs of irrigation consist of:

Investment on which depreciation and interest must be charged.

Water - either power for pumping or the cost of delivering gravity water to the site.

Repairs to the irrigation system.

Labor of applying water.

Land preparation for more efficient water application, such as land-planing, furrowing and ridging.

Water is the primary cost involved in irrigation. But application costs can be fairly high with sprinklers when you include the power cost to put the water under pressure, such as with a sprinkler system, the water application costs rise considerably.

Power requirements are a direct result of the amount of water pumped. Costs decrease per unit of water as a larger volume is pumped, as a result of the graduated power cost schedule.

Investment costs per manzana as well as operation costs, decrease as more land is irrigated from a given installation, up to the capacity of the water supply.

Labor costs per manzana would be fairly uniform, regardless of size of operation, except that costs will be higher where the water flow is small.

Repair costs are largely influenced by the hours the pump and other facilities are in operation and are not affected much by size of operation.

Investment

The investments involved will depend on the method of irrigation, but basically will consist of the following: well, pump, powerline, and sprinkler system. A flood system will not have an investment in a sprinkler system, but would have land leveling and ditch or pipeline costs.

The investments experienced by cooperators in Project Adelante are shown in Table 7-1.

Table 7-1

CAPITAL INVESTMENTS FOR IRRIGATION

PROJECT ADELANTE COOPERATORS

				Pump		Total Investment in Cordobas			
No.	Mz. Irri.	Well Depth Feet	Pumping Lift Feet	GPM	HP	Well & Pump	Power Line	Sprinkler	Total
4	11	Spring	65*	450	13	9,500	Diesel	36,390***	45,890
8	20	160	30	300	20	41,350	8,224	24,430	74,004
13	16	248	175	330	40	55,000	15,000	27,014	97,014
50	52.5	258	57	1370	40	51,250	16,000	-	69,250
50	12.5	Booster	-	300	15	5,959	-	31,353	36,701
62	20	200	76	300	25	46,000	15,634	-	61,634
86	19	240	140	600	60	68,500	13,595	26,773**	108,868

* Total Dynamic Head

** Only for 20 mz., total for 40 mz. = ₡ 41,252

*** Gated Pipe

Investments per manzana for sprinkler irrigation systems only can be summarized as follows: (See Table 7-2).

	High	Low	Average
Wells and pumps	₡ 3,605	₡ 1,453	₡ 2,572
Sprinkler system	2,508	1,278	1,720
Power line	938	305	630
Total System[1/]	₡ 6,064	₡ 3,757	₡ 4,922

In most cases the well and pump were included in one contract and no distribution was given. Wells vary from 160 to 258 feet in depth. Pump sizes vary from 300 to 1,370 gpm. Electric motor sizes vary from 15 to 60 HP.

[1/] The individual items may not add to the total because no individual farmer was either high or low for all items.

Investment Costs

Depreciation rates were established at 20 years on the wells, pumps, and power lines and seven years on the sprinkler system.

Interest is calculated at 10 percent of half the original cost since the investment depreciates from full cost to zero over its lifetime. This process gives an average annual cost over the life of the item.

Sprinkler Irrigation Systems

Annual Cost per Manzana

	High	Low	Average
Depreciation	$ 470	$ 306	$ 413
Interest	303	188	248
Total System	$ 763	$ 494	$ 661

The annual depreciation and interest costs per manzana for each of the cooperator sites are presented in Table 7-2.

Table 7-2

ANNUAL DEPRECIATION AND INTEREST COSTS PER MANZANA FOR IRRIGATION EQUIPMENT FOR PROJECT ADELANTE COOPERATORS

Cordobas per Manzana

Cooperator Number	Well & Pump	Power-line	Sprinkler	Investment Total	Depre-ciation	Interest
4 - Cost	864.00*	-	3,308.00**	4,172.00	-	208.60
- Depr.	86.40	-	330.80	-	417.12	-
8 - Cost	2,068.00	411.00	1,278.00	3,757.00	-	187.85
- Depr.	103.40	20.55	182.55	-	306.50	-
13 - Cost	3,438.00	937.50	1,688.40	6,063.90	-	303.20
- Depr.	171.60	46.90	241.20	-	459.70	-
50 - Cost	1,452.80	304.80	2,508.20	4,265.80	-	213.30
- Depr.	96.30***	15.25	358.30	-	469.85	-
62 - Cost	2,300.00	782.00	-	-	-	-
- Depr.	115.00	39.10	-	-	-	-
86 - Cost	3,605.00	715.50	1,409.10	5,729.60	-	286.50
- Depr.	180.25	35.75	201.30	-	417.30	-

*Pump installed by Spring. No well.

**Gated Pipe for surface irrigation. 10-yr. depreciation.

***Well & Pump allocated to 52.5 mz. Booster Pump allocated to 12.5 mz.

Power for Pumping

The power requirements for pumping irrigation water depend largely on the height which the water has to be lifted and on the efficiency of the irrigation system. The amount of water pumped, either gallons per minute or total gallons pumped, have little effect on the cost per unit of water except in the case of electricity where the cost per kilowatt hour decreases as more energy is used.

Electric power costs for pumping may be computed for various conditions by using the following formulas:

Efficiency of pumping plant = Efficiency of motor X Efficiency of pump

Example -

Efficiency of motor = 80%
Efficiency of pump = 70%

Efficiency of pumping plant = .80 X .70 = 56%

Power required to pump one manzana inch

$$\text{Kilowatt hours per manzana inch} = \frac{.14848 \text{ X lift or head in feet}}{\text{Efficiency at pumping plant}}$$

Example: Lift of 125 feet, Plant efficiency 56%

$$\text{Kilowatt hours per manzana inch} = \frac{.14848 \text{ X } 125}{.56} = 33.15$$

The constant .14848 has been arrived at by translating from kilowatt hours per acre foot as follows:

$$\text{Kwh/ac. ft.} = \frac{\text{Head (feet) X cu. ft./ac. ft. X lbs./cu.ft. X Kw/HP}}{\text{Efficiency of pumping plant X one HP X 60 minutes}}$$

One HP = 33,000 ft. lb./minute

$$= \frac{\text{Head X 43,560 cu.ft. X 62.438 lb. X .7457 Kw}}{\text{Efficiency X 33,000 X 60}}$$

Let Head = 1 foot and Efficiency = 100% (1.00), then the formula becomes -

$$= \frac{43{,}560 \text{ X } 62{,}438 \text{ X } .7457}{33{,}000 \text{ X } 60}$$

$$= 1.024$$

Substituting in the original formula given:

$$\text{Kwh/ac. ft.} = \frac{\text{Head (feet) X 1.024}}{\text{Efficiency of pumping plant}}$$

$$\text{Kwh/mz. in.} = \frac{\text{Kwh/ac.ft. X ac./mz}}{\text{12 inches}}$$

Let Head = 1 foot and Efficiency = 100% and the formula becomes -

$$= \frac{1.024 \times 1.74}{12}$$

$$= .14848$$

Therefore: $\text{Kwh/mz.in.} = \frac{\text{Head (feet)} \times .14848}{\text{Efficiency of pumping plant}}$

Lift normally refers to the distance between the water level during the time the pump is running and the pump discharge. Head is synonymous with lift but may also include the equivalent of 100 - 120 feet of lift required to put water under pressure for a sprinkler system.

Head may also refer to the amount of water flow such as gallons per minute.

Example of electric power costs

Assume a pump producing 800 gpm with a 120 foot head pumping 3,600 manzana inches and a 60% pump efficiency

Kwh required:

$$\text{Kwh per manzana inch} = \frac{.1485 \times 120}{.60} = \frac{17.82}{.60} = 29.7$$

Total Kwh for 3600 manzana inches = 29.7 X 3600 = 106,920

Therefore, using the ENALUF power schedule shown in Table 7-3, the power cost would be as follows:

1,000 Kwh	@ $ .14 =	$ 140.00
9,000 Kwh	.13 =	1,170.00
15,000 Kwh	.12 =	1,800.00
25,000 Kwh	.11 =	2,750.00
50,000 Kwh	.10 =	5,000.00
6,920 Kwh	.09 =	622.80
106,920 Kwh		$11,482.80

Cost per mz. inch = 3.19

TABLE 7-3

ENALUF AGRICULTURAL POWER SCHEDULE R-1

First	1,000 Kwh @	$ 0.14 Kwh
Next	9,000 Kwh @	0.13 Kwh
Next	15,000 Kwh @	0.12 Kwh
Next	25,000 Kwh @	0.11 Kwh
Next	50,000 Kwh @	0.10 Kwh
Over	100,000 Kwh @	0.09 Kwh

Minimum of $ 28.00 per month

Actual power bills were obtained for two cooperators who had irrigated crops during 1969. These power costs are shown in Table 7-4.

TABLE 7-4

ACTUAL ANNUAL IRRIGATION POWER COSTS

FOR TWO PROJECT ADELANTE COOPERATORS

Cooperator Site Number	Total Kwh	Total Cost	Mz. In. Pumped	Per Mz. In.	
				Kwh	Cost
No. 8	22,929	$3,603	612.4	37.4	$5.88
No. 50 [1]	12,578	1,599	263.6	47.7	6.06

Electric Power Costs for Pumping Irrigation Water: Nicaragua vs. California

A direct comparison between Nicaraguan power costs as charged by ENALUF and those in California is impossible because the major power companies in California, namely Pacific Gas and Electric Company (PG&E) and Southern California Edison Company, have a demand charge which is based on horsepower and is a fixed amount for the year regardless of the amount of electrical energy used. ENALUF charges only on kilowatt hours or energy used.

Agricultural power schedules for ENALUF have been given above whereas California power schedules are presented in Tables 7-5 and 7-6 for two major power companies in California.

TABLE 7-5

PG&E AGRICULTURAL POWER SCHEDULE PA - 1

Connected Load hp	Annual Service Charge per hp	Energy Charge in Addition per Kwh		
		First 1000 kwh per hp	Next 1000 kwh per hp	All over 2000 kwh per hp
2-4.9	$61.81	$.1295	$.0637	$.0455
5-14.9	52.22	.1113	.0637	.0455
15-49.9	47.11	.1043	.0637	.0455
50-99.9	41.93	.0966	.0637	.0413
100-249.9	36.82	.0931	.0637	.0413
250-499.9	36.82	.0896	.0637	.0413
500-999.9	35.35	.0854	.0637	.0413
1000-2499.9	33.11	.0854	.0637	.0413

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[1] 50% of power bill charged to sprinkler, balance to flood irrigation.

TABLE 7-6

SOUTHERN CALIFORNIA EDISON COMPANY SCHEDULE NO. PA -1

Horsepower of Connected Load	Service Charge per hp. per year	Energy Charge in Addition per Kwh		
		First 1000 kwh per hp. per year	Next 1000 kwh per hp. per year	All over 2000 kwh per hp. per year
2 to 4.9	$63.00	$.140	$.0595	$.0413
5 to 14.9	56.00	.126	.0595	.0413
15 to 49.9	52.50	.119	.0595	.0413
50 to 99.9	49.00	.112	.0595	.0413
100 and over	45.50	.105	.0595	.0413

TABLE 7-7

ELECTRIC POWER COST

FOR PUMPING IRRIGATION WATER

ENALUF

POWER SCHEDULE

Cordoba Per Manzana Inch
Based on 50% Overall Pumping Plant Efficienty

Manzana Inches Pumped	Total Lift in Feet					
	25	50	100	150	200	300
250	1.00	1.97	3.90	5.79	7.57	11.13
500	.98	1.95	3.78	5.57	7.25	10.52
1,000	.95	1.89	3.63	5.26	6.80	9.77
2,500	.94	1.78	3.31	4.75	6.09	8.76
5,000	.89	1.66	3.05	4.38	5.72	8.39
10,000	.83	1.52	2.86	4.20	5.53	8.20
20,000	.76	1.43	2.77	4.10	5.46	8.11

It would be impossible to give the electrical power costs for all possible combinations of lift, size of pump and total amount of water pumped. Therefore, we are using three assumed pumping situations to illustrate the differences on power costs between Nicaragua and California.

First - a pump producing 450 gallons per minute with a 50-foot head pumping 2,000 manzana inches of water per year and a 60% pumping plant efficiency.

Second - a pump producing 800 gallons per minute with a 120-foot head pumping 3,600 manzana inches per year and a pumping plant efficiency at 60%.

Third - a pump producing 1,200 gallons per minute with a 200-foot head pumping 6,000 manzana inches per year and a 60% pumping plant efficiency.

Electrical power costs for pumping irrigation water under these three situations are as follows:

	No. 1		No. 2		No. 3	
	Cordoba per mz. in.	%	Cordoba per mz. in.	%	Cordoba per mz. in.	%
ENALUF	1.54	100	3.19	100	4.76	100
PG&E	1.25	81	2.73	86	3.89	82
So. Cal. Edison	1.30	84	2.87	90	4.17	88

The figures given above would indicate that Nicaraguan power costs are 10-20 percent higher than those in California, depending on the situation under which the water is pumped.

Details of Calculations

Illustration No. 1

Pump producing 450 gpm with 50-foot head pumping 2,000 manzana inches per year and a 60% plant efficiency.

ENALUF

$$\text{Kwh} = \frac{.1485 \text{ X } 50}{.60} = \frac{7.425}{.60} = 12.38$$

Total kwh = 12.38 X 2.00 = 24,760

Power cost -	1,000 kwh @	$ .14	$ 140.00
	9,000 kwh @	.13	1,170.00
	14,760 kwh @	.12	1,771.20
	24,760 kwh		$ 3,081.20 for 2,000 mz. inches

Cost per manzana inch $ 1.54

PG&E

$$HP = \frac{450 \text{ X } 50}{3960 \text{ X } 60} = \frac{22,500}{2,376} = 9.1$$

Power cost - Service charge	10 HP @ 52.22	$ 522.20
Energy	10,000 kwh @ 11.13¢	1,113.00
	10,000 kwh @ 6.37¢	637.00
	4,760 Kwh @ 4.55¢	216.58
	24,760 kwh	$2,488.78 for 2,000 mz. inches

Cost per manzana inch $1.25

Southern California Edison

Power cost - Service charge	10 HP @ $56.00	$ 560.00
Energy	10,000 kwh @ 12.60¢	1,260.00
	10,000 kwh @ 5.95¢	595.00
	4,760 kwh @ 4.13¢	196.59
	24,760 kwh	$2,611.59 for 2,000 mz. inches

Cost per manzana inch $1.30

Illustration No. 2

Pump producing 800 gpm with 120-foot head pumping 3,600 manzana inches per year and a 60% plant efficiency.

ENALUF

$$Kwh = \frac{.1485 \text{ X } 120}{.60} = \frac{17.82}{.60} = 29.7$$

Total Kwh = 29.7 X 3600 = 106,920

Power cost -	1,000 kwh @ $ .14	$ 140.00
	9,000 kwh @ .13	1,170.00
	15,000 kwh @ .12	1,800.00
	25,000 kwh @ .11	2,750.00
	50,000 kwh @ .10	5,000.00
	6,920 kwh @ .09	622.80
	106,920 Kwh	$11,482.80 for 3,600 mz. inches

Cost per manzana inch $3.19

PG&E

$$HP = \frac{800 \text{ X } 120}{3,960 \text{ X } .60} = \frac{96,000}{2,376} = 40.4$$

Power cost - Service charge	40 X	$47.11	$1,884.40	
Energy	40,000 kwh @	10.43¢	4,172.00	
	40,000 kwh @	6.37¢	2,548.00	
	26,920 kwh @	4.55¢	1,215.76	
	106,920 kwh		$9,820.16	for 3,600 mz. inches

Cost per manzana inch $2.73

Southern California Edison

Power cost - Service charge	40 X	$52.50	$2,100.00	
Energy	40,000 kwh @	11.90¢	4,760.00	
	40,000 kwh @	5.95¢	2,380.00	
	26,920 kwh @	4.13¢	1,111.80	
	106,920 kwh		$10,352.80	for 3,600 mz. inches

Cost per manzana inch $2.87

Illustration No. 3

Pump producing 1200 gpm with 200-foot head, pumping 6,000 manzana inches per year and 60% plant efficiency.

ENALUF

$$\text{Kwh} = \frac{.1485 \times 200}{.60} = \frac{29.7}{.60} = 49.5$$

Total Kwh = 49.5 X 6,000 = 297,000

Power cost -	1,000 kwh @	$ .14	$ 140.00	
	9,000 kwh @	.13	1,170.00	
	15,000 kwh @	.12	1,800.00	
	25,000 kwh @	.11	2,750.00	
	50,000 kwh @	.10	5,000.00	
	197,000 kwh @	.09	17,730.00	
	297,000 kwh		$28,590.00	for 6,000 mz. inches

Cost per manzana inch $4.76

PG&E

$$\text{HP} = \frac{1200 \times 200}{3960 \times .60} = \frac{240,000}{2,376} = 101$$

Power cost - Service Charge	100 HP @	$36.82	$ 3,682.00	
Energy	100,000 kwh @	9.31¢	9,310.00	
	100,000 kwh @	6.37¢	6,370.00	
	97,000 kwh @	4.13¢	4,006.10	
	297,000 kwh		$ 23,368.10	for 6,000 mz. inches

Cost per manzana inch $3.89

Southern California Edison

Power Cost -	Demand Charge 100 HP @45.50	$ 4,550.00
	Energy 100,000 kwh @ 10.50	10,500.00
	100,000 kwh @ 5.95	5,950.00
	97,000 kwh @ 4.13	4,006.10
	297,000 kwh	$ 25,006.10 for 6,000 mz. inches

Cost per manzana inch $4.17

Repairs

The cost of repairs for an irrigation system will depend on several factors: cleanliness and purity of the water; age of the equipment; presence or absence of corrosive materials in the water; the care given the equipment.

The repairs to wells and pumping plants are usually minor, except for unusual situations and would be minor when distributed on a manzana basis over the lifetime of the equipment.

Repairs to sprinkler systems can be expensive and should be budgeted for at the rate of about 1 - 2% of the original cost per 100 hours of use.

For example a sprinkler system costing $2,500 per manzana used for five irrigations at 11 hours each,might have repair costs of

$\$2,500 \text{ X } .015 \text{ X} \frac{55}{100}$ = $20.60 repair costs per manzana per year, or 37.5 centavos per hour

Labor

Minimum labor required to move sprinklers is about as follows:

Assume a system covering 20 manzanas on a nine-day cycle; operating 11 hours per setting; using two men to move pipe.

2 men for 1 hour twice a day for 9 days = 36 hours

moving to other end of field every nine days -

2 men for 4 hours = 8 hours

Total hours 44

Hours per manzana per irrigation 2.2

Additional labor would be required to clean nozzles, make minor adjustments, replace sprinklers that have worked loose, and otherwise keep the system operating.

Analysis of the labor records of Project Adelante cooperators indicates that they usually have irrigators working full time and their labor costs for sprinkler irrigation are on the basis of 5 to 15 hours per manzana per irrigation.

Labor for a flood irrigation system will depend on the head of water used (gallons per minute), the slope of the land, type of soil, and other factors. With a good surface irrigation system, labor is usually about half of that required for a sprinkler system. Under poor flood irrigation conditions, labor cost might exceed that required for sprinklers. Even with full time irrigators, labor for flood irrigation would normally be less than with sprinklers because of the larger head of water which can be used.

Land Preparation

The costs of land preparation to increase the efficiency of production are largely connected with surface irrigation and will vary with the soil, slope, types of crops being grown, and the amount of soil preparation performed. In most flood irrigated areas, it is necessary to level the land before efficient irrigation can be undertaken. Land leveling costs in California vary from $1200 to $1800 per manzana, but this is a one-time cost and with proper management will not need to be releveled except for an occasional touch-up.

Flood irrigated land must usually be landplaned every 2 - 3 years to maintain proper grade. Usual landplaning consists of going both directions across the field and often a third diagonal pass is made. Flood irrigation water must also be controlled by ridges or furrows. Furrows are usually used with row crops and are made in conjunction with a cultivation so little extra expense is involved. Making ridges is an inexpensive operation, because of the small number required on a properly leveled and prepared field.

7.4 - SPRINKLER VS. FLOOD IRRIGATION

Although costs are usually a major determining factor, there may be other factors at a particular location which limit the selection to one of the two systems. The water needs of the plants can be supplied equally well by sprinkler or flood irrigation. There is no advantage of either system as far as method of water application is concerned or the availability of water to the plants.

Sprinklers have the advantage of being usable on most terrain and usually have a higher efficiency in the use of water. Deep penetration beyond the root zone and excess run-off can be prevented. Sprinklers may be the only practical system where there is only a small flow of water available, or on sandy soils with rapid penetration. Sprinklers are also useful where a surface accumulation of salt needs to be washed below the seed zone so the crop can germinate.

Sprinklers have the disadvantage of requiring the equivalent of 100 feet or more of lift to put the water under pressure to operate the sprinklers. This increases the power cost substantially over that required for most flood systems. There is a relatively large investment in the sprinkler system with the accompanying costs of depreciation, interest, and repairs. The amount of labor required is usually higher than with flood irrigation, and the sprinklers are subject to breakage, plugging, and other inconveniences which increase the cost of operation and contribute to unequal distribution of water. High winds can be a problem in obtaining good water distribution and contribute to high evaporation which decreases the efficiency of the system.

The advantages of flood irrigation are basically lower power costs (if the water is pumped). A larger flow of water can be handled which reduces the time required for irrigation or the amount of labor needed, and more water can usually be put on at a time if the soil capacity and the depth of the crop root system can make use of the deeper water penetration.

The disadvantages of flood irrigation are the need for relatively level land, a lower irrigation efficiency because of deep penetration below the root zone and a loss of tail water at the lower end of the field.

In general, flood systems of irrigation are more economical than sprinklers. There may be conditions however, where flood systems are not practical, but sprinklers are. The profit position of the crops being grown in these situations will determine whether a sprinkler system should be installed. In the major irrigated regions of the world, flood application is most prevalent because of its economy. Sprinklers are used on high value crops where frequent, but light irrigations are required or on sloping or rough terrain which cannot be flood irrigated.

The following example compares the relative costs of sprinklers and flood irrigation on:

a 20-manzana plot with

a 250-foot well,

a 150-foot pumping lift and irrigation 20 times per year,

with a 60 percent pumping plant efficiency.

7.41 - Sprinkler Irrigation System

Pumping lift 150 feet plus 100 feet for sprinkler
Apply 3.7" per irrigation
Irrigation efficiency 70%

Investment		Total Cost	Annual Cost	
			Depreciation	Interest %
Well	250' at $110	$27,500	$1,375	
Pump	40 HP	28,000	1,400	
Sprinkler system		27,200	3,886	
Powerline		13,000	650	
Total		$95,700	$7,311	$4,780
Per manzana		4,785	366	239

Power Cost

Water at 3.7 inches for 20 times on 20 manzanas = 1,480 mz. in.

$$\text{Kwh per mz. in.} = \frac{.14848 \times 250}{.60} = 61.87$$

Total Kwh = 61.87 X 1,480 = 91,568

Power Cost

1,000	Kwh at .14	$ 140
9,000	Kwh at .13	1,170
15,000	Kwh at .12	1,800
25,000	Kwh at .11	2,750
41,586	Kwh at .10	4,157
91,568		$10,017

Total Annual Cost

Depreciation	$ 7,311
Interest	4,780
Repairs sprinkler system 1% per 100 hrs., 3960 hrs.	108
Power	10,017
Labor 8 hrs. per mz. per irrig. - 3200 hrs.	3,200
Miscellaneous 5%	1,270
Total	$26,686
Per manzana	1,334
Per net mz.-in.	25.6

7.42 - Flood Irrigation System

Apply 4.3 inches per time
Irrigation efficiency 60%

Investment	Total Cost	Annual Cost Depreciation	Annual Cost Interest %
Well 250' at $110	$27,500	$1,375	
Pump	24,000	1,200	
Powerline	13,000	650	
Leveling	1,200	-	
Total	$65,700	$3,225	$3,285
Per manzana	3,285	161	164

Power Cost

Water at 4.3 inches for 20 times on 20 mz. = 1,720 mz. in.

Kwh per mz. in = $\frac{.14848 \text{ X } 150}{.60} = 37.12$

Total Kwh = 37.12 X 1,720 = 63,846

Power Cost

1,000	Kwh at .14	$ 140
9,000	Kwh at .13	1,170
15,000	Kwh at .12	1,800
25,000	Kwh at .11	2,750
13,846	Kwh at .10	1,385
63,846		$ 7,245

Total Annual Cost

Depreciation		$ 3,225
Interest		3,285
Power		7,245
Labor 4 hrs. per mz. per irrig. - 1,600 hrs.		1,600
Ditch		400
Furrow 5 X at 40		200
Miscellaneous 5%		798
	Total	$16,753
	Per manzana	838
	Per net mz.-in.	16,10

7.43 - Summary of Irrigation Costs

	Sprinklers	Flood
Investment per manzana	$ 4,785	$3,285
Annual cost per manzana	$ 1,334	$ 838
Cost per net manzana-inch	$ 25.6	$ 16,1

7.44 - Machinery Costs

The development of machinery operating costs is based on using an average repair cost over the useful life of the machinery. Repairs do not occur at a uniform rate each year and tend to change with the age of the machinery and farmers also have a tendency to lump all repair costs together and not allocate to the machine involved. It is therefore necessary to develop standards of costs which meet these criteria. Such costs for commonly used equipment in Project Adelante as developed from various sources are given in Table 7-8, plus other information necessary in calculating costs and determining efficiency of operation. These costs will have to be adjusted as additional information is developed in the Project area and as economic conditions change.

7.5 - COSTS OF PRODUCTION FOR CROPS GROWN IN PROJECT ADELANTE

7.51 - Introduction

Costs were developed for potential crops which could be grown in project Adelante. These costs were based on local data, management practices for the crops in other areas, knowledge that Project personnel had of the crops, and on other available information. These costs were developed for crops grown during the dry season except for those which require more than six months to mature and part of their growth would have to be during the rainy season. Costs were also developed for those crops which have been grown on the demonstration farms and a summary of these costs is compared with the costs described above.

7.52 - Definition of Costs

The costs which have been developed cover all inputs of production, whether cash or non-cash. The presentations give a breakdown between cash and non-cash costs which will fit most producers.

TABLE 7-8

MACHINERY COST AND PERFORMANCE

All Costs in Cordobas

Machine	Size	Price	Crew	Size of Tractor	Speed KPH	Field Effi-ciency	Hours[2] per Manzana	Life		Cash Cost per Hour		
								Years	Hours	Fuel[3]	Repairs	Total
	[1]										Cordoba	[4]
Tractor - wheel, diesel	30hp	40,000	--	--	--	--	--	7	10,000	3.20	8.10	11.30
	40hp	60,000	--	--	--	--	--	7	10,000	4.20	10.90	15.10
Chopper	1.5m	7,000	1	40	8.3	60	1.5	7	2,000		4.20	
Cotton Harvester	2 row	170,000	1	SP	2.5	70	1500 lb seed cotton/ hr.	5	3,000	4.40	50.00	54.40
Cotton Trailer	7 ton	8,000	--	--	--	--	3.0	7	10,000		2.00	
Combine SP with Corn Header attachment	3.3m	140,000	3-4	SP	2.6	80	1.0	7	2,000	5.00	42.70	47.70
Cultivator - 36" rows	2 row	7,600	1	20	4.0-8.5	70-80	.5-1.4	7	2,000		2.80	
36" rows	4 row	10,500	1	30	4.0-8.5	70-80	.3-.7	7	2,000		7.00	
Drill	3.6m	7,000	1-2	20	6.5	55	.5	7	2,000		12.20	
Fertilizer Attachment	2 row	2,800	1-4	30	5.6	50-60	1.3	7	2,000		1.80	
	4 row	4,100	1-4	30	5.6	50-60	.7	7	2,000		2.75	
Fertilizer Spreader	3 m	3,000	1-2	30			.6	7	2,000		2.80	
Disk Harrow	3 m	6,000	1-2	30	5.3	70	.6	7	2,000		7.00	
" "	3.7 m	9,800	1-2	40	5.3	70	.5	7	2,000		11.40	
Mower	2.1 m	4,000	1	20	8.5	75	.5	7	2,000		8.50	
Planter - 36" rows	2 row	4,800	1-2	30	3.5	50	2.2	7	2,000		4.20	
	4 row	6,300	1-2	30	3.5	50	1.1	7	2,000		7.00	
Plow, Disc	4 disc 1.5 m	6,300	1-2	30	5.6	75	1.1	7	2,000		8.40	
" "	4 disc	9,800	1-2	40	5.6	75	1.0	7	2,000		13.00	
Rake, Side delivery	2.4 m	6,000	1	20	7.7	75	.5	7	2,000		4.40	

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[1] Tractors listed at 75% of maximum drawbar horsepower.

[2] Manzana per hour = $\frac{\text{kilometers/hour x width (meters) x percent efficiency}}{690}$.

Hours per Manzana = $\frac{1}{\text{Hours per Manzana}}$ Manzana = 1.74 acres.

[3] Diesel @ $ 1.60/gallon

[4] Based on 7 Cordobas per Dollar

The irrigation costs are based on a sprinkler system for 20 manzanas. This system will apply .335 inches of water per hour or 3.7 inches during a normal 11-hour set. Pumping costs are based on a total lift of 200 - 250 feet which would put the water under pressure for the sprinkler system.

Labor - whether hire or within the family. The labor charge includes wages, food, housing, and other prerequisites furnished hired labor.

Cash expenditures

Fuel and repairs for the tractor and equipment
Power for pumping irrigation water
Seed at local cost
Fertilizer delivered to the ranch
Cash cost of custom operations
Spray materials
Other supplies
Miscellaneous overhead

Rent for the land at current rates even though the farmer may own the land.

Management allowance for the operation at 5% of the gross income.

Depreciation on the irrigation system and the machinery at acceptable years of life. Interest on the investment in the irrigation system and the machinery calculated at 10 percent on half the original cost.

Income prices are based on published information of the Ministry of Agriculture, information from budgets of the National Bank of Nicaragua, or estimates based on existing prices in the area.

The farm credit system needs revision for handling new crops and year-around farming with irrigation. Existing loan policies are largely based on cotton and cattle with little or no provision for loans on other agricultural enterprises. Project Adelante has been concerned only with crops, so we can ignore for the moment, loan policies on livestock. Crop loans are usually made on percentage of the expected gross income with the yield based on an industry average.

Sources of credit for the farmers include the Banco Nacional de Nicaragua, the private banks and the various agri-businesses. Most machinery purchases, for example, are financed by implement companies. A typical machinery loan requires 35 percent down with the balance on a three-year period with 14 percent interest and $10,000 maximum. Chemical companies vary in their credit policies but normally will give credit only under special situations.

Bank interest charges run 9 percent plus 2 percent commission, both payable in advance, which gives an effective interest rate of 12.4 percent.

Needed improvements in the credit system include the following:

Provision for loans on new crops and other agricultural enterprises.
Loans based on the farmer's ability to produce rather than on an industry average.
Loans based on the needs and repayment capacity of the borrower rather than on a maximum per farmer.

Interest charges on the time the farmer uses the money rather than advance payment

7.53 - Summary of Income and Cost

In Tables 7-10 through 7-41, one-page summaries are presented of the various agronomic and irrigation inputs and practices, and costs, for the crops for which reasonably reliable data were obtained, or could be deduced from related data. Some of these, such as cotton and potatoes, were not grown as part of the Adelante crop programs, but were included because of their potential importance, or because of special interest expressed in their potential. Summaries for such non-project crops reflect project experience and costs with similar operations, combined with knowledge of good irrigation management practices utilized where such irrigated crops have been grown elsewhere for several years. As stated earlier in this Chapter, the projected costs are representative, but the actual experience of every farmer, and of every crop year, would reveal individual differences in many items listed. The average result, though, could be expected to be about as shown.

Attention is invited to the following regarding costs.

a) Irrigation Water. Surface irrigation is assumed for castorbeans, and an alternative for surface irrigation is given for pastures. It will be noted that power costs for surface irrigation, for the conditions assumed, are 4.8 cordobas/mz-in. as compared to 7.5 cordobas/mz-in. for sprinkler irrigation, because less pumping lift is required. Other crop irrigation pumping costs would be reduced by the same amount, about 36 percent, if surface irrigation is used.

b) Combining Costs. Actual combining costs for Project Adelante were as much as 3 times greater than the rates used. This is understandable in that the combine owner rented his machine to harvest only a few manzanas. It is unrealistic to use such costs in these sample studies. Combining costs used are about one-third greater than California contract combining costs.

c) Haul. Costs shown are intended to cover hauling out of the field and to the nearest market. In the case of grains, a market or storage elevator was assumed to exist in the Leon-Chinandega area. For vegetables it was assumed that the produce would be hauled to Managua.

Table 7-9 summarizes production costs, and gives a comparison with possible yields and returns. The potential income and expenses for the various crops studied indicates that many of them may have a minus net income (i.e., the income does not cover all of the production costs). This does not necessarily mean that farmers should not produce those crops. If they do produce those crops, they will not be receiving full value for their management, rent on their land, or interest on their investment. The crop may still be the best one available for their soil type, location, and available market. In fact the studies indicate that cotton is probably not returning a net income when all economic costs are considered. This Table further shows that not all crops in California are profitable when costs are calculated on this basis. Profitability varies from year to year as prices change and yields fluctuate.

Notice in the California data that good management can usually result in yields considerably above average. Good management is defined here as proper seed bed preparation, use of suitable varieties, adequate fertilization, sufficient irrigation water applied at the optimum time, economical insect and disease control, and expenses based on economic analysis. It takes time and experience to acquire the necessary knowledge and skills to be a good manager. Nicaraguan growers will need experience with irrigated crops to acquire this skill and knowledge. Increasing yields as a result of such experience will result in profitable crop production for the good manager.

Profitable agricultural production depends on obtaining good yields, marketing for a good price, and having economical costs. Good yields depend on the proper combination of management practices and may not be the highest yield obtainable. Something less than the maximum yield may be most profitable when the costs are considered. A good price depends on selling a quality product in a quantity which will be attractive to a buyer and selling at a time of year when the prices are to the best advantage of the grower. Economical costs are usually not low costs. Expenditures must be made to provide inputs which will produce the good yields described above.

The Adelante experience indicates that careful consideration should be given to the selection of crops to be grown under irrigation, including markets and prices, and that good irrigation management practices should be developed before the success can be assured of large-scale irrigation programs.

Since Gross Income is the product of Yield times Price, one should always look at both, and estimate their potential variability, when comparing with estimated production costs. Some specific comments on the importance of this combination follow, for crops recommended for the area but whose profitability may not be obvious in Table 7-9.

Castorbeans: The indicated Nicaraguan yield is 50 cwt/mz. This can only be achieved with excellent management, and is not yet proven. However, an average yield of 35 cwt/mz would require a price of $60/cwt to provide a 5 percent return to management. This is less than the $70/cwt price obtained in California, and is realistic. A ratoon yield of 24 cwt/mz would provide the same return at the same price. Note that these values are for surface irrigation. With sprinkler irrigation costs would be higher.

Grain Sorghum: Yields of better than 80 cwt/mz are required to return 5 percent to management at a $20/cwt price. Such a yield is not out of reach, and possibly can be exceeded. This can be an important feed crop for an expanding beef industry.

Millet: Yields of 64 cwt/mz are required at the $20/cwt price shown. 80 cwt/mz yields have been obtained from improved varieties in India, and California reports 100 cwt/mz for a foxtail variety in recent trials.

Pasture: Pasture production costs are higher than most farmers realize; especially if sprinkler irrigated. A straightforward economic analysis, such as the one presented, does not necessarily give a complete picture of pasture benefits, since a farmer often needs pasture during the dry season for his livestock, and its value may be more than economists can justify.

Peanuts: The yields achieved are lower than the indicated yield. However, average California yields at California peanut prices would increase the profit margin indicated.

Safflower: Good yields and a reasonable price would make this crop profitable, especially if surface irrigated.

Yuca for Starch: Much interest has been exhibited in this plant as an industrial crop. At the indicated price it cannot be justified as an irrigated crop, even if surface-irrigated.

Well Costs: It is again pointed out that irrigation costs per manzana can be reduced by developing wells which can serve 50 to 100 manzanas each.

Table 7-9

SUMMARY OF IRRIGATED CROP PRODUCTION DATA, PROJECT ADELANTE, NICARAGUA, AND COMPARISONS WITH CALIFORNIA

Ref. Table No.	Crop	Data for this Study, Nicaragua (Sprinkler irrigated, except where marked with star*)					Data for California (Surface irrigated)					
		Yield Cwt. per Mz.	Price Corb per Cwt.	Cordobas per Manzana			Aver. Yield '64-68 Cwt./Mz.	Yield, Good Mgmt. Cwt./Mz.	Price Corb per Cwt.	Cordobas per Manzana		
				Gross Income	Total(6 Cost	Net Income				Gross Income	*Total(6 Cost	Net Income
7-14	Cotton	40(1	$60	$2,400	$2,550	$ -150	49	78(1	$77	$ 6,006	$ 6,218	$ -212
	(Non-irrigated, Nicaragua; irrigated, California)											
7-10	Beans, dry	30	50	1,500	1,600	-100	25	38	79	3,002	2,204	798
7-11	Castors	50	20	1,000	2,085*	-1,085	35(2	52	70	3,640	2,748	892
7-12	" ,Ratoon	40	20	800	1,400*	-600						
7-13	Corn	60	25	1,500	2,150	-650	86	122	17	2,074	2,740	– 666
7-15	Cucumbers	200	25	5,000	3,595	1,405	400	486	30	14,580	10,182	4,398
7-16	Eggplant	200	20	4,000	4,370	-370						
7-17	Grain Sorghum	60	20	1,200	1,700	-500	69	70	15	1,050	1,071	-21
7-18	",Ratoon	40	20	800	1,180	-380						
7-19	Melon	150	25	3,750	2,840	910	257(3	312	39	12,168	5,493	6,675
7-20	Millet (Pearl)	40	20	800	1,280	-480						
7-21	Okra	400	10	4,000	4,200	-200						
7-22,23	Papaya	300	25	7,500	7,605	-105						
7-24,25	Pasture				3,100(2,500)*	--					1,095	
7-26,27	Peanuts	50	50	2,500	2,160	340	34(2	35	84	2,940	2,667	273
7-28	Pepper, bell	100	40	4,000	3,305	695	296	348	52	18,096	24,053	-5,957
7-29,30	Quequisque	200	25	5,000	4,900	100						
7-31	Safflower	50	30	1,500	1,650	-150	35	59	30	1,770	1,498	272
7-32	Sesame	16	60	960	1,640	-680						
7-33	Squash	200	25	5,000	4,840	160	330(4	340	76	25,840	22,240	3,600
7-34	Sweet Corn	195	12.80	2,496	2,015	481	115	195	43	8,385	6,150	2,235
7-35,36	Sweet Potato	200	17	3,400	3,800	-400	167	226	65	14,690	9,230	5,460
7-37	Tomato	120	30	3,600	3,030	570	695(5	765	9.50	7,267	6,102	1,165
7-38	Watermelon	300	25	7,500	3,345	4,155	290	420	19	7,980	4,555	3,425
7-39,40	Yuca, fresh	240	15	3,600	3,190	410						
7-41	Yuca, starch	400	4	1,600	4,390	-2,790						

(1 Seed cotton (2 Kern County, 1966 (3 Cantaloupe (4 Tulare County (5 Processing tomatoes

(6 Costs include Value of Land Rent, Depreciation of Equipment, and Return to Management. (except for pasture.)

TABLE 7-10

DRY BEANS

SAMPLE COSTS TO PRODUCE DRY BEANS

Sprinkler Irrigated, 1969

Based on the Veranic variety yielding 30 cwt. per manzana (1,930 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

	Hours	Cordobas per Manzana				
	per		Fuel &	Material		
Operation	Mz.	Labor	Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow - 2 men	2.0	8.30	40.40			48.70
Disk - 2 men	1.0	4.15	18.80			22.95
Pre-irrigate, 2 men	1.1	4.20	12.40	Power for 7.5" @ 7.50	56.25	72.85
Disk - 2 times, 2 men	2.0	8.30	37.60			45.90
Disk with drag - 2 men	1.0	4.15	19.00			23.15
Plant & fertilize-5 men	1.3	12.80	31.20	Seed 90 lbs. 0-90-0	40.00 50.00	134.00
Cultivate-2 times,2 men	2.3	9.55	43.20			52.75
Weed	10.5	20.00				20.00
Spray - 2 times				Application	20.00	
				Material	30.00	50.00
Irrigate- 6 X 2 men	6.6	25.10	35.60	Power for 22" @ 7.50	165.00	225.70
Miscellaneous		11.10	27.75		51.25	90.10
Total Cultural Cost		111.05	286.95		412.50	810.50
Harvest Cost						
Cut	.6	1.35	11.25			12.60
Rake	10.5	20.00				20.00
Combine				30 cwt. @ 2	60.00	
				Sacks, 30 @ 3	90.00	150.00
Haul				30 cwt @ 1	30.00	30.00
Total Harvest Cost		21.35	11.25		180.00	212.60
Total Cash Cost		132.40	298.20		592.50	1,013.10
Miscellaneous Overhead						103.30
Rent				3.5 months @ 20.83		72.90
Management at 5% of 30 cwt @ 50 = 1,500						75.00

		Annual Cost		
Investment	per Manzana	Depreciation	Interest 10%	
Irrigation system	4,470 3.5 mo.	170.00	112.00	
Equipment	895 3.5 mo.	32.70	13.10	
Total	5,365	202.70	125.10	327.80

Total Cost per Manzana	1,602.10
Cost per cwt @ 30 cwt yield	53.30
Cost per cwt in U.S. Dollars	$7.63

TABLE 7-11

CASTOR BEANS

SAMPLE COSTS TO PRODUCE

Flood Irrigated, 1969

Based on yield 50 cwt. per Manzana (3,215 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

		Cordobas per Manzana				
	Hours			Material		
Operation	per Mz.	Labor	Fuel & Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow - 2 men	2.0	8.30	40.40			48.70
Disk - 2 men	1.0	4.15	18.80			22.95
Pre-irrigate	2.0	3.80		Power for 6.0"@ 4.80	28.80	32.60
Disk 2X - 2 men	2.0	8.30	37.60			45.90
Disk w/drag-2 men	1.0	4.15	19.00			23.15
Plant & Fertilize	1.3	12.80	31.20	Seed 20 lb. @ 2	40.00	
				100-100-0	150.00	234.00
Cultivate 2X - 2 men	2.3	9.55	43.20			52.75
Spray				Application	10.00	
				Material	15.00	25.00
Weed	15.0	28.50				28.50
Irrigate 12X	24.0	45.60	24.00	Power for 52" @ 4.80	249.60	319.20
Miscellaneous		14.65	23.80		66.80	105.25
Total Cultural Cost		143.20	259.00		560.20	962.40
Harvest Cost						
Harvest	200.00	380.00				380.00
Haul				50 cwt @ 1	50.00	50.00
Total Harvest Cost		380.00			50.00	430.00
Total Cash Cost		523.20	259.00		610.20	1,392.40
Miscellaneous Overhead						158.50
Rent				6 months @ 20.83		125.00
Management at 5% of 50 cwt @ 20 = 1,000						50.00

		Annual Cost		
Investment	Per Manzana	Depreciation	Interest 10%	
Irrigation system	2,845 6 mos.	142.25	142.25	
Equipment	1,000 6 mos.	50.00	25.00	
Total	3,845	192.25	167.25	359.50
Total Cost per Manzana				2,085.40
Cost per cwt @ 50 cwt yield				41.70
Cost per cwt in U.S. Dollars				$5.96

TABLE 7-12

CASTOR BEANS - RATOON CROP

SAMPLE COSTS TO PRODUCE

Flood Irrigated, 1969

Based on yield 40 cwt. per manzana (2,575 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana Labor	Fuel & Repairs	Material Kind and Quantity	Cost	Total
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Cultivate - 2 men	1.2	5.00	22.50			27.50
Cult. & Fert. - 4 men	1.5	11.90	29.10	100-100-0	150.00	191.00
Spray				Application	10.00	
				Material	15.00	25.00
Hoe	15.0	28.50				28.50
Irrigate 10X	20.0	38.00	20.00	Water 37" @ 4.80	177.60	235.60
Miscellaneous		8.80	9.40		29.20	47.40
Total Cultural Cost		95.60	102.00		381.80	579.40
Harvest Cost						
Harvest	200.00	380.00				380.00
Haul				40 cwt @ 1	40.00	40.00
Total Harvest Cost		380.00			40.00	420.00
Total Cash Cost		475.60	102.00		421.80	999.40
Miscellaneous Overhead						62.00
Rent				4 months @ 20.83		83.30
Management at 5% of 40 cwt @ 20 = 800						40.00

Investment	Per Manzana		Annual Cost Depreciation	Interest 10%	
Irrigation system	2,845	4 mos.	81.30	81.30	
Equipment	1,000	4 mos.	33.40	16.70	
Total	3,845		114.70	98.00	212.70

Total cost per manzana	1,397.40
Cost per cwt @ 40 cwt yield	34.90
Cost per cwt in U.S. Dollars	$4.98

TABLE 7-13

CORN

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 60 cwt per Manzana (3,860 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

	Hours	Cordobas per Manzana				
	per		Fuel &	Material		
Operation	Mz.	Labor	Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Shred previous crop	1.5	3.40	21.00			24.40
Plow - 2 men	2.0	8.30	40.40			48.70
Disk - 2 men	1.0	4.15	18.80			22.95
Pre-irrigate-2 men	1.1	4.20	12.40	Power for 7.5"@ 7.50	56.25	72.85
Disk 2X - 2 men	2.0	8.30	37.60			45.90
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Plant & Fert. 5 men	1.3	12.80	31.20	Seed 25 lb. @ .75	18.75	
				30-90-0	100.00	162.75
Cultivate 2 X 2 men	2.3	9.55	43.20			52.75
Cult. & Fert. 4 men	1.5	11.90	21.40	90-0-0	80.00	113.30
Weed		20.00				20.00
Spray 3X				Application	30.00	
				Material	45.50	75.50
Irrigate 8X 2 men	8.8	33.40	47.50	Power for 30" @ 7.50	225.00	305.90
Miscellaneous		14.10	32.20		69.00	115.30
Total Cultural Cost		134.25	324.70		624.50	1,083.40
Harvest Cost						
Pick		168.75				168.75
Haul				60 cwt @ 1	60.00	60.00
Shell				60 cwt @ 2.25	135.00	135.00
Total Harvest Cost		168.75			195.00	423.75
Total Cash Cost		303.00	324.70		819.50	1,447.20
Miscellaneous Overhead						115.20
Rent				4-1/2 months @ 20.83		93.75
Management at 5% of 60 cwt @ 25 = 1,500						75.00

			Annual Cost		
Investment	Per Manzana		Depreciation	Interest 10%	
Irrigation system	4,470	4.5 mos.	218.00	144.00	
Equipment	1,000	4.5 mos.	37.50	18.75	
Total	5,470		255.50	162.75	418.25

Total Cost per Manzana	2,149.40
Cost per cwt @ 60 cwt yield	35.80
Cost per cwt in U.S. Dollars	$5.12

TABLE 7-14

COTTON

SAMPLE COSTS TO PRODUCE

Non-irrigated, 1969

Based on a yield of 40 cwt. seed cotton per manzana (2,575 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, housing.

	Hours	Cordobas per Manzana				
	per		Fuel &	Material		
Operation	Mz.	Labor	Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow - 2 men	2.0	8.30	40.40			48.70
Disk 4 X	4.0	16.60	75.20			91.80
Plant & Fert. 5 men	1.3	12.80	31.20	Seed 50 lbs	40.00	184.00
				30-120-0	100.00	
Cultivate 4 X	4.6	19.10	86.40			105.50
Weed		50.00				50.00
Thin	10.00	12.00				12.00
Fertilize 2 X	1.6	8.15	34.00	140-0-0	120.00	162.15
Spray 25 X				Application	175.00	
				Material	400.00	575.00
Entomologist					20.00	20.00
Miscellaneous		12.65	28.80		83.00	124.45
Total Cultural Cost		143.00	317.00		938.00	1,398.00
Harvest Cost						
Picking		400.00		Sacks	10.00	410.00
Hauling - 3 men	3.0	15.30	41.40			56.70
Total Harvest Cost		415.30	41.40		10.00	466.70
Total Cash Cost		558.30	358.40		948.00	1,864.70
Miscellaneous Overhead						181.05
Rent						250.00
Management at 5% of 40 cwt @ 60 = 2400						120.00

		Annual Cost		
Investment	Per Manzana	Depreciation	Interest 10%	
Irrigation system	-	-	-	
Equipment	895 12 mos.	89.50	44.75	134.25
Total Cost per Manzana				2,550.00
Cost per cwt @ 40 cwt yield				63.95
Cost per cwt in U.S. Dollars				$9.12

TABLE 7-15

CUCUMBERS

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on a yield of 200 cwt per manzana (12,870 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

	Hours	Cordobas per Manzana				
	per		Fuel &	Material		
Operation	Mz.	Labor	Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Shred previous crop	1.5	3.40	21.00			24.40
Plow - 2 men	2.0	8.30	40.40			48.70
Furrow -	1.2	5.00	28.00			33.00
Pre-irrigate - 2 men	1.1	4.20	12.40	Water 7.5" @ 7.50	56.25	72.85
Disk 2X - 2 men	2.0	8.30	37.60			45.90
Disk w/drag - 2 men	1.0	4.15	19.00			23.15
Plant & Fert. - 5 men	.7	6.90	15.60	Seed 7 lb. @ 10	70.00	
				60-180-0	160.00	252.50
Thin & Weed	50.0	95.00				95.00
Cultivate 2X - 2 men	2.3	9.55	43.20			52.75
Cult. & Fert. - 4 men	1.5	11.90	21.40	100-0-0	90.00	123.30
Dust 4X				Application	40.00	
				Material	160.00	200.00
Irrigate 7X - 2 men	7.7	29.30	41.60	Water 26" @ 7.50	195.00	265.90
Misc.		20.25	27.70		90.60	138.55
Total Cultural Cost		206.25	307.90		861.85	1,376.00
Harvest Cost						
Pick	34.0	64.60		Baskets 460 @ 1.75	805.00	869.60
Haul				10 tons @ 40	400.00	400.00
Total Harvest Cost		64.60			1,205.00	1,269.60
Total Cash Cost		270.85	307.90		2,066.85	2,645.60
Miscellaneous Overhead						204.45
Rent				4 months @ 20.83		123.30
Management at 5% of 200 cwt @ 25 = 5,000						250.00

		Annual Cost		
Investment	Per Manzana	Depreciation	Interest 10%	
Irrigation system	4,470 4 mos.	194.00	128.00	
Equipment	1,000 4 mos.	33.30	16.65	
Total	5,470	227.30	144.65	371.95

Total Cost per Manzana	3,595.30
Cost per cwt @ 200 cwt yield	17.97
Cost per cwt in U.S. Dollars	$2.56

TABLE 7-16

EGG PLANT

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on a yield of 200 cwt per manzana (12,870 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana				
		Labor	Fuel & Repairs	Material		Total
				Kind and Quantity	Cost	
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow - 2 men	2.0	8.30	40.40			48.70
Disk - 2 men	1.0	4.15	18.80			22.95
Pre-irrigate - 2 men	1.1	4.20	12.40	Power for 7.5" @ 7.50	56.25	72.85
Disk - 2 men - 2X	2.0	8.30	37.60			45.90
Disk w/drag	1.0	4.15	19.00			23.15
Plant & fert. - 5 men	1.3	12.80	31.20	Seed 4 lbs. @ 75	300.00	
				60-60-0	90.00	434.00
Thin	50.0	95.00				95.00
Weed	30.0	57.00				57.00
Cultivate 2X - 2 men	2.3	9.55	43.20			52.75
Cult. & fert. - 4 men	1.5	11.90	21.40	60-0-0	50.00	83.30
Spray 2X				Application	20.00	
				Material	25.00	45.00
Irrigate 6X - 2 men	6.6	25.10	35.60	Power for 22" @ 7.50	165.00	225.70
Miscellaneous		27.50	34.00		105.35	166.85
Total Cultural Cost		271.35	314.60		811.60	1,397.55
Harvest Cost						
Harvest	35.0	66.50		Baskets 665 @ 1.75	1,163.00	1,229.50
Haul				200 cwt @ 1.95	390.00	390.00
Total Harvest Cost		66.50			1,553.00	1,619.50
Total Cash Cost		337.85	314.60		2,364.60	3,017.05
Miscellaneous Overhead						324.80
Rent				5.5 months @ 20.83		114.55
Management at 5% of 200 cwt @ 20 = 4,000						200.00

Investment	Per Manzana		Annual Cost		
			Depreciation	Interest 10%	
Irrigation system	4,470	5.5 mos.	267.00	176.00	
Equipment	895	5.5 mos.	51.40	20.60	
Total	5,365		518.40	196.60	715.00

Total Cost per Manzana	4,371.40
Cost per cwt @ 200 cwt yield	21.85
Cost per cwt in U.S. Dollars	$3.12

TABLE 7-17

GRAIN SORGHUM

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on a yield of 60 cwt per manzana (3,860 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana				
		Labor	Fuel & Repairs	Material		Total
				Kind and Quantity	Cost	
Cultural Costs						
Shred previous crop	1.5	3.40	21.00			24.40
Plow - 2 men	2.0	8.30	40.40			48.70
Disk 2X - 2 men	2.0	8.30	37.60			45.90
Pre-irrigate - 2 men	1.1	4.20	12.40	Power for 7.5" @ 7.50	56.25	72.85
Disk w/drag - 2 men	1.0	4.15	19.00			23.15
Plant & fertilize - 5 men	1.3	12.80	31.20	Seed 25 lb. @ 1	25.00	
				30-90-0	80.00	149.00
Cultivate - 2 men	1.2	5.00	21.50			26.50
Cultivate & fert. 4 men	1.5	11.90	21.40	90-0-0	80.00	113.30
Spray				Application	10.00	
				Insecticide	15.00	25.00
Irrigate 8X - 2 men	8.8	33.40	47.50	Power for 30" @ 7.50	225.00	305.90
Miscellaneous		9.15	25.20		50.75	85.10
Total Cultural Cost		100.60	277.20		542.00	919.80
Harvest Cost						
Combine				60 cwt. @ 2	120.00	120.00
Haul				60 cwt. @ 1	60.00	60.00
Total Harvest Cost						
Total Cash Cost		100.60	277.20		782.00	1,159.80
Miscellaneous Overhead						145.50
Rent				3 months @ 20.83		62.50
Management at 5% of 60 cwt @ 20 = 1,200						60.00

Investment	Per Manzana		Annual Cost		
			Depreciation	Interest 10%	
Irrigation system	4,470	3 mos.	145.50	96.00	
Equipment	895	3 mos.	22.50	11.20	
Total	5,365		168.00	107.20	275.20

Total Cost per Manzana	1,703.00
Cost per cwt @ 60 cwt yield	28.40
Cost per cwt in U.S. Dollars	$4.06

TABLE 7-18

GRAIN SORGHUM RATOON CROP

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated - 1969

Based on a yield of 40 cwt per manzana (2,575 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana Labor	Fuel & Repairs	Material Kind and Quantity	Material Cost	Total
Cultural Costs						
Shred previous crop	1.5	3.40	21.00			24.40
Cult. & Fert. - 4 men	1.5	11.90	21.40	100-0-0	90.00	123.30
Irrigate 10X - 2 men	11.0	41.80	59.40	Power for 37" @ 7.50	277.50	378.70
Spray				Application	10.00	
				Material	15.00	25.00
Miscellaneous		5.70	10.20		40.25	56.15
Total Cultural Cost		62.80	112.00		432.75	607.55
Harvest Cost						
Combine - 2 men	1.5	6.20	33.90			40.10
Haul				40 cwt @ 2	80.00	80.00
Dry				40 cwt @ 1	40.00	40.00
Total Harvest Cost		6.20	33.90		120.00	160.10
Total Cash Cost		69.00	145.90		552.75	767.65
Miscellaneous Overhead						34.65
Rent				3 months @ 20.83		62.50
Management at 5% of 40 cwt @ 20 = 800						40.00

Investment	Per Manzana		Annual Cost Depreciation	Annual Cost Interest 10%	
Irrigation system	4,470	3 mos.	145.50	96.00	
Equipment	895	3 mos.	22.50	11.20	
Total	5,365		168.00	107.20	275.20

Total Cost per Manzana	1,180.00
Cost per cwt @ 40 cwt yield	29.50
Cost per cwt in U.S. Dollars	$4.22

TABLE 7-19

MELONS

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on a yield of 150 cwt per manzana (9,650 kg. per hectare).
Labor at ₵2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana				
		Labor	Fuel & Repairs	Material		Total
				Kind and Quantity	Cost	
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow - 2 men	2.0	8.30	40.40			48.70
Disk - 2 men	1.0	4.15	18.80			22.95
Pre-irrigate - 2 men	1.1	4.20	12.40	Power for 7.5" @ 7.50	56.25	72.85
Disk 2X - 2 men	2.0	8.30	37.60			45.90
Disk w/drag - 2 men	1.0	4.15	19.00			23.15
Plant & fert. - 5 men	1.0	9.85	24.00	Seed 7 lb. @ 20	140.00	
				60-180-0	160.00	333.85
Thin & weed	10.0	19.00				19.00
Cultivate 2X - 2 men	2.5	9.55	43.20			52.75
Cultivate & fert. - 4 men	1.5	11.90	21.40	100-0-0	90.00	123.30
Irrigate 7X - 2 men	7.7	29.30	41.60	Power for 26" @ 7.50	195.00	265.90
Pest Control				Application	40.00	
				Material	270.00	310.00
Miscellaneous		13.70	31.60		114.60	159.90
Total Cultural Cost		125.80	311.00		1,065.85	1,502.65
Harvest Cost						
Pick	75.0	142.50				142.50
Haul				150 cwt @ 1.95	292.50	292.50
Total Harvest Cost		142.50			292.50	435.00
Total Cash Cost		268.30	311.00		1,358.35	1,937.65
Miscellaneous Overhead						196.85
Rent				4.5 months @ 20.83		94.00
Management at 5% of 150 cwt @ 25 = 3,750						187.50

Investment	Per Manzana		Annual Cost		
			Depreciation	Interest 10%	
Irrigation system	4,470	4.5 mos.	218.00	146.00	
Equipment	895	4.5 mos.	42.50	16.90	
Total	5,365		260.50	162.90	423.40

Total Cost per Manzana	2,839.40
Cost per cwt @ 150 cwt yield	18.92
Cost per cwt in U.S. Dollars	$2.70

TABLE 7-20

MILLET (PEARL)

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on a yield of 40 cwt. per manzana (2,574 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Labor	Fuel & Repairs	Cordobas per Manzana — Material: Kind and Quantity	Cost	Total
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow - 2 men	2.0	8.30	40.40			48.70
Disk - 2 men	1.0	4.15	18.80			22.95
Pre-irrigate - 2 men	1.1	4.20	12.40	Water 7.5" @ 7.50	56.25	72.85
Disk 2X - 2 men	2.0	8.30	37.60			45.90
Disk w/drag - 2 men	1.0	4.15	19.00			23.15
Plant & fert. - 3? men	1.3	12.80	31.20	Seed 60 lb. @ .70	42.00	
				60-60-0	90.00	176.00
Miscellaneous		7.85	22.80		46.00	76.65
Irrigate 4X - 2 men	4.4	16.70	23.80	Power for 15" @ 7.50	112.50	153.00
Total Cultural Cost		69.85	227.00		346.75	643.60
Harvest Cost						
Mow	.5	1.15	9.90			11.05
Rake	.5	1.15	7.90			9.05
Combine				40 cwt @ 2	80.00	
				Sacks 40 @ 1.40	56.00	136.00
Haul				40 cwt @ 1	40.00	40.00
Total Harvest Cost		2.30	17.80		176.00	196.10
Total Cash Cost		72.15	244.80		522.75	839.70
Miscellaneous Overhead						74.95
Rent				3 months @ 20.83		41.60
Management at 5% of 40 cwt @ 20 = 800						40.00

Investment	Per Manzana		Annual Cost: Depreciation	Annual Cost: Interest 10%	
Irrigation system	4,470	3 mos.	145.50	96.00	
Equipment	895	3 mos.	28.10	11.25	
Total	5,365		173.60	107.25	280.85

Total Cost per Manzana	1,277.10
Cost per cwt @ 40 cwt yield	31.75
Cost per cwt in U.S. Dollars	$4.54

TABLE 7-21

OKRA

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on a yield of 400 cwt per manzana (25,735 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana Labor	Fuel & Repairs	Material Kind and Quantity	Cost	Total
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow - 2 men	2.0	8.30	40.40			48.70
Furrow - 2 men	1.2	5.00	28.00			33.00
Pre-irrigate - 2 men	1.1	4.20	12.40	Water 7.5" @ 7.50	56.25	72.85
Disk 2X - 2 men	2.0	8.30	37.60			45.90
Disk w/drag - 2 men	1.0	4.15	19.00			23.15
Plant & fert. - 5 men	.7	6.90	15.60	Seed 15 lb. @ 10	150.00	
				30-90-0	80.00	252.50
Thin & weed	50.0	95.00				95.00
Weed	30.0	57.00				57.00
Cultivate 3X - 2 men	3.5	14.50	66.00			80.50
Cult. & fert. - 4 men	1.5	11.90	21.40	100-0-0	90.00	123.30
Irrigate 16X- 2 men	17.6	67.00	95.00	Water 59" @ 7.50	442.50	604.50
Spray 3X				Application	30.00	
				Material	120.00	150.00
Miscellaneous		29.40	36.80		58.40	124.60
Total Cultural Cost		315.05	393.20		1,027.15	1,735.40
Harvest Cost						
Pick	50.0	95.00		Baskets 500 @ 1.75	805.00	900.00
Haul				8 tons @ 40	320.00	320.00
Total Harvest Cost		95.00			1,125.00	1,220.00
Total Cash Cost		410.05	393.20		2,152.15	2,955.40
Miscellaneous Overhead						239.90
Rent						250.00
Management at 5% of 400 cwt @ 10 = 4,000						200.00

Investment	Per Manzana		Annual Cost Depreciation	Interest 10%	
Irrigation system	4,470	6 mos.	291.00	191.50	
Equipment	1,000	6 mos.	50.00	25.00	
Total	5,470		341.00	216.50	557.50

Total Cost per Manzana	4,202.80
Cost per cwt @ 400 cwt yield	10.50
Cost per cwt in U.S. Dollars	$1.50

TABLE 7-22

PAPAYA

SAMPLE COSTS TO PRODUCE
Sprinkler Irrigated, 1969

Based on yield 300 cwt. per manzana (19,300 kg. per hectare).

Labor at $2.25 and $1.90 per hour including wages, food and housing.

Operation	Hours per Mz.	Cordobas per Manzana Labor	Fuel & Repairs	Material Kind and Quantity	Cost	Total
Cultural Costs						
Weed	20.0	38.00				38.00
Fertilize 4X	12.0	22.80		300-300-0	450.00	472.80
Spray 12X				Application	120.00	
				Material	120.00	240.00
Cultivate 10X 2 men	10.0	41.50	190.00			231.50
Furrow 10X 2 men	12.0	50.00	280.00			330.00
Irrigate 11X 2 men	12.1	45.90	65.30	Water 40" @ $7.50	300.00	411.20
Miscellaneous		24.80	59.30		171.70	255.80
Total Cultural Cost		223.00	594.60		1,161.70	1,979.30
Harvest Cost						
Harvest 2.5 hr/ton	37.5	71.30		Crates 400 @ $2.10	840.00	911.30
Haul				15 ton @ $40.00	600.00	600.00
Total Harvest Cost		71.30			1,440.00	1,511.30
Total Cash Cost		294.30	594.60		2,601.70	3,490.60
Miscellaneous Overhead						358.45
Rent						250.00
Management @ 5% of 300 cwt @ $25 = 7,500						375.00

Investment	Per Manzana		Annual Cost Depreciation	Interest 10%	
Land	6,360		2,100.00	318.00	
Irrigation System	4,460	12 months	339.50	223.50	
Equipment	1,000	12 months	100.00	50.00	
Total	11,820		2,539.50	591.50	3,131.00
Total cost per manzana					7,605.05
Cost per cwt @ 300 cwt. yield					25.35
Cost per cwt in U.S. Dollars					$3.62

TABLE 7-23

PAPAYA PLANTATION

SAMPLE COSTS TO DEVELOP

Sprinkler Irrigated, 1969

Operation	Hours per Mz.	Cordobas per Manzana				
		Labor	Fuel & Repairs	Material		Total
				Kind and Quantity	Cost	
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Furrow 2 men	1.2	5.00	28.00			33.00
Pre-irrigate 2 men	1.1	4.20	12.40	Water 7.5" @ $ 7.50	56.25	72.85
Disk 2X 2 men	2.0	8.30	37.60			45.90
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Mark Field 9 X 9'	35.0	66.50				66.50
Plant	140.0	266.00		Plants 1,225 @ $ 2	2,450.00	2,716.00
Weed 5X	100.0	190.00				190.00
Fertilize 6X	20.0	38.00		300-300-380	450.00	488.00
Thin	30.0	57.00				57.00
Spray 8X				Application	80.00	
				Material	80.00	160.00
Cultivate 3X	3.0	12.40	56.50			68.90
Furrow 4X 2 men	4.8	20.00	112.00			132.00
Irrigate 10X2 men	11.0	41.70	59.40	Water 37" @ $ 7.50	277.50	378.60
Miscellaneous		76.15	44.10		406.75	527.00
Total Cultural Cost		801.10	430.40		3,800.50	5,032.00
Miscellaneous Overhead						499.10
Rent		8 months at $20.83				167.00

Investment	Per Manzana		Annual Cost		
			Depreciation	Interest 10%	
Irrigation System	4,470	7 months	339.50	223.50	
Equipment	1,000	8 months	66.60	33.30	
Total	5,470		406.10	256.80	662.90
Total Cost per manzana					6,361.00

TABLE 7-24

PASTURE

SAMPLE COSTS TO PRODUCE PANGOLA

Sprinkler Irrigation, 1969

Based on yield 60 ton green forage, 48 animal unit months of grazing
(77.2 metric tons green forage or 61.8 animal unit months per hectare)
Labor at $ 2.25 and $ 1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordoba per Manzana				
				Material		
		Labor	Fuel & Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Irrigate 22X 2 men	25.3	96.00	123.65	Power for 82" @ $ 7.50	615.00	834.65
Fertilize 6X 3 men	9.0	54.30	168.00	460-0-0	410.00	632.30
Mow for Weeds 4X	6.0	13.60	84.00			97.60
Miscellaneous		16.10	37.35		123.50	176.95
Total Cultural Cost		180.00	413.00		1,278.50	1,741.50
Miscellaneous Overhead						134.90
Rent						250.00

Investment	Per Manzana	Annual Cost		
		Depreciation	Interest 10%	
Pasture Stand	2,198	219.80	109.90	
Irrigation System	4,470	339.50	223.50	
Equipment	500	50.00	25.00	
Fences	70	3.50	3.50	
Total	7,238	612.80	361.90	974.70
Total cost per manzana				*3,101.10
Cost per ton at 60 ton				* 51.70
Cost per animal month at 48 animal unit months				* 64.70

*If gravity-irrigated, these figures would reduce to

Total Cost per manzana - 2500 cordobas
Cost per ton at 60 ton - 41.60 cordobas/ton
Cost per animal month at 48 animal unit month - 52.2 cordobas/a.u.m.

TABLE 7-25

PASTURE

SAMPLE COSTS TO ESTABLISH

Sprinkler Irrigated, 1969

	Hours	Cordobas per Manzana				
	per		Fuel &	Material		
Operation	Mz.	Labor	Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Disk 2 men	1.0	4.15	18.80			22.95
Pre-irrigate 2 men	1.1	4.20	12.40	Power for 7.5" @ $ 7.50	56.25	72.85
Disk 2X 2 men	2.0	8.30	37.60			45.90
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Fertilize 3 men	1.5	9.05	28.00	100-0-0	90.00	127.05
Furrow 2 men	1.2	5.00	28.00			33.00
Plant 16 men	10.0	304.00		Cutting 2 ton	100.00	404.00
Irrigate 8X 2 men	8.8	33.40	47.50	Power for 30" @ $7.50	225.00	305.90
Fertilize 3 men	1.5	9.05	28.00	100-0-0	90.00	127.05
Miscellaneous		43.20	33.80		83.25	160.25
Total Cultural Cost		436.20	314.50		644.50	1,395.20

Miscellaneous Overhead		120.50
Rent	6 months	125.00

			Annual Cost		
Investment	Per Manzana		Depreciation	Interest 10%	
Irrigation System	4,470	6 months	271.00	191.50	
Equipment	1,000	6 months	50.00	25.00	
Total	5,470		341.00	216.50	557.50
Total cost per manzana					2,198.20

TABLE 7-26

PEANUTS

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 50 cwt. per manzana (3,230 kg. per hectare)

Labor at $ 2.25 and $ 1.90 per hour including wages, food, and housing.

Operation		Hours per Mz.	Cordobas per Manzana Labor	Fuel & Repairs	Material Kind and Quantity	Cost	Total
Cultural Costs							
Chop previous crop		1.5	3.40	21.00			24.40
Plow	2 men	2.0	8.30	40.40			48.70
Disk	2 men	1.0	4.15	18.80			22.95
Pre-irrigate	2 men	1.1	4.20	12.40	Power for 7.5" @ $ 7.50	56.25	72.85
Disk 2X	2 men	2.0	8.30	37.60			45.90
Disk w/drag	2 men	1.0	4.15	19.00			23.15
Plant & Fert.	5 men	1.3	12.80	31.20	Seed 100 lbs.	140.00	
					30-60-0	60.00	244.00
Cultivate 3X	2 men	3.4	14.10	64.80			78.90
Weed			20.00				20.00
Spray 2X					Application	20.00	
					Material	50.00	70.00
Irrigate 5 X	2 men	5.5	20.90	29.70	Power for 18.5" @$7.50	138.75	189.35
Miscellaneous			13.90	33.70		78.50	126.10
Total Cultural Cost			114.20	308.60		543.50	966.30
Harvest Cost							
Dig	2 men	1.3	12.80	31.20			44.00
Combine					50 cwt at $ 2	100.00	
					Sacks 106 @ 1.40	148.20	248.20
Haul					50 cwt @ $ 1	50.00	50.00
Total Harvest Cost			12.80	31.20		298.20	342.20
Total Cash Cost			127.00	339.80		841.70	1,308.50
Miscellaneous Overhead							152.70
Rent					5 months @ 20.83		104.15
Management at 5% of 50 cwt @ $50 = 2,500							100.00

Investment	Per Manzana		Annual Cost Depreciation	Interest 10%	
Irrigation System	4,470	5 months	243.00	160.00	
Equipment	895	5 months	46.70	18.75	
Total	5,365		289.70	178.75	468.45
Total cost per manzana					2,158.80
Cost per cwt @ 50 cwt yield					43.17
Cost per cwt in U.S. Dollars					$6.16

TABLE 7-27

PEANUTS

COMPARATIVE COSTS OF PRODUCTION

	Adelante (Projected) 1969	Site No. 8 (Actual) 1969	Site No. 50 (Actual) 1969
Yield - cwt	50	17	12.4
Price - Cordobas	40	40	
Income	2,000	680	
Expense			
Burn			8.50
Chop previous crop	24.40	31.30	42.50
Plow	48.70		
Disk	22.95		
Pre-irrigate	16.60	10.00	2.70
Power	56.25	45.30	46.65
Disk	69.05	84.10	60.00
Plant	44.00	31.60	65.20
Seed	140.00	172.00	303.35
Fertilize		13.85	24.30
Fertilizer	60.00	92.00	70.00
Cultivate	78.90	18.50	70.60
Weed	20.00	34.00	264.00
Spray	20.00		3.00
Material	50.00		19.25
Irrigate	50.60	78.40	8.10
Power	138.75	130.55	66.65
Miscellaneous	126.10	125.60	
Total Cultural Cost	966.30	867.20	1,054.80
Chop tops		17.00	17.00
Dig	44.00	34.00	34.00
Combine	248.20		
Haul	50.00	21.25	15.50
Pick		416.50	305.30
Total Harvest Cost	342.20	488.75	371.80
TOTAL CASH	1,308.50	1,355.95	1,426.60
Miscellaneous Overhead	152.70	140.00	150.00
Rent	104.15	146.00	83.50
Management	125.00	34.00	24.80
Depreciation	289.70	133.70	172.20
Interest	178.75	72.35	74.70
Total Overhead	825.30	526.05	505.20
TOTAL COST	2,158.80	1,882.00	1,931.80
Cost per cwt	43.17	110.50	155.80

TABLE 7-28

BELL PEPPERS

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 100 cwt. per manzana (6,435 kg. per hectare).

Labor at $ 2.25 and $ 1.90 per hour including wages, food and housing.

Operation	Hours per Mz.	Cordobas per Manzana Labor	Fuel & Repairs	Material Kind and Quantity	Material Cost	Total
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Disk 2 men	1.0	4.15	18.80			22.95
Pre-irrigate 2 men	1.1	4.20	12.40	Power for 7.5" @ $7.50	56.25	72.85
Disk 2X 2 men	2.0	8.30	37.60			45.90
Disk w/Drag	1.0	4.15	19.00			23.15
Plant & Fert. 5 men	1.3	12.80	31.20	Seed 5 lb. @ $50	250.00	
				30-60-0	60.00	354.00
Thin	50.0	95.00				95.00
Weed	30.0	57.00				57.00
Cultivate 2 men	1.2	5.00	22.50			27.50
Cultivate & Fert.2X 4 men	3.0	23.80	42.80	170-0-0	150.00	216.60
Spray 2X				Application	20.00	
				Material	25.00	45.00
Irrigate 6X 2 men	6.6	25.10	35.60	Power for 22" @ $ 7.50	165.00	225.70
Miscellaneous		28.90	33.30		105.25	167.45
Total Cultural Cost		280.10	314.60		831.50	1,426.20
Harvest Cost						
Pick	40.0	76.00		Hamper 300 at 1.75	525.00	601.00
Haul				100 cwt. at 1.95	195.00	195.00
Total Harvest Cost		76.00	365.00		720.00	796.00
Total Cash Cost		356.10	314.60		1,551.50	2,222.20

Miscellaneous Overhead		253.45
Rent	5 1/2 months @ 20.83	114.55
Management at 5% of 100 cwt @ 40 = 4,000		200.00

Investment	Per Manzana	Annual Cost Depreciation	Interest 10%	
Irrigation System	4,470 5 1/2 mos.	267.00	176.00	
Equipment	895 5 1/2 mos.	51.40	20.60	
Total	5,365	318.40	·196.60	515.00
Total cost per manzana				3,305.20
Cost per cwt @ 100 cwt yield				33.05
Cost per cwt. in U.S. Dollars				$4.72

TABLE 7-29

QUEQUISQUE

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 200 cwt. per manzana (12,865 kg. per hectare)
Labor at $ 2.25 and $ 1.90 per hour including wages, food and housing.

	Hours	Cordobas per Manzana				
	per		Fuel &	Material		
Operation	Mz.	Labor	Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Chop previous crop	1.3	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Disk 2 men	1.0	4.15	18.70			22.85
Pre-irrigate 2 men	1.1	4.20	12.40	Power for 7.5" @ $7.50	56.25	72.85
Fertilize 3 men	1.0	6.05	17.80	60-180-0	160.00	183.85
Disc w/drag 2X	2.0	8.30	38.00			46.30
Plant	25.0	47.50		Corms 9630(2120 lbs)	424.00	471.50
Weed	55.0	104.50				104.50
Cult. & Fert. 4 men	1.5	11.90	21.40	60-180-0	160.00	193.30
Spray				Application	10.00	
				Material	75.00	85.00
Irrigate 6X 2 men	6.6	25.10	35.60	Power for 22" @ $7.50	165.00	225.70
Miscellaneous		27.70	29.30		150.75	207.75
Total Cultural Cost		251.10	234.60		1,201.00	1,686.70
Harvest Cost						
Dig	350.0	665.00				665.00
Clean and sack	70.0	133.00		Sacks 340 @ 1.40	478.00	611.00
Haul				10 ton @ 40.00	400.00	400.00
Total Harvest Cost		798.00			878.00	1,676.00
Total Cash Cost		1,049.10	234.60		2,079.00	3,362.70
Miscellaneous Overhead						347.75
Rent						250.00
Management at 5% of 200 cwt @ 25 = 5,000						250.00

			Annual Cost		
Investment	Per Manzana		Depreciation	Interest 10%	
Irrigation System	4,470	7 mos.	339.50	223.50	
Equipment	895	12 mos.	89.50	44.75	
Total	5,365		429.00	268.25	697.25
Total Cost per manzana					4,907.70
Cost per cwt @ 200 cwt yield					24.50
Cost per cwt in U.S. Dollars					$3.50

TABLE 7-30

QUEQUISQUE

COMPARATIVE COSTS OF PRODUCTION

	Adelante (Projected) 1969	Site No. 8 (Actual) 1969
Yield - cwt.	200	No Harvest
Price - Cordobas	25	
Income	5,000	
Expense		
Chop previous crop	24.40	
Plow	48.70	
Disk	22.85	
Pre-irrigate	16.60	10.00
Power	56.25	50.90
Fertilize	23.85	
Fertilizer	160.00	
Disk	46.30	84.10
Plant	47.50	62.00
Corms	424.00	328.50
Weed	104.50	60.00
Cultivate	33.30	21.10
Fertilize	-	4.30
Fertilizer	160.00	46.00
Spray	10.00	
Material	75.00	
Irrigate	60.70	78.40
Power	165.00	127.10
Miscellaneous	207.75	150.85
Total Cultural Cost	1,686.70	1,023.25
Dig	665.00	Sold
Clean & sack	611.00	in
Haul	630.00	Field
Total Harvest Cost	1,906.00	-
TOTAL CASH	3,362.70	1,023.25
Miscellaneous Overhead	347.75	100.70
Rent	250.00	250.00
Management	250.00	14.00
Depreciation	429.00	133.70
Interest	268.25	72.35
Total Overhead	1,545.00	570.75
TOTAL COST	4,907.70	1,594.00
Cost per cwt	24.50	----

TABLE 7-31

SAFFLOWER

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 50 cwt. per manzana (3,215 kg. per hectare).

Labor at $2.25 and $1.90 per hour including wages, food, and housing.

	Hours	Cordobas per Manzana				
	per		Fuel &	Material		
Operation	Mz.	Labor	Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Shred previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Disk 2X 2 men	2.0	8.30	37.60			45.90
Pre-irrigate 2 men	1.1	4.20	12.40	Water 7.5" @ $7.50	56.25	72.85
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Plant & Fert.	1.3	12.80	31.20	Seed 30 lb.@ $2	60.00	
				10-30-0	30.00	134.00
Cult. & Fert. 4 men	1.5	11.90	21.40	80-0-0	70.00	103.30
Cultivate	1.2	5.00	21.50			26.50
Irrigate 7X 2 men	7.7	29.30	41.60	Water 26" @ $7.50	195.00	265.90
Miscellaneous		9.95	26.50		52.50	88.95
Total Cultural Cost		97.30	272.60		463.75	833.65
Harvest Cost						
Combine				50 cwt @ 2.25	112.50	
Haul				50 cwt @ 1	50.00	
Total Harvest Cost					162.50	162.50
Total Cash Cost		97.30	272.60		626.25	996.15
Miscellaneous Overhead						120.75
Rent						83.35
Management at 5% of 50 cwt @ $30 = 1,500						75.00

			Annual Cost		
Investment	Per Manzana		Depreciation	Interest 10%	
Irrigation System	4,470	4 mos.	194.00	128.00	
Equipment	895	4 mos.	37.40	15.00	
Total	5,365		231.40	143.00	374.40
Total cost per manzana					1,649.65
Cost per cwt @ 50 cwt yield					32.99
Cost per cwt in U.S. Dollars					$4.71

TABLE 7-32

SESAME

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 16 cwt. per manzana (1,030 kg. per hectare).

Labor at $2.25 and $1.90 per hour including wages, food and housing.

	Hours	Cordobas per Manzana				
	per		Fuel &	Material		
Operation	Mz.	Labor	Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Shred previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Disk 2 men	1.0	4.15	18.80			22.95
Pre-irrigate 2 men	1.1	4.20	12.40	Power for 7.5" @ $7.50	56.25	72.85
Disk 2X 2 men	2.0	8.30	37.60			45.90
Plant & fert. 5 men	1.3	12.80	31.20	Seed 2 lb. @ 5	10.00	
				30-90-0	80.00	134.00
Cultivate 2X 2 men	2.3	9.55	43.20			52.75
Cult. & Fert. 4 men	1.5	11.90	21.40	90-0-0	80.00	113.30
Weed		37.00				37.00
Thin		20.00				20.00
Spray				Application	10.00	
				Insecticide	20.00	30.00
Irrigate 5X	5.5	20.90	29.70	Power for 18.5"@$7.50	138.75	189.35
Miscellaneous		16.40	29.00		57.75	103.15
Total Cultural Cost		156.90	284.70		452.75	894.35
Harvest Cost						
Cut	.6	1.35	11.25			12.60
Rake	10.5	20.00				20.00
Combine				16 cwt. @ 2	32.00	32.00
Haul				16 cwt. @ 1	16.00	16.00
Total Harvest Cost		21.35			48.00	144.60
Total Cash Cost		178.25	295.95		500.75	974.95
Miscellaneous Overhead						128.40
Rent				6 months		125.00
Management at 5% of 16 cwt @ 60 = 960						48.00

			Annual Cost		
Investment	Per Manzana		Depreciation	Interest 10%	
Irrigation system	4,470	4 mos.	194.00	124.00	
Equipment	1,000	4 mos.	33.30	16.70	
Total	5,470		227.30	140.70	368.00
Total cost per manzana					1,644.35
Cost per cwt @ 16 cwt yield					102.80
Cost per cwt in U.S. Dollars					$14.70

TABLE 7-33

SQUASH

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 200 cwt. per manzana (12,865 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana				
		Labor	Fuel & Repairs	Material Kind and Quantity	Material Cost	Total
Cultural Costs						
Shred previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Disk 2 men	1.0	4.15	19.00			23.15
Pre-irrigate 2 men	1.1	4.20	12.40	Water 7.5" @ $7.50	56.25	72.85
Fertilize 3 men	1.0	6.05	17.80	60-180-0	160.00	183.85
Disk 2X 2 men	2.0	8.30	37.60			45.90
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Plant 2 men	1.0	4.15	19.00	Seed 10 lb.	185.00	208.15
Thin	20.0	38.00				38.00
Weed	30.0	57.00				57.00
Cult. & Fert. 2 men	3.0	23.80	42.80	200-0-0	180.00	246.60
Pest Control				Application	40.00	
				Material	270.00	310.00
Irrigate 5X 2 men	5.5	20.90	29.70	Power for 18.5"@7.50	138.75	189.35
Miscellaneous		20.50	29.00		133.75	183.25
Total Cultural Cost		202.90	287.70		1,163.75	1,654.35
Harvest Cost						
Harvest	6000	1,140.00		Sacks 200 @ 2.80	560.00	1,700.00
Haul				200 cwt @ 1.95	390.00	390.00
Total Harvest Cost		1,140.00			950.00	2,090.00
Total Cash Cost		1,342.90	287.70		2,113.75	3,744.35
Miscellaneous Overhead						386.20
Rent				4 mos. @ 20.83	83.40	83.40
Management at 5% of 200 cwt @ 25 = 5,000						250.00

Investment	Per Manzana	Annual Cost		
		Depreciation	Interest 10%	
Irrigation system	4,470 4 mos.	194.00	128.00	
Equipment	895 4 mos.	37.40	15.00	
Total	5,365	231.40	143.00	374.40
Total cost per manzana				4,838.35
Cost per cwt @ 200 cwt yield				24.19
Cost per cwt in U.S. Dollars				$3.45

TABLE 7-34

SWEET CORN

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 25,000 ears (195 cwt) per manzana (27,100 ears or 9,650 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana Labor	Fuel & Repairs	Material Kind and Quantity	Material Cost	Total
Cultural Costs						
Shred previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Disk 2X 2 men	2.0	8.30	37.60			45.90
Pre-irrigate 2 men	1.1	4.20	12.40	Water 7.5" @ $7.50	56.25	72.85
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Plant & Fert. 5 men	1.3	12.80	31.20	Seed 25 lb. @ .75	18.75	
				30-90-0	80.00	142.75
Cultivate 2X 2 men	2.3	9.55	43.20			52.75
Cult. & Fert. 4 men	1.5	11.90	21.40	90-0-0	80.00	113.30
Weed		20.00				20.00
Spray 3X				Application	30.00	
				Insecticide	45.50	75.50
Irrigate 4X 2 men	4.4	16.70	23.80	Water 15" @ 7.50	112.50	153.00
Miscellaneous		10.40	25.80		51.75	87.95
Total Cultural Cost		109.70	275.80		474.75	860.25
Harvest Cost						
Harvest 150 cwt @ 2.25		337.00				337.00
Haul				150 cwt @ 2.00	300.00	300.00
Total Harvest Cost		337.00			300.00	637.00
Total Cash Cost		446.70	275.80		774.75	1,497.25
Miscellaneous Overhead						162.15
Rent				2 months @ 20.83		41.65
Management at 5% of 195 cwt 12.80 = 2,496						125.00

Investment	Per Manzana		Annual Cost Depreciation	Annual Cost Interest 10%	
Irrigation system	4,470	2 mos.	97.00	64.00	
Equipment	895	2 mos.	18.70	7.50	
Total	5,365		115.70	71.50	187.20
Total cost per manzana					2,013.25
Cost per cwt @ 195 cwt yield					10.32
Cost per cwt in U.S. Dollars					$1.47

TABLE 7-35

SWEET POTATO

COSTS TO PRODUCE PLANTING STOCK

Size 260 sq. ft. of bed to produce plants for one manzana

Bed construction	
Lumber 2" x 12" rough lumber - 2 x 4	$ 540.60
Labor 7 hours at $ 1.90	13.40
Total	$ 554.00
Growing Plants	
Seed 835 lb. at $ 17.00 cwt	142.00
Seed storage and curing	29.20
Fumigate	34.10
Plastic Cover	33.50
Tar Paper Cover	9.75
Irrigation Water	6.10
Clean Beds 7 hours at 1.90	13.40
Misc. Labor 10 hours at 1.90	19.00
Depreciation $ 554 for 5 years	110.80
Interest 10% of 1/2 of $ 554	27.75
Total cost of plants	$ 425.60*

* For One Manzana - Based on California USA Costs.

TABLE 7-36

SWEET POTATO

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 200 cwt per manzana (12,870 kg. per hectare).

Labor at $ 2.25 and $ 1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana				
		Labor	Fuel & Repairs	Material		Total
				Kind and Quantity	Cost	
Cultural Costs						
Cnop previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Disk 2 men	1.0	4.15	19.00			23.15
Pre-irrigate 2 men	1.1	4.20	12.40	Water 7.5" @ $7.50	56.25	72.85
Fertilize 3 men	1.0	6.05	17.80	60-180-0	160.00	183.85
Disk 2X	2.0	8.30	37.60			45.90
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Furrow 40" 2 men	1.0	4.15	19.00			23.15
Plant 40" x 18"	35.0	66.50		Plants 15,100 @	425.60	492.10
Cultivate 4X 2 men	4.6	19.10	86.40			105.50
Cultivate & Fert. 4 men	1.5	11.90	21.40	90-0-0	80.00	113.30
Weed	53.0	100.00				100.00
Irrigate 7X 2 men	7.7	29.30	41.60	Power for 26" @ 7.50	195.00	265.90
Spray 2X				Application	20.00	
				Material	30.00	50.00
Miscellaneous		29.80	38.00		120.90	188.70
Total Cultural Cost		299.30	373.60		1,087.75	1,706.65
Harvest Cost						
Dig	190.0	361.00		Sacks 105 @ 2.80	294.00	655.00
Haul				200 cwt @ 1.95	390.00	390.00
Total Harvest Cost		361.00			684.00	1,045.00
Total Cash Cost		660.30	373.60		1,771.75	2,805.65
Miscellaneous Overhead						250.55
Rent				5 months @ 20.33		104.00
Management at 5% of 200 cwt @ 17 = 3,400						170.00

Investment	Per Manzana		Annual Cost		
			Depreciation	Interest 10%	
Irrigation system	4,470	5 mos.	242.00	160.00	
Equipment	895	5 months	46.70	18.75	
Total	5,365		288.70	178.75	467.45
Total cost per manzana					3,797.65
Cost per cwt @ 200 cwt yield					18.98
Cost per cwt in U.S. Dollars					$2.71

TABLE 7-37

TOMATOES

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 120 cwt. per manzana (7,720 kg. per hectare).

Labor at $2.25 and $1.90 per hour including wages, food and housing.

Operation	Hours per Mz.	Cordobas per Manzana Labor	Fuel & Repairs	Material Kind and Quantity	Cost	Total
Cultural Costs						
Shred previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Disc 2X 2 men	2.0	8.30	37.60			45.90
Pre-irrigation 2 men	1.1	4.20	12.40	Water 7.5" @ $7.50	56.25	72.85
Fertilize 3 men	1.0	6.05	17.80	60-180-0	160.00	183.85
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Mark Field 40"X 24"	1.0	2.25	15.00			17.25
Transplant	35.0	66.50		Plants 11,500 0.5	575.00	641.50
Cultivate 2X 2 men	2.3	9.55	43.20			52.75
Cult. & Fert. 4 men	1.5	11.90	21.40	100-0-0	90.00	123.30
Hoe	28.0	53.20				53.20
Irrigate 7X 2 men	7.7	29.30	41.60	Water 26" at 7.50	195.00	265.90
				Application	40.00	
				Insecticide	90.00	130.00
Miscellaneous		22.20	29.20		133.75	185.25
Total Cultural Cost		229.30	298.60		1,340.00	1,867.90
Harvest Cost						
Pick	20.0	38.00				38.00
Pick-up	12.0	22.80				22.80
Haul				6 tons at 40	240.00	240.00
Total Harvest Cost		60.80			240.00	300.80
Total Cash Cost		290.10	298.60		1,580.00	2,168.70
Miscellaneous Overhead						223.45
Rent				1/3 of $250		83.35
Management at 5% of 120 cwt @ 30 = 3600						180.00

Investment	Per Manzana		Annual Cost Depreciation	Interest 10%	
Irrigation system	4,470	4 mos.	194.00	128.00	
Equipment	895	4 mos.	37.40	15.00	
Total	5,365		231.40	143.00	374.40
Total cost per manzana					3,029.90
Cost per cwt @ 120 cwt yield					25.24
Cost per cwt in U.S. Dollars					$3.60

TABLE 7-38

WATERMELON

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigation, 1969

Based on yield 300 cwt. per manzana (19,300 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana				
				Material		
		Labor	Fuel & Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Shred previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Disk 2X 2 men	2.0	8.30	37.60			45.90
Pre-irrigate 2 men	1.1	4.20	12.40	Water 7.5" @ $ 7.50	56.25	72.85
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Fertilize 3 men	1.0	6.05	17.80	60-180-0	160.00	183.85
Plant 2 men	.7	2.90	15.10	Seed 3.5 lb. @20.00	70.00	88.00
Thin & Weed	20.0	38.00				38.00
Cultivate 2X 2 men	2.3	9.55	43.20			52.75
Cult. & Fert. 4 men	1.5	11.90	21.40	200-0-0	180.00	213.30
Turn Vines	14.0	26.60				26.60
Hoe	40.0	76.00				76.00
Irrigate 7X 2 men	7.7	29.30	41.60	Water 26" @ 7.50	195.00	265.90
Pest Control 4X				Application	40.00	
				Insecticide	270.00	310.00
Miscellaneous		23.65	29.10		110.75	163.50
Total Cultural Cost		252.30	298.60		1,082.00	1,632.90
Harvest Cost						
Pick	32.0	61.00				61.00
Haul				300 cwt @ $ 2.00	600.00	600.00
Total Harvest Cost		61.00			600.00	661.00
Total Cash Cost		313.30	298.60		1,682.00	2,293.90
Miscellaneous Overhead						218.25
Rent				1/3 of 250		83.35
Management at 5% of 300 cwt @ 25 = 7500						375.00

			Annual Cost		
Investment	Per Manzana		Depreciation	Interest 10%	
Irrigation system	4,470	4 mos.	194.00	128.00	
Equipment	895	4 mos.	37.40	15.00	374.40
Total Cost per Manzana	5,365		231.40	143.00	3,344.90
Cost per cwt @ 300 cwt yield					11.14
Cost per cwt. in U.S. Dollars					$1.59

TABLE 7-39

FRESH MARKET YUCA

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigation, 1969

Based on yield 240 cwt. (12 ton) per Manzana in 12 months (15,400 Kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

	Hours	Cordobas per Manzana				
	per		Fuel &	Material		
Operation	Mz.	Labor	Repairs	Kind and Quantity	Cost	Total
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Furrow 2 men	1.2	5.00	28.00			33.00
Pre-irrigate 2 men	1.1	4.20	12.40	Water 7.5" @ $ 7.50	56.25	72.85
Fertilize 3 men	1.5	9.05	28.00	45-45-0	70.00	107.05
Disk 2X 2 men	2.0	8.30	37.60			45.90
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Furrow 2 men	.7	2.90	13.30			16.20
Plant	20.0	38.00		Stock 7,000 @ 1.5¢	105.00	143.00
Cultivate 2 men	1.2	5.00	22.50			27.50
Cult. & Fert. 4 men	1.5	11.90	21.40	100-0-0	90.00	123.30
Weed 2X	40.0	76.00				76.00
Prune 2X	20.0	38.00				38.00
Irrigate 5X 2 men	5.5	20.90	29.70	Power for 18.5"@7.50	138.75	189.35
				Application	10.00	
Dust 2X				Material	35.00	45.00
Miscellaneous		25.80	36.40		92.25	154.45
Total Cultural Cost		260.90	309.70		597.25	1,167.85
Harvest Cost						
Harvest		200.00				200.00
Haul				12 Ton @ 40	480.00	480.00
Total Harvest Cost		200.00			480.00	680.00
Total Cash Cost		460.90	309.70		1,077.25	1,847.85
Miscellaneous Overhead						197.00
Rent						250.00
Management at 5% of 240 cwt @ 15 - 3600						180.00

		Annual Cost		
Investment	Per Manzana	Depreciation	Interest 10%	
Irrigation system	4,470	339.50	225.50	
Equipment	1,000	100.00	50.00	
Total	5,470	439.50	275.50	715.00
Total Cost per Manzana				3,189.85
Cost per cwt @ 240 cwt yield				13.30
Cost per cwt in U.S. Dollars				$1.90

Table 7-40

FRESH YUCA

COMPARATIVE COSTS OF PRODUCTION

	Adelante (Projected) 1969	Site No. 8 (Actual) 1969
Yield - cwt	240	156
Price - Cordobas	15	6
Income	3,600	936
Expense		
Chop previous crop	24.40	
Plow	48.70	
Furrow	33.00	
Pre-irrigate	16.60	10.00
Power	56.25	50.90
Fertilize	37.05	
Fertilizer	70.00	
Disk	69.05	84.10
Furrow	16.20	
Plant	38.00	96.00
Stock	105.00	
Cultivate	60.80	42.20
Fertilize	-	6.00
Fertilizer	90.00	45.80
Weed	76.00	80.00
Prune	38.00	
Irrigate	50.60	78.45
Power	138.75	127.60
Dust	10.00	
Material	35.00	
Miscellaneous	154.45	191.20
Total Cultural Cost	1,167.85	812.25
Dig	200.00	Sold in Field
Haul	480.00	
Total Harvest Cost	680.00	-
TOTAL CASH	1,847.85	812.25
Miscellaneous Overhead	197.00	80.00
Rent	250.00	250.00
Management	180.00	46.80
Depreciation	439.50	405.70
Interest	275.50	237.55
Total Overhead	1,342.00	1,020.05
TOTAL COST	3,189.85	1,832.30
Cost per cwt	13.30	11.75

TABLE 7-41

YUCA FOR STARCH

SAMPLE COSTS TO PRODUCE

Sprinkler Irrigated, 1969

Based on yield 400 cwt. (20 ton) per manzana in 18 months. (25,700 kg. per hectare).
Labor at $2.25 and $1.90 per hour including wages, food, and housing.

Operation	Hours per Mz.	Cordobas per Manzana Labor	Fuel & Repairs	Material Kind and Quantity	Cost	Total
Cultural Costs						
Chop previous crop	1.5	3.40	21.00			24.40
Plow 2 men	2.0	8.30	40.40			48.70
Pre-irrigate 2 men	1.1	4.20	12.40	Water 7.5" @ $ 7.50	56.25	72.85
Fertilize 3 men	1.5	9.05	28.00	45-45-0	70.00	107.05
Disk 2X 2 men	2.0	8.30	37.60			45.90
Disk w/drag 2 men	1.0	4.15	19.00			23.15
Furrow 2 men	.7	2.90	13.30			16.20
Plant	20.0	38.00		Stock 7,000 @ 1.5¢	105.00	143.00
Cultivate 2 men	1.2	5.00	22.50			27.50
Cult. & Fert. 4 men	1.5	11.90	21.40	100-0-0	90.00	123.30
Weed 2X	40.0	76.00				76.00
Prune 2X	20.0	38.00				38.00
Irrigate 22X 2 men	24.2	92.00	130.80	Power for 82" @ 7.50	611.50	834.30
Dust 2X				Application	10.00	
				Material	35.00	45.00
Miscellaneous		38.80	40.90		127.75	207.45
Total Cultural Cost		340.00	387.30		1,105.50	1,832.80
Harvest Cost						
Harvest		350.00				350.00
Haul				400 cwt @ $1.00	400.00	400.00
Total Harvest Cost		350.00			400.00	750.00
Total Cash Cost		690.00	387.30		1,505.50	2,582.80
Miscellaneous Overhead						277.50
Rent				18 mos.		375.00
Management at 5% of 400 cwt @ 4 = 1600						80.00

Investment	Per Manzana		Annual Cost Depreciation	Interest 10%	
Irrigation system	4,470	18 mos.	509.25	338.25	
Equipment	1,000		150.00	75.00	
Total	5,470		659.25	413.25	1,072.50
Total Cost per manzana					4,387.80
Cost per cwt @ 400 cwt yield					10.96
Cost per cwt in U.S. Dollars					$1.56

Chapter 8

PROJECT ORGANIZATION

Chapter 8

PROJECT ORGANIZATION

8.0 - MINISTRY OF AGRICULTURE AND LIVESTOCK

8.01 - Project Sponsor

Project Sponsor for the Government of Nicaragua was the Ministry of Agriculture and Livestock. The Government and the Ministry consummated a formal Project Agreement on May 20, 1967, with the U. S. Government and its Agency for International Development in Nicaragua, to jointly develop and execute Project Adelante as an irrigation demonstration project. MAG, with the assistance of AID, was responsible for the immediate direction, execution, and coordination of the project.

8.02 - Legal Basis of MAG

Legal basis for the Ministry, its responsibilities, and authority, are set forth in the following:

> Political Constitution of 1 November 1950, published in the Gazette, official publication dated 6 November 1950; Law creating the Ministries of State and other agencies having Executive Power, official publication of 13 November 1948 and revisions of 7 July 1952 and Decree N°1383 of 3 October 1967.

8.03 - Principal Functions of MAG

The Ministry of Agriculture and Livestock has the following functions:

1. The organization, development and protection of the nation's agriculture.
2. The preservation, improvement and protection of the livestock industry.
3. The conservation, reproduction and acclimation of all useful species of animals and plants.
4. The protection of the nation's rich forests.
5. Increasing the production of agriculture, livestock and forestry production.
6. The creation, regulation and operation of agricultural schools in collaboration with the Ministry of Public Education.

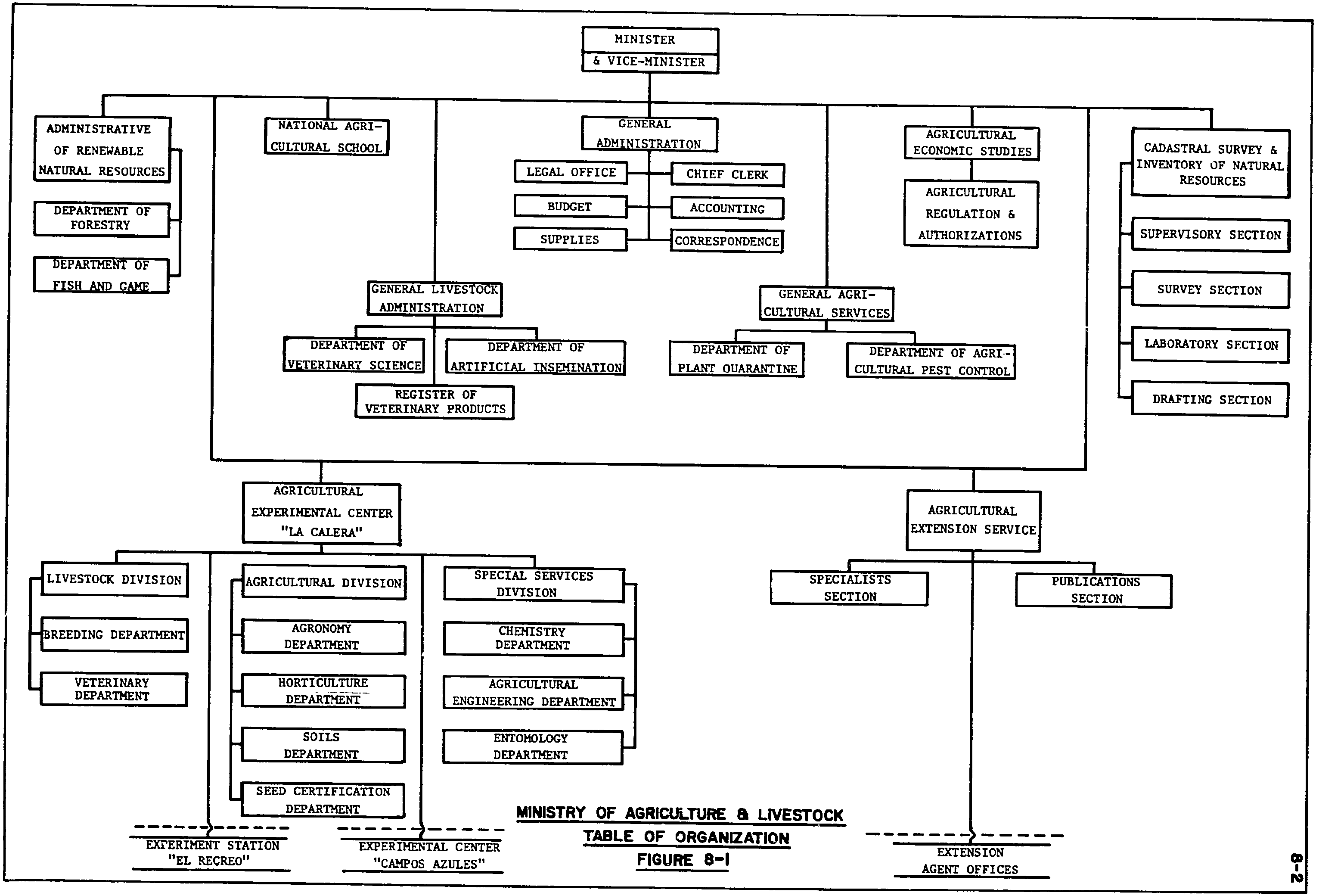
8.04 - MAG Organization

The Ministry is organized as shown in Figure 8-1 on the next page of this report.

8.05 - Policies of the Ministry

Some of the basic policies of MAG, as of the Spring of 1970, are summarized as follows:

> "In accordance with the aims of the National Program of the Government, this Ministry shall continue directing and coordinating, not only the development of the nation's agriculture and livestock, but also all other activities connected with it that have as a final goal the improvement in the standard of living, especially that of the "campesinado" and of the general populace as a whole.



MINISTRY OF AGRICULTURE & LIVESTOCK
TABLE OF ORGANIZATION
FIGURE 8-1

Experimentation shall continue with renewed vigor, with present efforts being continued towards the establishment of regional centers that shall dedicate themselves to research with crops of each zone, with the aim of introducing new crops and also promising varieties. Studies shall be carried out with the objective of improving the following crops: coffee, cotton, pasture, fruit, vegetables, spices, etc.

Pasture improvement projects shall be carried out, as a complimentary activity to the swine improvement program, this activity to be given the importance that it deserves as it constitutes a basic source of revenue of our national economy. Likewise, the practices of artificial insemination and animal husbandry shall reach the entire Country.

Important measures shall be effected in the field of plant sanitation, (control of pests and plant diseases) in order to provide greater returns from existing crops and to avoid the introduction of pests and diseases not now present in Nicaragua.

Agricultural education shall receive major attention, inasmuch as there already exists in the country personnel that are adequately trained to guide agriculture and livestock in accordance with scientific techniques and practices used in other progressive countries. Measures should be taken to establish scholarships to permit qualified candidates to receive advanced training in foreign countries.

The agricultural extension service shall increase its area of operation, working directly with the farmers in the solution of their problems. Extension Agents shall act as advisors to agriculture and livestock farmers, showing them the best practices to use in order that they may derive the greatest benefits from these improvements.

The rural home shall benefit from the development of integral programs aimed at improving their conditions receiving by different educational methods or teaching of children by their mothers, concerning the use of family budgets, home economics, etc.

The protection of fauna, flora, etc., shall not be disregarded. Reforestation of our forests shall continue.

Legislation having to do with agriculture and livestock shall be carefully reviewed with the aim of applying all of its provisions; also, a publishing campaign will be realized to inform and enlist the cooperation of the local populace in such important matters.

The Ministry of Agriculture and Livestock, shall continue in the development of the irrigation project "Adelante", in which are involved lands having great productive capacity and which have already benefited ostensibly by efforts that have been expended.

Works presently in progress shall be amplified in accord with the contract signed with Louisiana State University in May, 1968. Technicians from this University shall assist the Ministry in training and evaluation, for the production, harvest, storage, processing and marketing of basic food products: rice, corn,sorghum and beans.

Apart from the preceding, increasing research will be effected in forage for dairy and meat livestock, systems of dairy and swine management, etc.

> Valuable research in the growing of cotton will continue to be realized, not only in the introduction of new varieties, but also trials in the laboratory in order to compare the resistance, qualities, etc., of the fiber against that which has been grown to-date and to permit selection of the most promising.
>
> Integrated control shall be amplified and special programs will be developed to improve practices in the cutting and management of cotton, with the aim of increasing its level of purity and thereby increasing its sale price in the international market. In order to protect the cotton growers, a platform-scale will be installed at each gin for exact weighing of product delivered."

8.1 - OTHER GON AGENCIES WITH RESPONSIBILITIES IN AGRICULTURE & LIVESTOCK

While the responsibilities of MAG for work in agriculture and livestock in Nicaragua are many, there are several other government institutions which also have important responsibilities in one or more aspects of agricultural activities. This is not an unusual circumstance, as most governments in the world discover that it is not easy, nor necessarily desirable, (if possible), to put all such activities under one agency. A listing of the principal agencies having official duties in this field is given below.

1. Minister of Agriculture and Livestock (MAG).
2. National Cotton Commission.
3. Nicaraguan Coffee Institute.
4. National Milk Products Company.
5. National Institute of Interior and Foreign Commerce (INCEI).
6. National Bank of Nicaragua (BNN).
7. Institute for National Development (INFONAC).
8. National Agrarian Institute of Nicaragua (IAN).
9. Agriculture Section, Office of Planning, Ministry of Economy.
10. National Resources Inventory Project.

It is beyond the scope of this report to even summarize the activities of each of these agencies. It is noted, however, that MAG, BNN, INFONAC, IAN, and the Office of Planning, all have certain interests in irrigation development, and have sponsored irrigation projects one way or another. In addition there is an autonomous organization, Rivas Irrigation Project, that has as its principal business the development and operation of a large irrigation project south of Managua.

Both BNN and INFONAC have sponsored relatively large projects, and the 15,000-hectare Leon Irrigation Project sponsored by BNN, has a major portion of its development area in the Project Adelante region. This is both advantageous and disadvantageous. An advantage is that the experiences and information obtained by Adelante can provide the basis for good planning and operations for other, expanded, projects. A disadvantage is that the very few agricultural technicians and engineers in Nicaragua who have any experience in irrigation are spread too thinly over the country, and among organizations. As a result exchange of information is incomplete, and their efforts are not as "synergistic" as might be possible if most of them were centralized in one career organization.

8.2 - PROJECT FINANCING AND SUPPORT

Project Adelante was a joint undertaking of MAG and USAID/Nicaragua. The basic agreement set forth principal financing and support responsibilities for the first two project years as shown in Table 8-1.

The Minister of Agriculture personally represented MAG in establishing all project policies, in staffing the project with qualified Nicaraguan personnel, in furnishing GON financing, in liaison with other GON agencies, in approving project budgets and plans of operation, and in formalizing project cooperator agreements. Working directly under the Minister as onsite Project Adelante MAG Supervisor, and simultaneously as Deputy Project Director in the area, was a Nicaraguan engineer who also served during that time as Chief of the MAG Department of Agricultural Engineering.

In charge of the project for US/AID was the Rural Development Officer, assisted by his deputies and staff. All U.S. contributions were monitored by this office, with approval by MAG generally also required.

Table 8-1

PROJECT FINANCING AND SUPPORT

First Two Years of Project Adelante - 1968-70
(All costs in US $)

U.S.AID Contributions		MAG Contributions	
chnical Assistance (U.S. personnel & expenses)	$197,600	Personnel (irrigation engineer, agronomist, ag economist, secretary, clerk, sub-professional field man, two drivers)	$64,000
ell & Irrigation Equipment	20,500		
erating Costs (local travel, vehicle operation and maintenance)	10,750	Office Supplies & Equipment	2,000
iscellaneous Costs	5,150	Total	$6[illegible],000
Total	$250,000		
addition to the above, USAID agreed to nd appropriate short-term training for rsonnel selected by MAG to work on the oject.		In addition to the above, MAG would furnish: office space transportation in Nicaragua interpreting services (if required) assistance from other MAG Divisions	

tes:

1. It was estimated that in addition to the above that five cooperating farmers would contribute an estimated equivalent of $30,000 in the form of additional well and production costs. Cooperating farmers were assumed to be responsible, with limited exceptions, for financing investment and operational expenses required for carrying out the demonstrations.

2. The initial phase of the project was extended through 31 May 1970, and additional funds were provided by both USAID and MAG to cover this additional period of approximately three months.

8.3 - CONSULTANT

Foreign specialists in irrigated agriculture were provided to the project in accordance with the terms of a contract between MAG and Uniconsult, Inc., an agricultural and engineering consulting firm located in Lafayette, California. Financing of the contract was by USAID.

Planning and project activities of both the foreign specialists and Nicaraguan staff were under the direction of Mr. Robert C. Harkens of Agriculture Industries, Inc., of Davis, California, who, together with Mr. Frederick L. Hotes of Uniconsult, served as the Uniconsult Project Management team. Both of these men served also as Part-Time Specialists for the Project.

Two full-time Uniconsult technicians, an irrigation engineer and an agronomist, were resident in Leon during the project life. One of these served as the Uniconsult Resident Representative, and as Onsite Project Adelante Director, responsible for day-by-day project operations, and contact with MAG and AID.

Part-time Specialists from the Uniconsult group served both in Nicaragua and in the United States in support of the project. Their specialties and roles are set forth later.

All Nicaraguan and foreign personnel were organized to function as an integral project team from the Leon headquarters. Project duties were established as first priority, and foreign resident personnel in particular operated primarily as managers and workers, responsible for getting work accomplished on the ground, although at the same time serving as onsite technical consultants.

8.4 - PROJECT ORGANIZATION AND STAFFING

8.41 - Personnel

Listed below are the personnel from MAG and the Consultant who worked directly on the project.

Consultant

Project Manager
Robert C. Harkens

Resident Representative
(and Irrigation Engineer)
Wallace J. Schoenleber

Agronomist
Roydon T. Edwards

Part-time Specialists
Timothy R. Maestas (Soils & Agronomy)
Robert M. Hoffman (Tropical Agriculture)
Dr. A. Doyle Reed (Agricultural Economics)
Robert C. Harkens (Agronomy)
Frederick L. Hotes(Irrigation & Organization)

MAG

Supervisor
Alcides Tijerino M.

Agronomist
Orlando Watson S. (Apr 69-Jun 70)
Julio R. Paguaga O.(Aug 68-Apr 69)
Jose M. Narvaez G.(Feb 68-Jul 68)

Agricultural Economist
Roger Peralta M. (Jul 69-Jun 70)

Field Technician
Gustavo Escobar L.(Sep 69-Jun 70)
Raul Gomez U. (May 68-Aug 69)

Secretaries
Maria Yolanda Portocarrero N.
Juanita Berrios S. (Nov 69-Jun 70)

8.42 - Primary Functions of Key Personnel

Primary functions of key project personnel are outlined below.

Project Manager: RCH (Consultant)

a) Establish the Plan of Operations and development programs for the Project.
b) Establish the general criteria to be followed in execution of the work.
c) Determine, in accordance with the terms of the MAG-Uniconsult contract, the times of service of the consultant's technical personnel to best meet project needs.
d) Direct the preparation of the final report and establish guidelines for the preparation of monthly and special reports.

Resident Representative and Irrigation Engineer: WJS (Consultant)

a) Design the irrigation system for use by the Project.
b) Develop and control budgets for activities of the Project.
c) Program and direct the irrigation operations on the demonstration parcels.
d) Compile information on the existence and development of ground water resources in the project area.
e) Assist cooperators and their personnel, as well as other farmers in the project area who so request, in providing training in the use and installation of irrigation equipment.
f) Prepare monthly reports on project activities, and supplemental informational reports, as needed.
g) Assure the good use and proper maintenance and preservation of all project equipment and facilities.

Agronomist: RTE (Consultant)

a) Develop detailed cropping and cultivation plans for the demonstration parcels.
b) Inspect and oversee the execution of the farming plans.
c) Assist cooperators and their personnel, and other farmers in the project area who so request, in providing training in better agricultural practices, in using better equipment adapted to the crops grown, and adoption of new techniques in all aspects related to agronomy.
d) Compile information on the behavior of both new and traditional crops in the project area.
e) Assist in the preparation of monthly and special reports.

Supervisor: ATM (MAG)

a) Coordinate activities of MAG and Consultant personnel.
b) Review the calculations, design, and operation of project irrigation systems.
c) Provide technical assistance to cooperators, their personnel, and other farmers in the project area who so request, on the use, maintenance, and expansion of irrigation systems.
d) Coordinate project activities with other official agencies, especially those involved in the development and conservation of water and land resources.
e) Prepare quarterly reports on project activities for submission by MAG to USAID in accordance with the Project Agreement.
f) Collaborate in the preparation of reports on project activities.

Agronomist: OWS (MAG)

a) Act as counterpart to the Consultant's agronomist.
b) Present reports on his activities.
c) Inspect and oversee agronomic operations carried out on the demonstration parcels.
d) Lend technical assistance to the cooperators and their workers, and to other farmers in the area who so request.

Agricultural Economist: RPM (MAG)

a) Collect detailed information on all costs involved in the farming of the project demonstration parcels.
b) Assist cooperators in their presentations and loan applications to the National Bank.
c) Seek markets for the crop production from the demonstration parcels.
d) Compile all available agricultural economic information in Nicaragua, and determine how it can be applied to project work.
e) Develop farm budgets and other economic information relative to project work.

Field Technician: GEL (MAG)

a) Assist the project agronomists in the supervision of crop cultivation work on project parcels.
b) Help train farm workers on the cooperator parcels in the use of improved agricultural practices and farm equipment.
c) Assure that project equipment is adequately maintained.

Secretaries: MYP and JBS (MAG)

a) Prepare letters, maintain office files, answer telephone, and perform all related office work.
b) Take charge of mimeographing and reproduction of reports, tables, etc.

8.43 - Administrative Activities

Some of the key administrative arrangements and activities of the local project organization, headquartered at Leon, are set forth in this Section.

a) Control of Project Accounting and Handling of Project Funds

A general bank account was opened at the Leon office of the Banco Nicaraguense, and was used for the purchase of tools, supplies, some seed, etc. both in Nicaragua and in the U.S.A. All checks drawn on the account required the signature of both the MAG Project Supervisor and the Consultant's Resident Representative. Funds were deposited to the account from time-to-time by USAID, based on documentation, and within amounts budgeted for the project, as approved by MAG and USAID.

A Petty Cash Fund for small local purchases was under the control of the principal secretary.

Acquisition of the sprinkler irrigation equipment and the new project vehicles was made directly by AID, with the technical advice of project personnel. Custody of all AID-purchased equipment and material was vested in MAG, who in turn delegated custody and responsibility to the Project Adelante local organization.

Some types of local purchases, such as fuel for project vehicles, were made following MAG procedures, with MAG vouchers.

b) Plan of Operations and Periodic Reports

Revisions to the General Plan of Operations, and monthly reports to MAG and USAID were the primary responsibility of the Consultant's Resident Representative. The monthly reports were circulated by MAG to interested parties. An index for all monthly reports is given in Appendix III.

Quarterly reports to MAG were the responsibility of the MAG Project Supervisor.

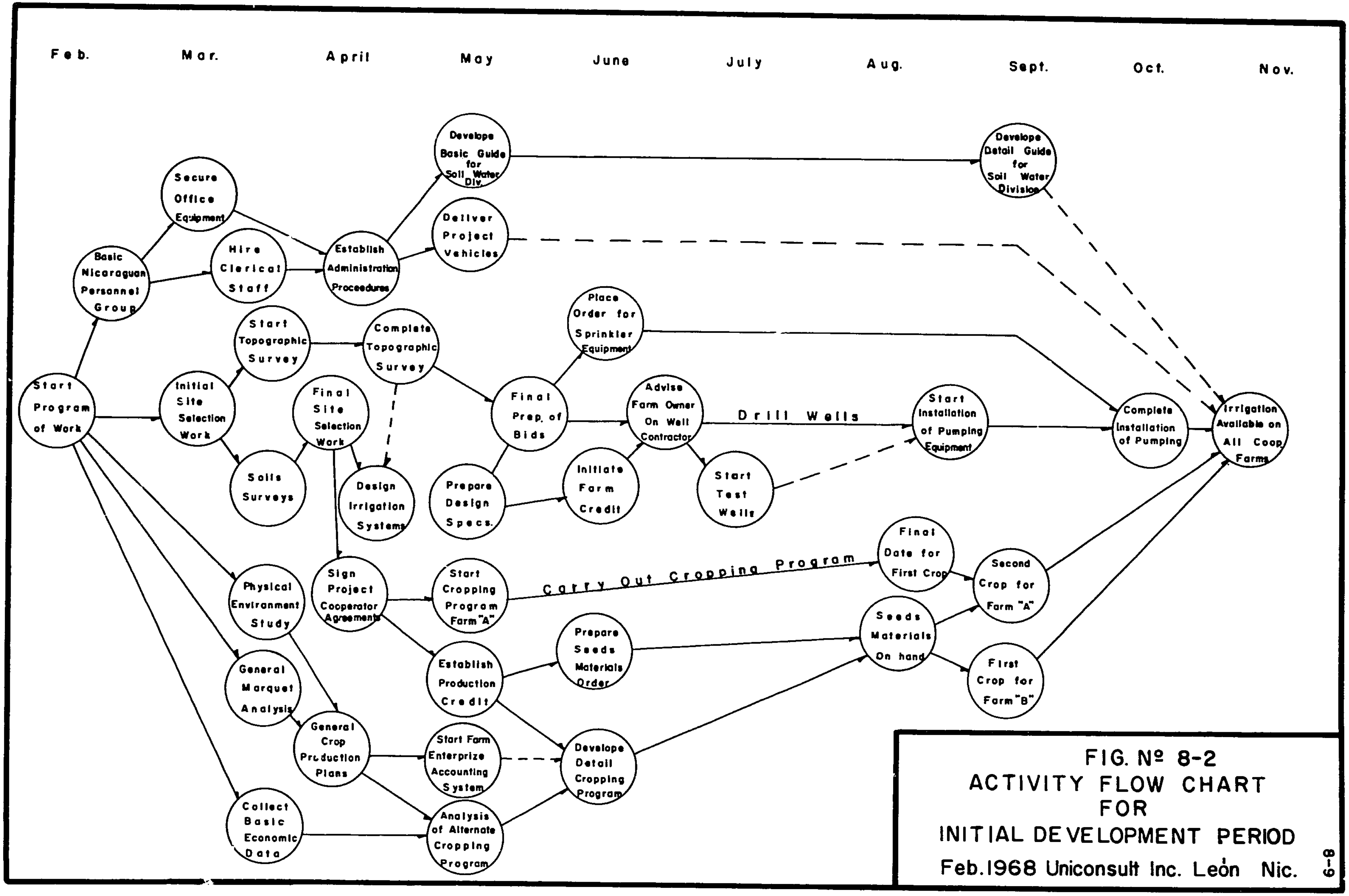


FIG. Nº 8-2
ACTIVITY FLOW CHART
FOR
INITIAL DEVELOPMENT PERIOD
Feb.1968 Uniconsult Inc. León Nic.

One of the first action items performed when work began on Project Adelante in February 1968, was the development of a Detailed Program of Work. This was submitted to MAG and USAID in March 1968. Figure 8-2 is a copy of the Activity Flow Chart contained in that report. It indicates the many major items of work which were desired to be completed during the first project year. The time schedule turned out to be far too optimistic, for many reasons, most of which have been discussed in this report. Nevertheless, the items of work were all performed, and the Chart reveals the very considerable number and types of activities which were required.

c) Project and Public Relations

Since the program was a demonstration type requiring the direct cooperation of the farmers and other public and private entities, good relationships with them and with the general public, were of great importance. The co-administrators devoted careful attention and considerable effort to assure that this aspect of the project work was not neglected.

The following objectives were realized:

1. Negotiated agreements with six full-time cooperators and five associate cooperators to work in the establishment of crop demonstration parcels under irrigation. A copy of an agreement for a full-time cooperator is included in this report as Appendix IV.

2. Obtained the agreement of ENALUF to furnish four full-time cooperators with free installation of 3-phase electrical energy with a cost of $ 41,000.00.

3. Arranged with Oil Company "Corona" for the marketing of peanuts produced on project parcels.

4. Organized and conducted a Field Day at one of the Project Cooperator's farm in which authorities of the highest rank attended, including the President of the Republic, and more than 300 farmers, technicians and absentee landowners.

5. Held technical and semi-technical discussions with personnel from institutions such as: Banco Nacional, Banco Central, National Geological Service, National Cotton Commission, Ministry of Economics, INCEI, ENALUF, Ingenio San Antonio, teachers from the department of Leon, and general farmers.

6. Obtained information from foreign institutions and persons of value to project activities.

7. Obtained authorization of the Governor of the Department of Leon to use one floor of the Government building in Leon as the main project office.

d) Project Equipment

Project staff developed complete procurement lists and budgets for project equipment, and maintained those items not installed on cooperator parcels.

This equipment included:

1. Office equipment
2. Transportation equipment
3. Irrigation equipment
4. Agriculture equipment
5. Engineering and Drafting equipment

8.5 - CHRONOLOGICAL LISTING OF PROJECT ACTIVITIES

The Consultant's Resident Representative and Project Agronomist prepared chronological lists of some of the major project activities during their respective sojourns on the Project. They are included as Tables 8-2 and 8-3 respectively, since the information gives further insight into project activities.

Table 8-2

MAJOR PROJECT ACTIVITIES

(In Chronological Order)

by Resident Representative & Irrigation Engineer

No.	Date	Description
1.	12 Jan 68	Contract signed between MAG and Uniconsult.
2.	8 Feb 68	Uniconsult team arrived in Nicaragua. Two Nicaraguans on job - Tijerino and Narvaez.
3.	29 Feb 68	Furniture for office arrived from AID.
4.	11 Mar 68	Secretary and Clerk-typist on job.
5.	16 Mar 68	Consultants returned to USA.
6.	29 Mar 68	Meeting with MAG to set up mobilization funds.
7.	22 Apr 68	Mobilization funds deposited in bank.
8.	8 May 68	Field assistant reported for duty. (Gomez).
9.	11 Jun 68	Official sign-up of all Cooperators, with exception of Escobar. (MAG in Leon).
10.	1 Jul 68	Field Technician resigned. (Narvaez)
11.	18 Jul 68	Drilling started on Pineda and Quintanilla Wells.
12.	26 Jul 68	Banco Nacional informed Project; no funds available, during meeting on well and pump. Loans for Pineda, Galo and Quintanilla.
13.	29 Jul 68	Tested well of Pineda and Quintanilla. Pumps ordered for Pineda and Quintanilla.
14.	12 Aug 68	Replacement for Field Technician. (Narvaez). Reported for work (J. Paguaga).
15.	14 Aug 68	Meeting with ENALUF to discuss power line construction.
16.	21 Aug 68	Drilling started at Galo's. (Site 13).

Table 8-2 (continued)

No.	Date	Description
17.	15 Oct 68	Well tested at Galo - pump ordered.
18.	17 Oct 68	ENALUF agreed to contribute $ 40,000 to put in power to wells.
19.	21 Oct 68	Sprinkler equipment delivered to Leon
20.	8 Nov 68	ENALUF installed power lines at Pineda.
21.	21 Dec 68	Met with Banco Nacional for loans for; Pineda, Galo, Fonseca, and Quintanilla. All approved except Quintanilla.
22.	6 Jan 69	Sr. Reyes came in about Site 84. (Interest in irrig.)
23.	6 Jan 69	Millet harvest at La Leona
24.	8 Jan 69	Site 85 (Medina) - field investigation.
25.	15 Jan 69	Safflower planted at Site 84 (Reyes).
26.	15 Jan 69	Bank loans approved for Sites 8, 13, & 50.
27.	24 Jan 69	Pump installed at Site 8 by McGregors.
28.	31 Jan 69	Pres. Somoza visited Site 60 (San Jeronimo).
29.	1 Feb 69	First cotton chopped at Site 8. Land preparation initiated.
30.	4 Feb 69	Riegos de Nicaragua delivered sprinkler equipment to Site 8.
31.	4 Feb 69	Mr. R. C. Harkens arrived to serve as Project Agronomist.
32.	10 Feb 69	Planted 0.5 mz. safflower at Robelos (Site No. 87).
33.	10 Feb 69	ENALUF made final power hook-up at Site 8. Pump primed.
34.	13 Feb 69	Sprinklers started at Site 8 (24 to 36 hr. pre-irrigation cycle).
35.	17 Feb 69	Mr. Edwards returned to Project from extended sick leave.
36.	25 Feb 69	Irrigating safflower at Site 84.
37.	26 Feb 69	Rotovator at Site 8.
38.	27 Feb 69	Planting started at Pineda.
39.	27 Feb 69	Mr. Harkens left for U.S.A.
40.	4 Mar 69	Cleared safflower from Aduana at Corinto
41.	17 Mar 69	D-6 Dozer started at Site 50. Irrigation canal excavation.
42.	19 Mar 69	Turbine pump installed at Site 50.
43.	19 Mar 69	Removal of cotton crop, and pump installed at Fonseca.
44.	23 Mar 69	Sprinkler system started at Site 50. (24-hr. pre-irrigation cycle started.)
45.	11 Apr 69	MAG & Koone visit to Project Sites 8, 84, & 50.
46.	11 Apr 69	Field Technician, J. Paguaga, transferred to La Calera.
47.	12 Apr 69	Planting started at Fonseca.
48.	15 Apr 69	Completed planting at Fonseca.

Table 8-2 (continued)

No.	Date	Description
49.	17 Apr 69	Ing. Escobar talks about being a Cooperator, Site 86.
50.	18 Apr 69	Cotton chopped at Vaca.
51.	21 Apr 69	Sr. Watson reports for duty. (Replacement for Paguaga)
52.	24 Apr 69	Mr. Hotes arrives for irrig. consult. work.
53.	1 May 69	Mr. Hotes left for U.S.A.
54.	8 May 69	Field Day at Site 8.
55.	8 May 69	Project was informed Quintanilla's loan approved by Banco Nacional.
56.	14 May 69	African Star Pangola grass seeded at Site 50.
57.	28 May 69	Gated pipe delivered to Vaca.
58.	29 May 69	Pump test at Site 4.
59.	3 Jun 69	Mr. Edwards left on annual leave.
60.	4 Jun 69	Messrs. Besser & De Grazio arrived for bird control work.
61.	10 Jun 69	Pump delivered and installed at Galo. (Wrong voltage)
62.	11 Jun 69	Messrs. Besser & De Grazio returned to U.S.A.
63.	12 Jun 69	Drilling started at Escobar.
64.	13 Jun 69	Combining sorghum at Site 8.
65.	18 Jun 69	Mr. Edwards returns from annual leave.
66.	26 Jun 69	Dr. and Mrs. Reed arrived for economic study.
67.	26 Jun 69	Pump installed at Quintanilla. No power hook-up. (No payment)
68.	27 Jun 69	Sr. Quintanilla informed us about pump installation at Site 62, on 26 June 1969.
69.	1 Jul 69	Checked cucumber yields at Site 8.
70.	1 Jul 69	Prepared rebuttal to "La Prensa" article about sorghum harvest at Site 8.
71.	8 Jul 69	Field Technician (Escobar) reported for work. (All positions filled)
72.	9 Jul 69	Percasa failed to show for well yield test at Site 86.
73.	10 Jul 69	Dr. and Mrs. Reed return to U.S.A.
74.	11 Jul 69	First well yield test at Site 86 by Percasa.
75.	14 Jul 69	Combining sorghum at Site 50.
76.	31 Jul 69	Quintanilla planted cotton at Project Site. Verbally instructed by Project personnel that he is no longer Cooperator.
77.	1 Aug 69	Pump starter mechanism was changed to proper voltage.
78.	11 Aug 69	Sr. Raul Gomez (Field Technician) resigned.
79.	20 Aug 69	Planting Meloland sorghum at Site 86.

Table 8-2 (continued)

No.	Date	Description
80.	21 Aug 69	Second well yield test at Site 86 by Percasa
81.	22 Aug 69	Messrs. McLendon & Foresberg visit to Project.
82.	23 Aug 69	Lynn Castors seeded at Site 13.
83.	1 Sep 69	Sr. Gustavo Escobar (Field Technician) reports for duty. (Replacement for Gomez).
84.	7 Sep 69	Mr. Harkens arrives for program planning work.
85.	12 Sep 69	Nat. Guard Drill rig arrived at Site 86, to begin observation well excavation.
86.	21 Sep 69	Mr. Hotes arrived for Project irrig. consult. work.
87.	24 Sep 69	Mr. Hotes left for U.S.A.
88.	30 Sep 69	Mr. Harkens left for U.S.A.
89.	6 Oct 69	Tech. Coord. Com. Meet. postponed first time.
90.	15 Oct 69	" " " " " second time.
91.	20 Oct 69	" " held at Banco Central Managua.
92.	21 Oct 69	Picked up sprinkler pipe from Site 62 and moved to Site 86.
93.	28 Oct 69	Tech. Coord. Com. tour of Project Sites.
94.	3 Nov 69	Srita. Juanita Berrios Saenz reports for duty.
95.	4 Nov 69	Took soil samples of site 13 & 86 to La Calera.
96.	18 Nov 69	Mrs. Kley arrived for consultation of Project photo work.
97.	21 Nov 69	Alternate pump installation postponed at Site 86 by Percasa.
98.	4 Dec 69	Mr. Hargreaves visit to Project for evaluation report to Mr. Arneson, USAID.
99.	5 Dec 69	Mr. Koone & G.A.O. inspectors visit Project Sites 8, 13, 50, and 86.
100.	5 Dec 69	Combining Meloland sorghum at Site 13.
101.	29 Dec 69	Mr. Mason Marvel (vegetable expert) and Mr. Koone visit to Project Area. (Site 60)
102.	9 Jan 70	Pump installed at Site 86 by Percasa.
103.	4 Feb 70	Messrs. Harkens and Hotes arrived for program extension discussions.
104.	9 Feb 70	Planted corn at (Galo) Site 13.
105.	10 Feb 70	Planted corn and cowpeas at Site 4.
106.	11 Feb 70	Planted beans and corn at Site 50.
107.	12 Feb 70	Checked on irrigation at Site 4.
108.	13 Feb 70	Mr. Hotes left for U.S.A.
109.	17 Feb 70	Replanted corn in skipped rows at Site 4.
110.	19 Feb 70	Soil profile pits investigated at Sites 13 and 86.
111.	22 Feb 70	Aerial application of Diazinon on Sites 8 & 50.

Table 8-2 (continued)

No.	Date	Description
112.	25 Feb 70	Mr. Harkens met with Mr. Dave Stine at Banco Nacional.
113.	3 Mar 70	Dr. Reed arrived in Nicaragua.
114.	4 Mar 70	Meeting of Coop. in Leon.
115.	6 Mar 70	Mr. Frizel talked about Yuca.
116.	10 Mar 70	Mr. Harkens met with R.D.O. officials about extension of P.A.
117.	10 Mar 70	Dr. Reed returns to the U.S.A.
118.	11 Mar 70	Mr. Harry Pitts visited Project.
119.	15 Mar 70	Mr. Harkens leaves for Colombia.
120.	18 Mar 70	Castors moved to Managua for threshing.
121.	20 Mar 70	Mr. Harkens called from Managua.
122.	21 Mar 70	Quequisque replanted at Site 8.
123.	22 Mar 70	Mr. Edwards leaves Project to return to his home in Idaho.
124.	23 Mar 70	Yuca material moved to Site 4.
125.	25 Mar 70	Boron and Gesaprin plots established at Site 86.
126.	31 Mar 70	Mr. Maestas arrived in Nicaragua to work on soils report.
127.	2 Apr 70	Leaf burn noticed in Lynn castors.
128.	7 Apr 70	Sprinkler pump out at Site 50.
129	13 Apr 70	Rain in Leon 0.85 inches.
130	14 Apr 70	Rain in Leon 0.80 inches.
131	17 Apr 70	Planted 1.8 mz. corn and 0.5 mz. millet at Site 8.
132	18 Apr 70	Planted 4.0 mz. corn at Site 50.

Table 8-3

MAJOR AGRONOMIC ACTIVITIES

(In Chronological Order)

by Project Agronomist

No.	Date	Description
1.	8 Feb 68	Arrived Managua.
2.	9 Feb 68	Meet Mr. Koone, USAID and Dr. Lovo, MAG.
3.	10-18 Feb 68	Tour Leon-Chinandega area.
4.	19-20 Feb 68	Visit potential project cooperator sites.
5.	21-24 Feb 68	Work on cropping plans, schedule for Mr. Hoffman's visit.
6.	25-29 Feb 68	Assist with the Monthly Report.
7.	1-9 Mar 68	Tour of markets and Western Nicaragua with Mr. Hoffman, Vegetable Crops Specialist, Uniconsult.
8.	10-16 Mar 68	Crop plans & marketing report with Mr. Hoffman.
9.	19-31 Mar 68	Site selection.
10.	1-11 Apr 68	Site selection, visit San Ramon Farm.
11.	20 Apr 68	Make arrangements for use of 5 manzanas of irrigated land on the La Leona Farm.
12.	29 Apr 68	Visit Corona Oilseed Co. and Custom Fertilizer Service, Managua.
13.	1-23 May 68	Work with Dr. Reed, Ag. Economist, Uniconsult, Inc.
14.	24-29 May 68	Plant Crops at La Leona.
15.	5-11 Jun 68	Signing of Cooperators.
16.	19 Jun 68	Meeting with Mr. Astorga, National Bank - promise full support of Bank for Loans to Cooperators.
17.	19-20 Jul 68	Irrigate at La Leona.
18.	30 Jul 68	Harvest of irrigated corn at San Geronimo.
19.	20 Aug 68	Plant corn at El Olivo.
20.	30 Aug 68	Work on irrigated rice fertilization at La Queserita.
21.	5 Sep 68	Replant corn at El Olivo - first planting lost to lesser corn stalk borer.
22.	12 Sep 68	Plant beans and peanuts at El Olivo.
23.	24 Sep 68	Apply fertilizer test at La Leona.
24.	2 Oct 68	Visit of Peanut experts, University of Florida.
25.	15 Oct 68	Plant Quequisque at El Olivo.
26.	23 Oct 68	Plant Sesame and Meloland Sorghum at La Leona.
27.	30 Oct 68	Plant Safflower, soybeans, corn millet and vegetables at La Leona.
28.	1 Nov 68	Transplant tomatoes at El Olivo
29.	2-20 Nov 68	Work with Dr. Reed, Uniconsult Economist, on crop costs.

Table 8-3 (continued)

No.	Date	Description
30.	1 Dec 68	El Olivo is abandoned because of failure to get bank loan for irrigation pumps.
31.	10 Dec 68	Picking of an excellent crop of cucumbers - started at La Leona.
32.	10-23 Dec 68	Harvest Millet (See Dec. Monthly Report for results)
33.	16 Jan 69	Plant small field of Safflower at Penjamo.
34.	30 Jan 69	Ratoon crop harvest at La Leona with the best varieties yielding over 10,000 lbs. per manzana for the two harvests. The cucumber yields indicated that over 20,000 lbs. per manzana could be produced.
35.	15 Feb 69	Harvest corn and Ryer sorghum at La Leona.
36.	15 Feb 69	Harvested 8 varieties of peanuts at El Olivo. (See February report)
37.	15 Feb 69	Planted 3 small plots of safflower.
38.	20-30 Feb 69	Planted 20 manzanas of irrigated crops at Pineda's. Planted 10 manzanas of irrigated crops at Reyes' Planted 14 manzanas of irrigated crops at Fonseca's.
39.	4-13 Apr 69	Dr. Lovo visited the Project farms.
40.	6 May 69	Harvest safflower at Reyes.
41.	8 May 69	Field Day at Pineda's.
42.	9 May 69	Harvest cucumbers and okra at Pineda's.
43.	2-14 Jun 69	Bird control by U.S. Department of Interior experts.
44.	15 Jun 69	Complete cucumbers harvest of 34,000 lbs/mz. at Pineda's.
45.	20 Jun 69	Sorghum field lost to rain and birds.
46.	25 Jun 69	Meet with Corona Oilseed Co. for trying Project peanuts.
47.	26 Jun 69	Dr. Reed, Uniconsult Economist arrives to work.
48.	4 Jul 69	Sell okra seed from Pineda's to Mr. Callejas.
49.	10 Jul 69	Start sorghum harvest at Fonseca's.
50.	12 Jul 69	Start peanut harvest at Reyes.
51.	17 Jul 69	Start peanut harvest at Pineda's.
52.	25 Jul 69	Test furrowing shovels at Vaca's.
53.	26 Jul 69	Sell Fonseca's sorghum at $18 per cwt.
54.	1 Aug 69	Harvest late okra at Pineda's with combine.
55.	7 Aug 69	Start peanut harvest at Fonseca's.
56.	20-22 Aug 69	Plant Sorghum and castors at Escobar's.
57.	22-23 Aug 69	Plant sorghum and castors at Galo's.
58.	26-27 Aug 69	Plant Sorghum and millet at Vaca's.
59.	3 Sep 69	Sell Fonseca and Pineda peanuts to Corona at $40 per cwt.
60.	20 Sep 69	Plant cowpeas and sweet corn at Vaca's.
61.	11 Oct 69	Callejas starts harvest of Yuca at Pineda's.

Table 8-3 (continued)

No.	Date	Description
62.	17 Oct 69	Work on getting quequisque into U.S. duty-free
63.	19 Oct 69	Rice birds eat millet at Vaca's.
64.	28 Oct 69	Technical coordinating Committee visits project.
65.	17 Nov 69	Work with Catastral group on soils maps.
66.	19 Nov 69	Mr. Van Hooven, Vice President of Grand Union Food visits Project.
67.	25 Nov 69	Plowing at Pineda's at 4-6 inches --- unacceptable.
68.	27 Nov 69	Callejas offers buy quequisque -- Pineda rejects offer.
69.	1 Dec 69	Make arrangements with Banco Nicaraguense to get moldboard plow and ditcher for canals.
70.	3 Dec 69	Start harvest of Galo's Sorghum.
71.	10 Dec 69	Harvest Vaca's Sorghum, cowpeas, and sweet corn.
72.	11 Dec 69	Chop Galos Sorghum for ratoon crop.
73.	12 Dec 69	Have Madeca make furrowing equipment.
74.	13 Dec 69	Take moldboard plow to Pineda's.
75.	16 Dec 69	Start harvest of Escobar's Sorghum. Start irrigation on ratoon Sorghum at Galo's.
76.	11 Jan 70	Make raised beds at Pineda's.
77.	14 Jan 70	Make raised beds at Vaca's.
78.	22 Jan 70	Plant cowpeas and sorghum at Pineda's.
79.	24 Jan 70	Use wooden bedshaper for safflower planting.
80.	25 Jan 70	Plant safflower at Pineda's.
81.	27 Jan 70	Plant yuca at Pineda's.
82.	28 Jan 70	Plant corn at Galo's.

Chapter 9

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Chapter 9

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

9.0 - SUMMARY

In January 1968, the Minister of Agriculture of Nicaragua signed a contract with Uniconsult, Inc., a United States company, to implement Project Adelante. This agreement was financed by funds supplied by the United States Agency for International Development which provided for payment of the contractor, equipment and operating expenses.

The purpose of Project Adelante was to stimulate irrigation development and to identify alternative crops, testing them on demonstration farms under irrigation, in the development of year-around cropping programs. The Project was designed to work through local farm cooperators, each drilling a well on his land to carry out the demonstration program. The Project supplied the sprinkler system, in addition to technical assistance to the farmers. Funds for the purchase of sprinkler systems were provided by the United States Agency for International Development.

The Project is located in the Leon-Chinandega area, 60 to 80 miles northwest of Managua, and is one of the best agricultural areas in the Pacific Zone of Nicaragua. The soils are extremely good and the topography and climate are well suited for intensive agriculture. However, the area receives no rainfall during the six-month period of November to May, which reduces the effective year-around use of these resources.

An irrigation engineer and an agronomist were provided by the contractor, plus part-time consultants. The irrigation engineer and agronomist were resident staff and lived in Leon, where the Project office is located. The Nicaraguan staff, provided by the Minister of Agriculture, included both technicians and clerical personnel.

A comprehensive report covers the period January 1968 through May 31, 1970, the period of Uniconsult's involvement. During this period, monthly reports were published regularly by the contractor.

9.1 - RESULTS

The goals of the Project have been accomplished and an important segment of work essential to widespread irrigation and new cropping practices has been completed. A coordinated group, represented by the two resident staff members from Uniconsult and the Nicaraguan technicians and clerical staff, was responsible for the accumulation of data and results. The most important results of Project Adelante were:

- identification of alternative crops under irrigation
- substantiation that there are no basic limitations in producing these crops under irrigation
- economic analysis of these crops

- identification of those factors which are most limiting in the development of irrigated agriculture and which will delay its success.

Demonstration farms were established and a wide range of information was collected in the two-year Project period. Work was planned and carried out in a manner so that the Project was able to evaluate irrigation potential in the area and test crops, cropping patterns and markets. New crops and new cultural methods were identified and tested and the results circulated in the report published each month.

The crops which were identified for irrigation are: safflower, castor beans, grain sorghum, corn, Foxtail millet, Pearl millet, yuca, quequisque, cowpeas, and peanuts. It had already been established that pasture is an adaptable crop under irrigation. Other adaptable crops for irrigation on less widespread acreage are: citrus, okra, melons, tomatoes, cucumbers and sweet corn.

Information was gathered on operations in crop production and records were kept for analysis by the consulting farm management economist. Sample cost studies representing actual conditions were developed from this material.

In many cases Project staff was required to carry out on-farm operations including irrigation, tractor and equipment operation, and direct supervision of field labor. All exploratory marketing was done by Project staff and in a number of instances these personnel located buyers and negotiated sales for the cooperator. As a result, this group became extremely knowledgeable in the many details of intensive irrigated cropping in the area.

The period of Project operation also resulted in the identification of problems associated with irrigation and multicropping. There were problems with weather, equipment and lack of equipment, diseases, insects and with people.

Low yields and low profits from the crops grown on the demonstration farms were major problems in developing farmer enthusiasm. Crop losses were quite common and a normal part of the information processes. At times, these losses were due to lack of equipment, poor timing or breakdown of communications. It was understandable that at times farmers and Project personnel were disappointed and discouraged.

New work will lead to high yields through improved management practices, because the results of Project Adelante were significantly encouraging regarding the potential for irrigated agriculture.

9.2 - CONCLUSIONS

The Pacific Zone of Nicaragua has the physical requirements necessary to develop irrigated agriculture and year-around cropping.

Soils in the area are extremely well suited to intensive crop production under irrigation. Compared to many areas of the world, the Pacific Zone has a very high percentage of outstanding soils for irrigation. These soils are producing the highest yields of cotton without irrigation. There are soils in the Project area however, with production limitations under non-irrigated agriculture, which become extremely good producing soils under irrigation. The very light, sandy soils and the shallow soils, where moisture storage is limited, are examples of the kinds of soils that, with irrigation and the proper cropping practices, can compete with the best soils in the area. As irrigation develops, these very light soils will become premium soils.

Water quality is excellent for irrigation. Adequate supplies are available with pump lifts that result in acceptable water costs.

The equipment and personnel for well development are available in the area. Farmers who plan to go into irrigation should make sure that the irrigation equipment can be supplied at the proper time by the dealer. This can best be enforced by a penalty clause in the contract. However, the Project experienced a serious delay in pump delivery from one supplier. A major unknown is the extent to which irrigation can be developed from ground water sources.

Climate is moderate, with temperatures ranging between 70 and 90 degrees Fahrenheit, which is very acceptable for a large number of crops.

Day length at this latitude is a factor in the exclusion of some crops such as soybeans, which require longer days for high yields. Day length may play a more important role than is presently known in affecting yields of corn and even grain sorghum.

Rainfall is not always adequate for optimum plant growth and there will be many occasions when supplemental irrigation will be required. This will be particularly critical in the August to October period when growers are trying to establish new stands that are to be harvested in the dry season.

When rains are heavier than usual and extend beyond the normal season, as in 1969, there can be serious damage to growing crops, delays in harvest and subsequent delays for following crops.

Dry Season is normally dependable, but it is limited by torrential rains at each end of the season. The growing season may be extended by planting early, when possible, in September or October, but final harvest of irrigated crops must be finished by May 15. Careful crop selection and scheduling is required to get full cropping use of the dry period.

Topography - Much of the area is quite flat and a significant percentage of the irrigable land requires minimum earth moving and shaping for surface irrigation. These areas should be identified and designated for surface irrigation. Large acreages that can be surface irrigated provide additional competitive advantages for the production of irrigated crops. This would be based on lower water costs, labor costs and improved efficiency under favorable wind conditions.

There is a relatively wide choice of alternative crops that are well adapted to the Pacific Zone.

As Nicaragua shifts to irrigation, new crops and cropping programs will be needed. Under irrigated conditions the big need will be for extensive crops which can be grown on large acreages. Intensive crops such as citrus, melons, tomatoes, cucumbers, sweet corn, okra and similar crops are higher income crops, but the existing markets will only support a very small acreage of these crops. In the examination of crops in this category, sugar cane, tobacco, rice and bananas were left out because of the special nature of these crops. There are a number of crops which grow very well in the dry season with irrigation, while the crops that can be grown during the rain season are not as plentiful. The potential crops both for industrial use and feed purposes are shown below.

Feed Crops are:

Grain Sorghum: harvest time limited to dry season
Corn: suitable for wet season production
Millet: (Foxtail and Pearl) dry season crop
Yuca: 10 month crop
Pasture: two to three year crop

Industrial Crops are:

Castor Beans: dry season only
Safflower: dry season only
Peanuts: harvest limited to dry season

At present, beans, soybeans and Proso millet are not acceptable as crops for the area. Quequisque is a promising crop under irrigation but since it is for fresh market, the acreage must be fairly small.

The change from rain-fed, one-crop-a-year farming to intensive multi-cropping will change the important crop producing period from the rain season to the dry period. There will be more difficulty in identifying rain season crops than irrigated dry season crops. Cotton will require major changes in cultural practices to be a part of the year-around irrigated cropping program. Timing will not permit cotton to be grown during the dry season with irrigation and there is no economic advantage in growing cotton during this period.

The major problem will be to train the human resources to meet the intensive demands of irrigated agriculture.

There will be problems and delays in getting the people - owners, foremen, equipment operators, labor and technicians to make the changes necessary for year-around agriculture. This is the weakest resource in the potential for irrigated agriculture.

The on-farm personnel, from the farm managers to the foremen and the farm laborer, are not prepared through training or experience to meet the demands of year-around irrigated cropping. There is a lack of management ability in what to do, how to do it and when. There is adequate available labor but it is untrained. Supervisors (labor foremen) are untrained or non-existent. Technicians from the research stations, the extension service or the banks are not supporting the farmer at the level needed. At present the best help available to farmers is from commercially oriented sources, which are not always objective nor unbiased.

The income potential is quite high for irrigated agriculture in the Pacific Zone.

There will be real economic benefits from irrigation and year-around cropping as the productive use of land is extended to include the entire twelve-month period. Land will only be out of use for the time required to harvest, pre-irrigate, and to prepare a new seedbed and plant. Crops that are presently impossible to grow can be grown in the dry season with irrigation.

Studies by the Project show that costs of the inputs of production are in line with other irrigated areas, such as California. Power costs (water cost) are slightly higher than comparable conditions in California. However, future water supplies in California will cost considerably more than water is costing farmers in Nicaragua. Labor in the area is inexpensive on an hourly basis, but is expensive on a job basis and in work quality, due primarily to lack of training and supervision. Cost of land (or rent) is low when compared to most areas with comparable soil and the supporting facilities found in the Pacific Zone of Nicaragua.

The cost of production per unit produced is very high at present, because of low yields. In order to lower unit costs, it is necessary to increase some input costs such as fertilizer, insecticide or others, as the needs are identified. These added inputs will increase the yields and thus lower the cost per unit.

Existing credit programs are not geared to the needs of irrigated agriculture. Bank technicians need more training in irrigated agriculture and should be involved more directly in supervision of credit at the farm site.

Farm equipment is not adequate for the intensive program under the very demanding schedules connected with year-around cropping. Delays in getting machinery to the field at the proper time contributed to low yields and crop losses. Farmers do not have the proper equipment and what they have is in poor repair. This equipment deficiency applies also to post harvest equipment such as storage, dryers, and other processing machinery.

Ownership units are large enough to justify the investment required in the irrigation system and operating equipment. This is not true in much of the world where land units have been divided to a size too small to develop an economic or management unit.

A normal tendency as cotton acreage declines will be to keep the high yielding areas in cotton and use the less productive areas for irrigation. As the pressures due to lower world price and poorer average yield affect cotton acreage, the normal inclination by the financing agency will be to reduce cotton production on the less suitable land by limiting cotton loans to the best soils. From a lending agency's point of view this may be the soundest way to reduce risk. From the Nicaraguan land use standpoint, this approach may not meet the needs of the agrarian economy.

The better lands have more crop flexibility even without irrigation than the less productive cotton lands. A careful look might suggest to land use planners that cotton should be used on the lower range (not the poorest) of the previous cotton acreage and reserve the higher classification areas for more intensive land use. This will not come about if the criteria used by lending agencies is the only influence on land use.

To return the highest profit on the investment, irrigation should be combined with the greatest degree of intensive farm management and the most suitable land available. Under present circumstances, the major influence on land use comes from the lending agencies. But the lending agencies are not as concerned with appropriate use of land resources as they are with reducing the risk on their production loans. This, in fact, is what they should be concerned with, but they should also be a part of an overall land use planning group. However, there is no land use planning group in Nicaragua at this time, but one is needed to be sure that the most suitable land is designated for irrigation.

9.3 - RECOMMENDATIONS

Training Programs are the first priority need in the development of irrigation. Training is a major undertaking and should involve active assistance by the Banks, Infonac, MAG, equipment dealers and other commercial organizations.

Participation in training programs should be mandatory for everyone going into irrigation. A requirement that equipment operators, foremen and laborers take part in these courses could be a condition of production loans. Owners who act as farm managers are the group which needs this help most seriously. In some fashion they must be influenced to participate. Training programs must be geared to these different groups of people involved in the farm operation, the farm foremen, equipment operators, laborers, and farm managers.

Farm foremen need to learn how to supervise the laborers and equipment operators and carry out the field operations as laid out by farm managers. These people should know how to keep records and some theory relative to irrigation and crop production.

Laborers need training in hand operations such as thinning, weeding with hoes, moving sprinkler pipe, replanting and harvesting. Women should be included in this training because they are particularly good as members of thinning and weeding crews.

Equipment operators need practical training on a formal basis. There will be new operations to be performed and new equipment used in irrigated farming. The condition of most equipment and the quality of work performed are extremely poor. The workers must have help in order to gear up to the demands of irrigated crops.

Owners and managers need courses in enterprise accounting and analysis and in principles of irrigation, weed control and management factors relating to the problems on their farms.

Training programs must be supported by technical assistance at the farm. This may be supplied by the Extension service and Bank technicians. These people aren't doing this job now but with support, training and discipline they can provide badly needed assistance.

A Machinery Program with Custom Equipment Operators is the second priority need. Farmers cannot afford to buy all of the equipment necessary to carry out the intensive work to be done. The major jobs are land preparation, furrowing out, and harvesting. In an irrigated program, some of these jobs, like land preparation (disking, plowing, harrowing) will be done three times as often each year as they are now.

The recommended method to assist the farmers with these peak equipment loads is to establish custom operators with large-size equipment to augment the equipment which the farmers now have.

The people who become involved in this business should be owner-operators. That is to say, loans should be made to individuals who will devote full-time to the management of this specific business. It is essential that the owner not only manage but also be able to operate most, and preferably all, of the types of equipment used. To make the Custom Operator program work, in addition to the proper selection of the owner-operators, there must be:

- A complete order of equipment provided, including a pick-up and trailer.

- Equipment loans at a subsidized rate or a direct use of the capital equipment funds. This must be a standard medium term loan which doesn't require non-movable assets as collateral.

- A technical agricultural group, to approve the quality of work performed.

- A guarantee of payment to the operator. The recommended method is that the operator be paid by the bank from the farmer's production loan fund.

- Agreed-on prices for work performed which are high enough to cover total costs, including interest and depreciation plus an agreed-on profit. These prices should be agreed on with the credit organization.

Supervised Production Credit programs are seriously needed as a supporting tool for irrigated agricultural development. Loans should be based on actual costs of production with the proper level of inputs. The loan should not include cost of living. If a cost-of-living loan is needed, a personal loan should be made to the farmer, with the collateral being something other than the crops.

In a Supervised Production Credit program, bank technicians visit the farm repeatedly to be of assistance, to confirm that the inputs are made to the crops and to go over the records for each crop. It is the responsibility of the farmer to keep accurate and detailed records of each operation on each crop. The responsibility of bank technicians is to see that the money resource is used effectively.

Land Leveling for Surface Irrigation is the next recommendation. In previous sections it has been stated that large areas in the Project area can be leveled for surface application of water with a minimum movement of soil. This should be started now by including a unit or two of land leveling equipment in the custom operator's equipment list. A training program is needed for the land leveling equipment operators and this can be done most easily by starting now.

A Tissue Testing Laboratory is recommended for the purpose of developing information on plant nutrition and optimum fertilizer levels. These results cannot be obtained from soil testing and the results from Project Adelante show that there is much to be learned about the kinds and amounts of fertilizers needed for maximum production.

9.4 - RECOMMENDATIONS FOR PROJECT ADELANTE

Project Adelante's future roll should be quite different from what it has been. The identification of new crops has largely been done, although this does not mean that the subject has been exhausted completely. Certainly an awareness of, and interest in, potential new crops and varieties should be encouraged, in both technical personnel and farmers, but it is believed that research and experimentation for new crops might best receive its primary emphasis at Experiment Station farms. At the same time Adelante demonstration farm work should be concentrated on those extensive crops already identified as being potentially profitable.

If the work is done on intensive crops, such as tomatoes, melons, cucumbers, and similar fresh market crops, the results might be more profitable to the Project farmer, but not to the total irrigated community. The future for the large irrigated zone is in extensive crops like grain sorghum, safflower, peanuts, castor beans, and possibly yuca. These can be grown and marketed in large amounts, while intensive but more profitable crops have very limited markets. Therefore, the work must be done with the lower income per unit crops to show how to produce high yields of these crops.

Farmers need information on a multitude of items, such as: seedbed preparation; irrigation furrows, ditches, and equipment; planting times; plant population; proper farm machinery and equipment; proper times, types, and amounts of fertilization; times and manner of cultivation; disease and pest control procedures and materials; irrigation amounts and timing for good yields; and harvesting. All of this information must be directed towards reducing production costs, and maximizing yields, of the already-identified crops. Supplying the information, even when determined, is only the beginning. As stated in Section 9.3, each farmer and his workers must learn to properly use the information on his demonstration area. This will not be accomplished instantly, and until the farmer can produce good yields at reasonable costs on small areas, he cannot be expected to economically farm and irrigate on large areas.

It seems reasonable, therefore, to make provisions for some subsidy to cooperator farmers, if necessary to prevent, or limit, financial loss to them during their learning and development period with extensive crops. As they learn, as proper equipment becomes available at reasonable rates, and as markets materialize with fair prices, the need for any subsidy, if such need exists at all, will diminish and vanish. The subsidy might be in the form of a small rental for the demonstration area.

It is recommended that the Project rent a portion of each demonstration farm so that work can be continued on extensive crops, with information, rather than profit, being the primary purpose of the program. Efforts should be made to encourage increased owner-farmer participation in the farming operations, and perhaps an incentive subsidy, based upon meeting or bettering target values for yields per manzana, or production costs per unit of crop produced, should be given consideration.

One of the demonstration farms should be rented by the Project for the purpose of carrying on intensive plot work. This will allow plot work to be carried out which would develop information on differences in time of planting, plant population, fertilizer response and other cropping practices.

In order to do this plot work and to carry out demonstration work at the cooperator sites the Project must have farm equipment at its disposal. It was clear from the experience with Project Adelante that the lack of available equipment seriously hampered the success of the program.

The continuation of Project Adelante is recommended through the support of USAID under the conditions outlined. There is a real and immediate need for the information that can be developed and demonstrated. This will require:

- A subsidy to the cooperator farmer for the land used to demonstrate extensive crops.
- A rental of one demonstration farm for plot work.
- The purchase of equipment for use by the Project.

Without these changes and supports, the Project will not be able to contribute substantially to the early and widespread use of irrigation in the Pacific Zone. The financial position of the cooperators will not improve significantly, and may even show a loss during the initial years, for reasons explained previously. There will then be a tendency to measure Project success by economic returns rather than by the information and demonstrations it provides to the farming community; data without which the farmers would find it exceedingly difficult to produce large acreages of irrigated crops at a profit.

Unless the supporting programs can be provided by a Nicaraguan organization which the consultants feel should be the Ministry of Agriculture, it is recommended the program be terminated. This would be better than to carry on a token program which is not geared to the needs of the area. It has been recommended throughout the period of the Project that the Project personnel be highly qualified and be located in Leon. The salaries paid these people should be increased beyond the standard scale to assure the highest qualifications and compensate for the time required by this job. This concept was a part of the original ProAg and the consultants recommend that it be a mandatory part of any program continuation whether the additional salary increment be funded from the host country or USAID support.

The consultant's recommendation regarding the continuation of Project Adelante as a USAID supported program is that it is worthwhile under the conditions previously stated. If the Project can be structured with the personnel, the farm equipment and the subsidy program to the cooperators which allows work to continue on extensive crops for the good of the entire developing irrigated community, the consultants recommend that USAID continue to provide financial support, including the services of a United States consulting firm.

If these conditions are not possible, the consultant recommends that USAID assist Nicaragua in the specific programs recommended in this report:

Formal Training Programs

Custom Operator Equipment Programs

Supervised Production Credit

Land Leveling, helping to supply initial equipment and operator training

Tissue Testing Laboratory

These programs, any or all, can be carried out without involvement in a project such as Adelante and still provide the assistance to the expanding irrigated area.

The time and money invested in Project Adelante are just reaching the stage that will bring about important results to the irrigated area. The consultant strongly recommends that the MAG and USAID find ways to make the recommended additions and continue Project Adelante.

APPENDIX I

INITIAL REPORT ON ORGANIZATION OF NEW MAG DEPARTMENT OF IRRIGATION AND SOIL CONSERVATION AND NEED FOR IRRIGATION AND WATER USE REGULATIONS

by

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Submitted to

PROJECT ADELANTE

Leon, Nicaragua

May 1968

APPENDIX I	INITIAL REPORT ON ORGANIZATION OF NEW MAG DEPARTMENT OF IRRIGATION AND SOIL CONSERVATION AND NEED FOR IRRIGATION AND WATER USE REGULATIONS
APPENDIX I-A	Selected Bibliography on Water Law and Codes
APPENDIX I-B	Example of Application Form Used in the State of California for Application to Appropriate Water
APPENDIX I-C	Example of Well Driller's Log Used in the State of California
APPENDIX I-D	Plates - New MAG Department of Irrigation and Soil Conservation

SPECIAL SUPPLEMENT TO APPENDIX I - (Decree Prepared but never Published)
Ministry of Agriculture and Livestock
Managua, D. N.

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INITIAL REPORT ON
ORGANIZATION OF NEW MAG DEPARTMENT OF IRRIGATION AND SOIL CONSERVATION AND NEED FOR IRRIGATION AND WATER USE REGULATIONS

by Frederick L. Hotes, Irrigation Specialist

Chapter 1

INTRODUCTION

1.1 SPECIFIC IMPETUS

"Fundamental to attainment of the project objectives is the establishment of a department or entity of the MAG which can develop the capacity to be the official center for irrigation development, and carry-on investigation and development as required. Through the assistance of well-qualified U.S. technicians, various forms of training, both here and in the U.S., and additional experience, this department of the MAG can develop the capacity to assume increasing responsibilities of continuing phases of irrigation development and related soil and water conservation, and also to start establishing irrigation and water use regulations which can avert many difficulties, and water and irrigation mismanagement, in the future."

The preceding quotation from the May 20, 1967 Project Agreement between MAG and AID, which set both objectives, scope, and financing for Project Adelante, summarizes the initiating impetus for this specific report.

1.2 PRESENT MAG ORGANIZATION FOR IRRIGATION AND SOIL AND WATER CONSERVATION

As regards organization, at the present time the Engineering Department of MAG has the responsibility for irrigation and soil and water conservation activities within that Ministry. This department is organized as follows:

ENGINEERING DEPARTMENT - MAG

			Totals
Office of Chief of Department	Engineer - Director	- 1	
	Secretary	- 1	
	Office Boy	- 1	
	Draftsman	- 1	4
Irrigation Division	Technicians	- 2	
	Subprofessionals	- 2	4
Soil Conservation Division	Surveyor	- 1	
	Subprofessionals	- 3	4
Agriculture Industrialization Division	Technician	- 1	
	Subprofessionals	- 2	3
		TOTAL	15

While this Department is providing many necessary services at the present time, it is not functioning as the principal center for irrigation activity in the country. In the first place, there are relatively few areas of agricultural land under irrigation, and the largest blocks of such land are under the management of private groups, who generally have provided their own technical and development resources. In the second place, since 1950, when FAO recommended to the Government of Nicaragua that the irrigation potential of the Pacific Zone by investigated further, the extensive studies and preliminary planning which have been carried on, primarily have been handled, on the Nicaraguan side, through the Institute of National Development (INFONAC). Consequently there has not been great pressure for expanded MAG services in this area.

Although Soil and Water Conservation planning has not received the same degree of financial and technical planning support as has irrigation, the MAG Engineering Department is active in providing technical assistance to farmers in conservation practices such as terracing and contouring. Its importance to the conservation of vital resources of Nicaragua has not been overlooked. Still, a tremendous amount of additional work remains to be accomplished in this field.

1.3 WATER RIGHTS AND REGULATIONS, PRESENT STATUS

At the present time Nicaragua has no formal Water Code, and few (if any) actively-enforced regulations covering the withdrawal, diversion, or use, of surface and underground waters. This is a normal situation in areas where water is considered to be in surplus supply. The majority of States in the U.S.A. in 1950 were in a similar situation. It is when water becomes a scarce commodity that the need for formalized laws, and regulations governing its use, and enforcement, becomes mandatory in societies which use law as an instrument of equity and justice.

Nicaragua does have several laws relating to water, but there is no regulatory or recording agency, other than the Judiciary. That is to say, unless a person can reconcile his differences with his neighbor in a dispute over water, his only legal recourse is to the courts, and each case requires an independent investigation of all facts. Unless a court decision has been rendered, one would have no way to prove his right to a water use, and even then, such a decision probably would not be binding upon persons who were not parties to the court action.

Now that the potential of irrigation has begun to be realized, Nicaragua has initiated action to develop a modern Water Code (or Law). Within the Ministry of Economics, Industry, and Commerce, Dr. Gilberto Bergman P. has been given a full-time assignment to draft such a law, and he has been working on this project now for several weeks. It is understood further that other studies are being made which may include aspects of this subject (i.e., the Natural Resources Inventory; the UNDP Ground Water Study; the FAO Study of Water Law in Central America).

The Project Adelante office has been asked already by one landowner, who irrigates by diversion from a river, how he can establish his water right with certainty, so that the very considerable investment which he has made in irrigation facilities can be protected.

1.4 PURPOSE OF REPORT

It is the primary purpose of this report to present recommendations for the organization, within MAG, of a new Department of Irrigation and Soil Conservation. It is the secondary purpose of this report to suggest some key points which should be considered in the drafting of water legislation and regulations.

1.5 SCOPE OF REPORT

This report is the result of information obtained, and observations made by Mr. Frederick L. Hotes, Irrigation Specialist, during his stay in León and

Managua during the period May 7 through May 21, 1968. In its preparation he has drawn upon his knowledge, experience, and references of irrigation organizations, water law, and regulations in most of the irrigated areas of the United States, and in many other countries of the world.

Because of this experience, the writer wishes to emphasize that there is neither a model irrigation organization, nor a water code, which can be adopted in total and be the best such for Nicaragua, or for any other place in the world. Each country has different physical conditions, different customs, different legal systems and histories, different governments, and different people. Consequently, it is believed strongly that each country must develop its own unique format and procedures for these matters.

However, despite differences, there are many elements which must, or should, be included in any organizational plans. This report presents these elements in a certain framework, with the idea that this might be an initial starting point for developing an organization. Three other prime considerations are:

1. The personal characteristics and abilities of the persons in the new organization.
2. The numbers of qualified personnel available.
3. The funds available.

These are seldom known initially, but the organization adapts to the resources available; or is adapted to them.

As regards the Water Code and Regulations, in view of the intensive efforts being carried on elsewhere within the government on that subject, this report will be limited to an outline of needs, particularly as related to Project Adelante. Some mention also will be made of certain basic principles.

Since this report is only an initial effort, it is hoped that, following review and study by MAG, Project Adelante will have the opportunity to work with MAG and other GON agencies, to help refine, implement, and develop, a new irrigation, soil and water conservation institution, and a Water Code and Regulations, for Nicaragua.

Chapter 2

ORGANIZATION FOR NEW IRRIGATION AND SOIL CONSERVATION DEPARTMENT

2.1 NEED

Initiation of Project Adelante marks the start of another important step in the progressive development of the full agricultural production potential of the Pacific Zone of Nicaragua. As the demonstration irrigation areas reveal the benefits to be realized from modern irrigation farming, more and more farmers will want to incorporate irrigation into their operations. They will obtain water from new wells, new pumping plants at streams and springs, and from new river diversion structures. At first, while these new developments are few in number and somewhat scattered in location, perhaps no great problems or controversies will arise. Inevitably, though, diversions from surface streams, or extractions from underground reservoirs, will begin to interfere with one another. Also, especially in the case of surface diversions, water can be developed at much less cost by the establishment and operation of an irrigation system for a larger area. In addition, unless used properly, irrigation can accentuate problems of water and wind erosion, many of which exist already; thus adversely affecting the future utility of a valuable natural resource---the soil.

For these and other reasons, it is necessary that irrigation development take place within a basic framework which is planned, with maximum freedom for private initiative and development included as an element of that framework. Furthermore, the state of the development, the problems, and the needs should be known to the government at all times, so that remedial measures or incentives can be applied early, for the public good. The government will have to assume the leadership in the development of larger projects, which are beyond the ability of groups of landowners to achieve.

As already mentioned in Chapter 1, the planning of large irrigation projects in Nicaragua is now being done under the aegis of government agencies other than MAG. The governmental operation and supervision of these projects, however, might be logically a prime responsibility of MAG. While agriculture is not the sole user of water, in an irrigated region as much as 90 percent of all the water used is by agriculture. (This was the case in the State of California, a state with many large industries and with many people, as late as 1950.) If MAG is to operate or control irrigation projects, it must be organized to do so.

This chapter indicates the nature of the functions of a department within MAG, which could enable that Ministry to discharge that responsibility. Bearing in mind that there is a shortage of trained technical personnel, the organization outlined herein also includes the planning function for future irrigation projects, on the premise that Nicaragua cannot afford to scatter, and diminish the effectiveness, or its limited number of irrigation technicians, and their training, and that it will be better for the government, the personnel themselves, and for the people, if all irrigation work is concentrated eventually in one department. More efficient management, less duplication of effort, and reduced operating costs should result. In addition, because the technology required is almost identical in soil conservation work and irrigation work, it is again only logical that these functions be carried-out within the same department.

2.2 FRAMEWORK FOR EVENTUAL ORGANIZATION

A. General Comments

Plate 1, located at the back of this report, is a conventional type of organization chart, showing various important activities with which a new Department would be involved, and their general relationship to one another and to two other new government activities. The chart does not indicate the number of personnel required, although the inference can be drawn that if all these activities were staffed by two or more persons that a substantial number would be needed. On the other hand, the workload might be such that one person could be assigned two, or more of these activities as his responsibility, and that some of the activities could be performed by other departments within (or outside) MAG. This certainly would be the case during the early years of the development of the department, as it is now. Regardless of the actual amount of workload, the chart performs a useful function by indicating, in a condensed form, the various major categories of work, technical and administrative, which must be performed.

B. Functional Organizational Chart

Plate 2, also located at the back of this report, presents the same organizational elements as shown on Plate 1, listed in a column rather than by a pattern of boxes. Across the top of the chart, within diagonal lines, are listed a great number of the functions which the department would be expected to perform. In each column leading down from a functional diagonal, a mark may be found opposite each departmental office which normally will participate in the proper handling of that function. For each function, only <u>one office is given primary responsibility</u>. It will receive support from other offices in the department, as indicated. Where another office plays a rather prominent support role, its responsibility is upgraded to secondary responsibility.

Thus, for any function, going down a column will reveal which offices have responsibility, and to what degree. Going horizontally across in the space for any office, will indicate all of the department functions in which that office participates. All of the Department responsibilities are summarized at the top, and all offices on the left.

This type of chart is a much more useful, and powerful, management tool than a conventional organizational chart. Functional responsibilities can be added, subtracted, or shifted, as may be appropriate to meet requirements, personnel, and budgets, and yet the responsibility for action is clearly identified; both to management and to all subordinate offices.

C. Change of Agricultural Industrialization Office

With the anticipated increase in irrigation and soil conservation work, it is suggested that it may be desirable to change the Agricultural Industrialization office, presently a part of the MAG Engineering Department, to the status of a separate MAG Department, or to make it a part of another MAG Department. It is concerned primarily with rural electrification, farm structures, and farm machinery, and probably could best be responsive to the needs of MAG outside the framework of the new Irrigation and Soil Conservation Department. Hence it is not shown on Plates 1 and 2.

2.3 INTERIM ORGANIZATION

A framework embracing all aspects of irrigation and soil conservation which could be brought logically into one integrated organization, for more efficient management and reduced costs, deliberately has been presented first, in the preceding section. When the potential (eventual) requirements are understood first, the initial organizational steps may be framed so that as the organization grows with the requirements of those it services it can do so smoothly and effectively. Otherwise organizational growth often is erratic and inefficient, with frequent changes which reduce service effectiveness.

Project Adelante is the first irrigation project operation of MAG. As it becomes fully operational, sometime before the end of the second project year, it may well be that the new department will be given another project to build and operate, or plan. With this assumption, First Phase Organizational Charts have been prepared, Plates 3 and 4 at the back of this report, which present a possible initial target organization. This First Phase may itself be an interim target, as discussions among top-level GON officials must take place, and decisions must be made as to the pace and schedule to be followed in the development of irrigation projects, and of the MAG role in irrigation and soil conservation activities, before work, personnel, and equipment loads can be established, and budgets drafted.

Plates 1 through 4 can provide a basis for these discussions.

2.4 NATIONAL ADVISORY COMMITTEE ON IRRIGATION AND SOIL CONSERVATION

A. Purposes

At the upper left of Plates 1 and 3 a new activity is indicated: a "National Advisory Committee on Irrigation and Soil Conservation." This committee would have advisory authority only. Its primary purposes are:

1) To provide MAG periodic information from a broad cross-section of knowledgeable people, on the needs for irrigation and soil conservation work in Nicaragua and on the effectiveness of current programs in these fields, and to make recommendations to MAG on the policies and scope of current and future programs related thereto, or on any aspects of irrigation and soil conservation work in Nicaragua.

2) To provide support on behalf of MAG irrigation and soil conservation programs before Nicaraguan legislative and executive bodies and agencies, by resolutions, letters, oral presentations, or other appropriate means.

3) To perform an important educational function by explaining, and providing facts on, MAG irrigation and soil conservation programs to other GON agencies, to district and local governmental bodies, and to farmers and other interested citizens.

B. Membership

Composition of the Committee would be as follows:

1) Minister of Agriculture and Livestock - Chairman
2) Prominent Nicaraguan farmer (who does not hold any public office) - Vice-Chairman
3) Representatives of other Ministries and GON Agencies who need to be informed on the subject and whose support is needed; such as,
   a) Ministry of Finance
   b) Ministry of Economics, Industry, and Commerce
   c) INFONAC
   d) One member from each branch of Nicaraguan legislative body
   e) Other
4) Two or more representatives of Banks who engage extensively in crop loans.
5) Four or five additional prominent Nicaraguan farmers

The preceding five groups all would be voting members. Non-voting members would be as follows:

6) Committee Secretary - Chief of MAG Department of Irrigation and Soil Conservation
7) Honorary Members - Non-Nicaraguan citizens who are interested in the subject and who represent agencies such as AID, BDI, FAO, etc.

Total membership should not exceed 20 to 25 persons, including the non-voting members.

C. Functioning

There would be no extra salary or per diem payments to any member, other than for travel expenses.

Meetings would be held at least four times each year, in Managua or elsewhere in Nicaragua, at the call of the Chairman. At least one meeting each year should be held in an area of activity in irrigation and soil conservation, such as León or Chinandega, where a field inspection trip could be made in conjunction with the meeting.

Whether or not all meetings should be open to the public and press is a matter best decided by Nicaraguan custom and law, but it is suggested that some of the meetings should be "open," so that the opinions and requests of other citizens can be obtained.

Representatives of agencies would be nominated by their respective agencies, upon invitation of MAG. All appointments would be by MAG.

Such advisory committees, especially those composed of citizens whose opinions are respected in their own communities, have been found to be an effective tool in the U.S.A. for developing "grass roots" support of programs, and in securing support of governmental agencies and legislative bodies for allocation of funds.

2.5 NATIONAL WATER RIGHTS COMMISSION

A. General

The need for new and comprehensive legislation on water rights has been summarized in the Introductory Chapter of this report. To be effective, such a law, and its implementing regulations, must be administered. It is recommended that this be done through an independent National Water Rights Commission as the decision-making body, supported by a fact-finding and field-executing Water Rights Division arm of the Department of Irrigation and Soil Conservation. These agencies and their relationship are shown on the right-hand side of Plates 1 and 3.

B. Water Rights Division

The administration of water rights and the allocation of the public waters of any state to various users, or applicants who aspire to become users, involves not only law and clerical work, but a considerable amount of technical knowledge and work, especially in the fields of hydrology, hydraulic engineering, and geohydrology. Furthermore, as has been mentioned previously, since perhaps as much as 90 percent of all water diverted from streams or reservoirs, or pumped from underground reservoirs, will be for irrigation use, an intimate knowledge of irrigation practices and soil-plant-water relationships is needed to establish or evaluate irrigation water requirements.

Since several technical personnel with these latter abilities will be available within the new Department of Irrigation and Soil Conservation, it would seem to be an efficient use of these technical resources, to utilize them to determine the technical facts in water rights cases, and to supervise the distribution of use of water at major diversion points when this is necessary. Historically this has been found to be the case in almost every one of the 17 western United States. The State Engineer, or his equivalent, has assumed this role, and in most instances still fulfills it. Of course it would be possible for the Chief of the new MAG Department to also assume this role, but for a reason which will be set forth in the succeeding section of this report, it is recommended that the Department's role be limited to fact-finding, data accumulation, and watermaster service.

Initially only the recording and data collection function would be required. Watermaster Service, the actual field supervision of major diversions or extractions, becomes necessary only after the National Water Rights Commission, a Court of Law, or a group of water users, decree or request such a strict supervision in an area where demand is greater than supply, and a continuous and equitable allocation, in accordance with decision or agreement by compact, is required.

C. The Commission

There are two principal reasons why the suggestion is made to have an independent decision-making body or the granting or determination of water rights:

1) Water use does involve domestic, industrial, power, mining, municipal, and recreational uses, as well as for irrigation. Conflicting requests do arise, and it is therefore good to have the power of final decision in a body independent of any specific interests. This is especially desirable when the new Department itself, and other government agencies, will be requesting water rights allocations for projects sponsored by them.
2) The new Department will have more than enough to do without entering the cross-fire of conflicting water demands.

It is suggested that the Commission be appointed by the President of the Republic, to serve a term of at least 4 years, and that the assignment be considered a full-time, salaried, appointment. (Initially, perhaps only half-time would be required).

It would consist of three voting members, and an Executive Secretary, with these qualifications:

An Attorney
An Engineer
Another appointee, who need have no special professional qualifications

All of these men should be of ability and stature commensurate with that of a Court Judge.

The Executive Secretary would be an attorney, or a highly-qualified administrator.

The Chairman would be designated by the President of the Republic, from among the three appointees.

Chapter 3

WATER RIGHTS AND REGULATIONS

3.1 NECESSITY

As has been indicated in Section 1.3 of the Introductory Chapter of this report, as irrigation increases in Nicaragua, problems and conflicts with respect to the rights and the amount of water which may be used by various parties, will arise and multiply, especially during periods of drowth. Persons, groups, and agencies, need to have reasonable certainty as to how much water they may use on a sustained basis, if they are to invest money in water development. One farmer in the León area already has discussed such a problem with Project Adelante personnel. Nicaragua does not now have a systematic, known, procedure to establish such rights as may exist now, or which could be acquired in the future.

There is even a more subtle danger. Persons may proceed on the assumption that they have all the water they need, and find out later that the development of the same source of water by others has caused an overdraft condition, which, if allowed to continue, will exhaust the supply. This is more readily apparent in the case of surface water diversions, in which case the downstream user often learns after a few years that upstream users have reduced the amount of water available to him. He may not know which, if any, of the upstream users have precedence over him. In the case of ground water, hundreds of farmers may have wells drilled, and use the water for many years, even though the water levels may slowly fall, with resultant increased pumping lifts and costs. Which of these must cease pumping, if any, if an overdraft exists?

In another type of case, a new well on a farm may significantly lower the water levels in the well of his neighbor. What are the rights of each, and how may these situations be avoided?

These problems are not yet numerous in Nicaragua. Now is the best time to inaugurate new procedures. Project Adelante can serve to some extent in a helpful role in implementing action for both surface and ground water rights within its area of operations, once the proper administrative and legal framework has been provided.

3.2 REFERENCE SOURCES

Since Nicaragua has no Water Code at present, she is free to develop one which can be in accord with legal traditions in the country, insofar as possible, and yet incorporate the best from the experience of countries which have had working water codes and regulations for many years. Nicaragua need not, indeed she should not, repeat the many mistakes which have been made elsewhere.

Vested water rights under Nicaraguan law should not be summarily abrogated without just compensation. On the other hand, now, while few water shortages exist, is the time to reacquire and reallocate these rights, if this be necessary for the greatest ultimate public welfare. This may not at all be necessary if the new laws and rules are adopted and implemented promptly.

The writer is prejudiced in favor of western U.S.A. water law experience, as the best basis for development of a Nicaraguan Water Code. He believes that this prejudice is independent of the fact that he is a citizen and resident of that area of the world. Instead, it is based on his knowledge of the state of water code development and water law in many countries of the world. The western U.S.A. experience reflects millions of hectares of irrigation development, by both private and public agencies, and reflects a long tradition of government by law. It reflects also the results of innumerable problems and disputes, the resolution of which have helped refine and hone the law. Certainly the greatest concentration of combined surface and ground water use in the world today, exists in that area; and this is one of the major areas of technology.

Furthermore, western U.S.A. water law is not purely a derivative of English law, as many might believe. Indeed, some of the most important English riparian law was derived from U.S. court decisions!!! Roman, Spanish, and Mexican water law, tempered and adjusted to meet the needs of a society which is both agricultural and industrial.

The foregoing does not imply that western U.S.A. water law is perfect, for this certainly is not the case. Every state has a different code, and it is certain that the Nicaraguan Code will be different also from any of those.

In Appendix A of this report, a limited selective bibliography is presented, of some references which can provide excellent background material on water law, codes, and regulations.

3.3 BASIC PRINCIPLES

A. General

The items to be set forth subsequently in this section certainly are not all-inclusive. They are only a few of the more important ones.

Among those in the U.S.A. who are familiar with ground water law, those of the State of New Mexico generally are considered to be the most detailed. As a total Water Code, that of the State of California is probably the most voluminous, and one of the best. It is interesting to note, however, that California does not have a regular system for obtaining an appropriative ground water right; and that this is considered, by many, to be a weakness.

Extracts and paraphrases from and of both New Mexico and California water law and regulations will be given to illustrate certain points in the following discussion, along with other statements.

B. Ownership of Water

California - "It is hereby declared that the people of the State have a paramount interest in the use of all the water of the State and that the State shall determine what water of the State, surface and underground, can be converted to public use or controlled for public protection." "All water within the State is the property of the people of the State of California, but the right to use of the water may be acquired by appropriation in the manner provided by law."

New Mexico - All natural waters flowing in streams and water courses in New Mexico are declared to be public and subject to appropriation for beneficial use. Where any well is to be drilled within the boundaries of a declared underground water basin, application to appropriate shall be submitted to the State Engineer.

Nicaragua - Dr. G. Bergman P. of the Ministry of Economics, Industry and Commerce, informed the writer that Nicaraguan law presently states that all water belongs to the public (State). This is an excellent starting point.

C. Beneficial Use

California - "----the general welfare requires that the waters of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented,----"

New Mexico - Beneficial use is the basis, measure, and limit of the right to use water. No water right, therefore, may be granted or claimed for more than the amount that can be beneficially used.

D. Priority by Type of Use

California - "It is hereby declared to be the established policy of this State that the use of water for domestic purposes is the highest use of water and that the next highest use is for irrigation."

E. Reject Doctrine of Riparian Law

Any doctrine of riparian law should be terminated or rejected. Riparian users (those owning land adjacent to streams and using water from the streams on those lands) should have any intangible right which they might now be entitled to, replaced by an appropriative right for a specific quantity of water, during specific periods of up to the full year.

Any remnants of riparian law remaining in a new water code will add to the difficulties and costs of administration, and can be avoided as suggested.

F. Pollution of Streams Prohibited

While pollution of streams may not now be a problem, this point certainly should be covered in the water code. Downstream water users are entitled to water of reasonable good quality, and reasonable standards can be established for both domestic and irrigation uses.

The problem of enforcement can be treated when the need arises, but the basic policy should be adopted now. Later, may be too late.

G. Applications, Permits, Licenses, to Appropriate Water

1) Applications: For Nicaragua, it is recommended that an application be required to be submitted to the National Water Rights Commission for a Permit or a License to use water from either a well or surface stream. A low limit can be set, below which applications need not be submitted, say, in the 1,000 to 5,000 gallons per day range. The limit might be higher for areas with a foreseeable continuous surplus supply.

Applications usually contain information on name of applicant, amount of water to be appropriated, method of diversion, location of diversion or of well, location and nature of use, storage and conveyance facilities, times of diversion, times of use, and other technical information.

2) Permits: The application would be sent to the Water Rights office of the new department for review, and for determination of whether or not water is available to satisfy the request, and what restrictions, if any, should be included. If no conflicts with other applications, permits, or licenses, appear, a Permit would be issued, which would allow the development to proceed.

3) Licenses: When a permit holder has completed his development, and put the water to beneficial use, he may be granted a license, which gives him a permanent right to use the water, as long as he continues to use it in accordance with the license terms. If the water is not used, the license can be terminated, or amended. Usually non-use over 3 or 4 years would justify a termination.

3.4 INITIAL STEPS

A. Reports, or Applications, to Construct a Water Well

For a few years yet, it probably is not necessary that a formal application be submitted and approved before a water well is started. In lieu of an application, a report should be required both before construction of such a well begins, and again afterwards, when completed, on forms provided by the Department. Enforcement can be helped by the licensing of drillers, with the revocation of a license being the penalty if the reports before and after drilling are not submitted. This procedure has worked well in California. Extracts from the California Code follow:

> "Every person who hereafter intends to dig, bore, or drill a water well, or who intends to deepen or re-perforate any such well, or to abandon or destroy a water well, shall file with the department a notice of intent to engage in such construction, alteration, destruction, or abandonment prior to commencing such construction, alteration, destruction, or abandonment; provided, that when such construction, alteration, destruction, or abandonment must be accomplished immediately in order to prevent damage to persons or property due to the loss of an existing water supply, such notice shall be filed with the department as soon as possible thereafter, but in any event not more than five days after commencement of such construction, alteration, destruction, or abandonment or repair."
>
> "The report shall be made on forms furnished by the department and shall contain such information as the department may require, including, but not limited to: (a) description of the well site sufficiently exact to permit location and identification of the well; (b) proposed date of construction of well; (c) the use for which the water well is intended; (d) the work to be done and a description of type of construction; and (e) in event of late filing, the reasons therefore."
>
> "Every person who hereafter digs, bores or drills a water well, or abandons or destroys a water well, or who deepens or re-perforates any such well, shall file with the department a report of completion of such well within 30 days after its construction or alteration has been completed."

> "The report shall be made on forms furnished by the department and shall contain such information as the department may require, including, but not limited to: (a) description of the well site sufficiently exact to permit location and identification of the well; (b) detailed log of the well; (c) description of type of construction; (d) details of perforation; and (e) methods used for sealing off surface or contaminated waters."

In addition to the above information, information on the depth to water surface in the completed well; results of pumping tests; characteristics of pump to be installed; and depth to water surface in well when pumping, should be required

All such information should be treated as confidential, and made available only to persons who have a need to know in their official or technical capacity; provided, information on locations of wells and their owners by name, could be released.

B. Licensing of Drillers

All water well drillers should be licensed. Exemptions could be made for persons who dig wells on their own property with their own equipment, provided that they can establish to the satisfaction of the department that they can construct the contemplated well in accordance with acceptable standards. Exemptions also could be made for small, dug wells used for domestic or stock-watering purposes.

It has been found that reputable water well contractors will support such a licensing requirement. Requirements for a license would include demonstrated ability to properly construct a water well, to develop and test it, and to file the proper reports correctly. Details on such requirements are in publications in Project Adelante files.

C. Water Well Construction Standards

Recommended minimum standards for the construction of wells should be promulgated, to protect the public from poor well construction, from surface contamination in the case of wells providing any domestic water supplies, and to protect the underground aquifers themselves from the intermingling of poor and good quality waters, when this is needed. Again, information on acceptable standards are in Project Adelante files.

D. Obtain Data on Existing Wells and Surface Diversions

As much data should be obtained on existing and new wells and surface diversions from streams and springs in the Project Adelante area, as can be obtained with the voluntary cooperation of landowners, and as available time and personnel permit.

3.5 LATER STEPS

Following the drafting and establishment of a National Water Code, and the staffing of the implementing agencies, applications for all new water uses, first in potentially critical areas (such as the Project Adelante area), later in other areas, should be required. Once this step is taken, the subsequent steps of issuing permits and licenses will follow easily.

At the same time, all present water users should be required to file applications to confirm their present uses. Failure to file should hold the potential penalty of loss of right, although such power must be wielded judiciously.

APPENDIX I-A

SELECTED BIBLIOGRAPHY ON WATER LAW AND CODES

APPENDIX I-A

SELECTED BIBLIOGRAPHY
ON WATER LAW AND CODES

1. American Water Rights Law, by C. E. Busby, South Carolina Law Quarterly, Volume 5, No. 2-A, 1952.

2. Selected Problems in the Law of Water Rights in the West, by Wells A. Hutchins, Misc. Publication No. 418, United States Department of Agriculture, 1942.

3. Water Resources and the Law, Legislative Research Center, University of Michigan Law School, Ann Arbor, Michigan, 1957.

4. The New Mexico Law of Water Rights, by Wells A. Hutchins, Technical Report No. 4, Agricultural Research Service, United States Department of Agriculture, Santa Fe, New Mexico, 1955.

5. Manual of Rules and Regulations Governing the Appropriation and Use of the Surface Waters of the State of New Mexico, Revised August 1953, State Engineer Santa Fe, New Mexico.

6. Rules and Regulations Governing Drilling of Wells and Appropriation and Use of Ground Water in New Mexico, 1966, State Engineer, Santa Fe, New Mexico.

7. Water Code of the State of California, Volume One, 1967, Department of General Services, State of California, P.O. Box 20191, Sacramento, California 95820.

8. Surface and Ground Water Codes, State of Washington, 1962, Department of Water Resources, State of Washington, Olympia, Washington.

9. Las Leyes de Aguas en Sudamerica, by Guillermo J. Cano, Agricultural Development Pamphlet No. 56, Food and Agricultural Organization, United Nations Rome, Italy, 1956.

APPENDIX I-B

EXAMPLE OF APPLICATION FORM USED IN THE STATE OF CALIFORNIA FOR APPLICATION TO APPROPRIATE WATER

STATE OF CALIFORNIA
THE RESOURCES AGENCY
STATE WATER RIGHTS BOARD

APPLICATION TO APPROPRIATE WATER

Application No.__________ **Filed**__________________ **at**__________ **M.**
(Applicant must not fill in the above blanks.)
(This application should be typewritten or legibly written in ink.)

I, Sterling International Paper Sales (a Corporation)
Name of applicant

650 California Street — San Francisco — California — 94108
Address — City or Town — State — Zip Code

do hereby make application for a permit to appropriate the following described unappropriated waters of the State of California, SUBJECT TO VESTED RIGHTS:

1. The source of the proposed appropriation is (1) Ritchie Creek (2) Napa River
Give name of stream, lake, etc., if named. If unnamed, state nature of source and that it is unnamed.

located in Napa County, Tributary to (1) Napa River (2) San Pablo Bay

2. The amount of water which applicant desires to appropriate under this application is as follows:

(a) To be directly applied to beneficial use 3.0 cubic feet per second ~~gallons per day~~
16,000 gallons per day is approximately 0.025 cubic feet per second. Use gallons per day if less than 0.025 c.f.s.

to be diverted from November 1 to April 30 of each year.
Beginning date — Closing date

(b) To be stored and later applied to beneficial use 75 acre-feet per annum, to be collected

between November 1 to April 30 of each season.
Beginning date — Closing date

If offstream storage is proposed, maximum rate of diversion to storage will be 3.0 c.f.s.

NOTE.—Neither the amount nor the season may be increased after application is filed. If underground storage is proposed a special supplemental form will be supplied by the State Water Rights Board upon request.

3. The use to which the water is to be applied is Domestic, Irrigation, Frost Protection

____________________ purposes.
Domestic, irrigation, power, municipal, mining, industrial, recreational, stockwatering, fish culture, etc. Describe more fully in paragraphs 13, 14, 15, 16 and/or 17.

4. The point(s) of diversion is (are) to be located as follows:

Bearing and distance or coordinate distances from section corner or quarter-section corner	40-acre subdivision of public land survey or projection thereof	Section	Town-ship	Range	Base and Meridan
(1) 2600'N&2600'E from the SW corner Sect.10	NE ¼ of SW ¼	10	8N	6W	MDB&M
(2) 50'N&1000'E from the SW corner of Sec.10	SW ¼ of SW ¼	10	8N	6W	MDB&M
(3)Rediversion #1 25'N&1150'E from the SW corner of Sect.10	¼ of ¼				
(4)Rediversion #2 1100'N&2400'E from the SW corner of Sect.10					

The point(s) of diversion ~~is~~ (are) located in Napa County.

5. The main conduit will terminate in________ of Sec.______, T.______, R.______, ______ B. & M.
State 40-acre subdivision of U. S. Government survey or projection thereof.

Description of Diversion Works

NOTE.—An application cannot be approved for an amount grossly in excess of the estimated capacity of the diversion works.

6. **Intake or Headworks** (complete only those blanks which apply)

Complete (a) and/or (b) for direct diversion or diversion to offstream storage.

(a) Diversion will be made by pumping from sumps in Napa River and Ritchie Creek
Sump, offset well, unobstructed channel, etc.

(b) Diversion will be by gravity, the diverting dam being ________ feet in height (stream bed to level of overflow), ________ feet long on top, and constructed of ________
Concrete, earth, brush, etc.

(c) Complete (c) for storage reservoirs only

Height of dam (streambed to spillway level)	Crest length of dam, ft.	Freeboard above spillway level, ft.	Material of construction
(1) Offstream storage only i	n excavated rese	rvoirs, 10'-15' deep	
(2)			
(3)			

7. **Storage Reservoir(s)**

Name, if any	Sections flooded by reservoir. Also name 40-acre subdivisions unless shown on map	Surface area, acres	Capacity acre-feet
(1) None	Small part of Section 10	2.5	25 maximum
(2) None	Small part of Section 10	2.5	25 maximum
(3)			

For any reservoir having a capacity of 25 acre-feet or more, complete the following:

Diameter of outlet pipe, inches	Length of outlet pipe, feet	Difference in elevation, spillway level to top of outlet pipe in reservoir, feet	Fall in outlet pipe, feet
(1) 12"to14" Pipe	Outlet is by pumping only		
(2)			
(3)			

8. Conduit system (describe main conduits only)

(a) Open channel, ditch, flume, canal, etc. (underline appropriate words)

Width of top at water line, feet	Width at bottom, feet	Depth of water, feet	Length, feet	Grade, feet per 1,000 feet	Construction Materials earth, rock, concrete, plastic, etc.
(1)					
(2)					

(b) Pipeline, tunnel, etc.

Diameter, inches	Length, feet	Pump lift, feet	Gravity fall intake to outlet, feet	Construction Materials steel, concrete, wood, etc.
(1) 8"to14"	2000'	50'		Steel, aluminum or concrete
(2)				

9. (a) The estimated capacity of pumping plant(s) is (are) (1) 12 cfs (2) ______

(b) The estimated capacity of the diversion conduit(s) is (are) (1) 12 cfs (2) ______

(c) The estimated total cost of the diversion works proposed is ______

Give only cost of intake, or headworks, pumps, storage reservoirs and main conduits described herein.

Completion Schedule

10. (a) Construction work will begin on or before 1 June 1967

(b) Construction work will be completed on or before 1 June 1968

(c) Water will be completely applied to the proposed use on or before 31 August 1967

Description of Proposed Use

11. **Place of use**

If area is unsurveyed indicate the location as if lines of the public land survey were projected. If space does not permit listing all 40-acre tracts, indicate sections, townships, and ranges and show detail on map.

40-acre tract	Section	Township	Range	Base and Meridian	If irrigation, show number of acres
SW 1/4	10	8N	6W	MDB&M	80 approximately
SE 1/4	10	8N	6W	MDB&M	20 approximately

Does applicant own the land where use of water will be made? Yes Jointly? No

All joint owners should include their names as applicants and sign the application at bottom of page 4.

______

If applicant does not own land where use of water will be made, give name and address of owner and state what arrangements have been made with him.

______

ATTACH EXTRA SHEETS HERE

12. Other Rights. Describe all rights except other applications on file with the State Water Rights Board under which water is served to the above-named lands.

Nature of Right (riparian, appropriative, purchased water, etc.)	Year of first use	Use made in recent years including amount, if known	Season of use	Source of other supply
(1) Napa River & Riparian, Ritchie Creek	Unknown	Irrigation (56 acres)	1 Feb. to 1 Oct.	
(2) Riparian, Ritchie Creek	"	" (45 acres)	" " "	
(3) Overlying (well not in use)	"	Domestic	Year around	Ritchie Creek

13. Irrigation Use. The total area to be irrigated is 101 acres. Acreage of crops is as follows: Rice ______ acres; alfalfa ______ acres; orchard ______ acres; general crops ______ acres; pasture ______ acres. all vineyards

Net acreage

Care should be taken that the various statements of acreage are consistent with each other, with the statement in Paragraph 11 and with the map.

The irrigation season will begin about February 1 and end about October 1

Beginning date — Closing date

14. Power Use. The total fall to be utilized is ______ feet. The maximum amount of water to be used through

Difference between nozzle or draft tube water level and first free water surface above.

the penstock is ______ cubic feet per second. The maximum theoretical horsepower capable of being generated by the works is ______. The use to which the power is to be applied is ______.

Second feet × fall ÷ 8.8 — For distribution and sale or private use, etc.

The nature of the works by means of which power is to be developed is ______. The size of the nozzle to be used is ______ inches.

Turbine, Pelton wheel, etc.

will
The water will not be returned to ______ in ______ of

Name of stream — State 40-acre subdivision

Sec. ______, T. ______, R. ______, ______ B. & M.

15. Municipal Use. This application is made for the purpose of serving ______

Name city or cities, town or towns. Urban areas only.

having a present population of ______. The estimated average daily consumption during the month of maximum use at the end of each five-year period until the full amount applied for is put to beneficial use is as follows:

16. Mining Use. The name of the mining property to be served is ______

Name of claim

and the nature of the mines is ______. The method of utilizing the water is

Gold placer, quartz, etc.

______. It is estimated that the ultimate water requirement for this project will be ______.

Cubic feet per second, gallons per minute. State basis of estimate.

will
The water will not be polluted by chemicals or otherwise ______

Explain nature of pollution, if any.

will
and it will not be returned to ______ in ______ of

Name of stream — State 40-acre subdivision

Sec. ______, T. ______, R. ______, ______ B. & M.

17. Other Uses. The nature of the use proposed is ______

Industrial, recreational, domestic, stockwatering, fish culture, etc.

State basis of determination of amount needed ______

Domestic - 3 homes, 15 people including lawns & gardens, total approx. 2 acre-ft. pr. yr.

Number of persons, residences, area of domestic lawns and gardens, number and kind of stock, type of industrial use, and unit requirements.

Frost Protection - 210 acre-feet per month maximum

Irrigation - 101 acres, 70 acre-feet per month

General

18. If maps as required by the Regulations are not filed with the application, state the reason(s) for not filing them ______

I will need ______ (days) (months) within which to file the required maps because ______

19. Does the applicant own the land at the proposed point of diversion? Yes If not, give name and address of owner and state what steps have been taken to secure right of access ______

20. What is the name of the post office most used by those living near the proposed point of diversion? Calistoga

21. What are the names and addresses of diverters of water from the source of supply below the proposed point of diversion? See files, State Water Rights Board

22. (a) Have you investigated the effect of the proposed appropriation on fish and wildlife? No (b) Have you consulted with the State Department of Fish and Game concerning this proposed appropriation? No (c) Will your proposed diversion or impoundment of water beneficially or adversely affect fish and wildlife? No

(d) State all data and information reasonably available to you or that can be obtained from the California Department of Fish and Game concerning the extent, if any, to which fish and wildlife would be affected by the appropriation. (Attach further supplement if necessary.) ______

(e) Describe any measures you propose to take for the protection of fish and wildlife in connection with the appropriation. (Attach further supplement if necessary.) No obstructions will be placed in stream channel of the Napa River. Sumps will be excavated in both Napa River and Ritchie Creek.

Signature of applicant(s)
(Refer to Section 671 of the Board's regulations)

Mr.
~~Mrs.~~ PETER L. NEWTON
~~Miss~~ President

Mr.
~~Mrs.~~ MARTIN J. WATERFIELD
~~Miss~~ Secretary

The complete information needed for preparation of this application may be found in the Regulations and Information Pertaining to Appropriation of Water. If there is insufficient space for answers in the form, attach extra sheets at top of page 3 and cross reference. Send application in duplicate to the State Water Rights Board, Room 1140, Resources Building, 1416 Ninth Street, Sacramento, California 95814, and retain one copy for your files.

INSTRUCTIONS FOR PREPARING MAPS

(1) Show location of the spring or stream, and give name.

(2) Show location of the main ditch or pipe line.

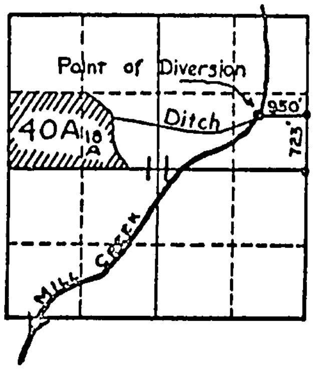
(3) Indicate clearly the proposed place of use of the water, as follows:

- (a) For irrigation, show the number of acres to be irrigated in each forty-acre tract. See Sketch No. 1 below.
- (b) For power, locate the power house on the map. See Sketch No. 2 below.
- (c) For mining, locate the mines to the nearest forty-acre subdivision. See Sketch No. 3 below.
- (d) For domestic use, locate the house on the map. See Sketch No. 4 below.

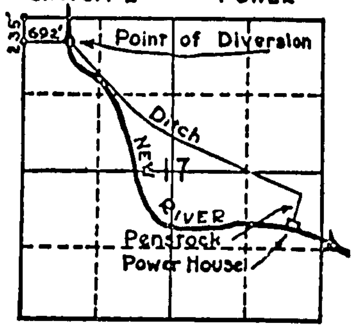
(4) Locate and describe the point of diversion (*i.e.*, the point at which water is to be taken from the stream or spring) in the following way: Begin at the most convenient known corner of the public land survey, such as a section or quarter section corner (if on unsurveyed land more than two miles from a section corner, begin at a mark or some natural object or permanent monument that can be readily found and recognized) and measure directly north or south until opposite the point which it is desired to locate; then measure directly east or west to the desired point. Show these distances in figures on the map as has been done in the sketches below.

SAMPLE SKETCHES

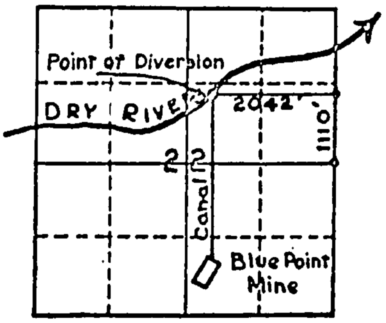
SKETCH 1 - AGRICULTURE



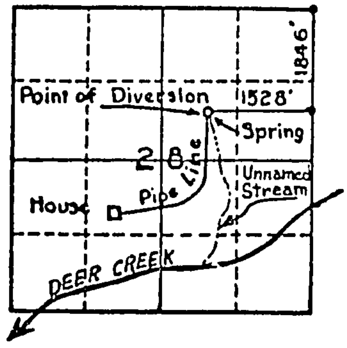
SKETCH 2 - POWER



SKETCH 3 MINING



SKETCH 4 - DOMESTIC USE



Maps Must Be Neatly and Accurately Drawn and Submitted in Duplicate

APPENDIX I-C

EXAMPLE OF WELL DRILLER'S LOG USED IN THE STATE OF CALIFORNIA

GINAL
riginal, Duplicate and Triplicate with the
IONAL WATER POLLUTION
NTROL BOARD No.________
t appropriate number)

WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

STATE OF CALIFORNIA

Do Not Fill In
№ 34877

State Well No.____________________
Other Well No.____________________

OWNER:

ne
lress

LOCATION OF WELL:

y Owner's number, if any—
D. or Street No.

TYPE OF WORK (*check*):

Well ☐ Deepening ☐ Reconditioning ☐ Abandon ☐
andonment, describe material and procedure in Item 11.

PROPOSED USE (*check*):

estic ☐ Industrial ☐ Municipal ☐
gation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☐
Cable ☐
Dug Well ☐

CASING INSTALLED:

LE ☐ DOUBLE ☐

n	ft. to	ft.	Diam.	Gage or Wall
	"	"	"	"
	"	"	"	"
	"	"	"	"
	"	"	"	"
	"	"	"	"

If gravel packed

Diameter of Bore	from ft.	to ft.
	"	"
	"	"
	"	"
	"	"
	"	"

nd size of shoe or well ring
Size of gravel:
e joint

PERFORATIONS:

: perforator used
of perforations in., length, by in.

	ft. to	ft.	Perf. per row	Rows per ft.
	"	"	" " "	" " "
	"	"	" " "	" " "
	"	"	" " "	" " "
	"	"	" " "	" " "

CONSTRUCTION:

urface sanitary seal provided? ☐ Yes ☐ No To what depth ft.
y strata sealed against pollution? ☐ Yes ☐ No If yes, note depth of strata

	ft. to	ft.
	"	"

od of Sealing

WATER LEVELS:

e which water was first found ft.
g level before perforating ft.
g level after perforating ft.

WELL TESTS:

ump test made? ☐ Yes ☐ No If yes, by whom?
gal./min. with ft. draw down after hrs.
ature of water Was a chemical analysis made? ☐ Yes ☐ No

(11) WELL LOG:

Total depth ft. Depth of completed well f

Formation: *Describe by color, character, size of material, and structure.*

ft. to	ft.	
"	"	
"	"	
"	"	
"	"	
"	"	
"	"	
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"	"	
"	"	

Work started 19 Completed 19

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME
(Person, firm, or corporation) (*Typed or printed*)
Address

[SIGNED]____________________
Well Driller
License No.____________________ Dated____________________, 19........

APPENDIX I-D

PLATES

CHART

N AND SOIL CONSERVATION

PLATE 1

Showing potential long-range organization.

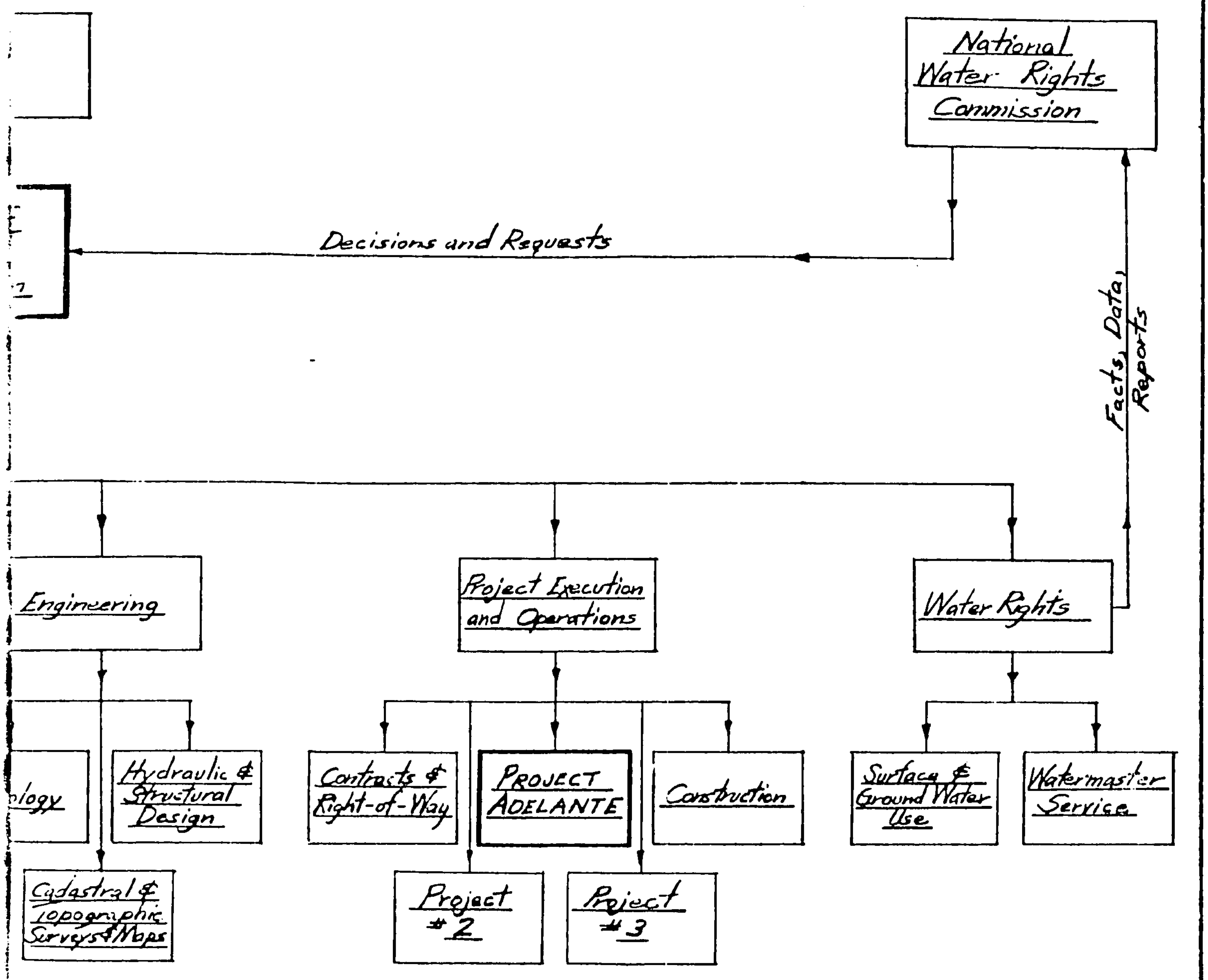
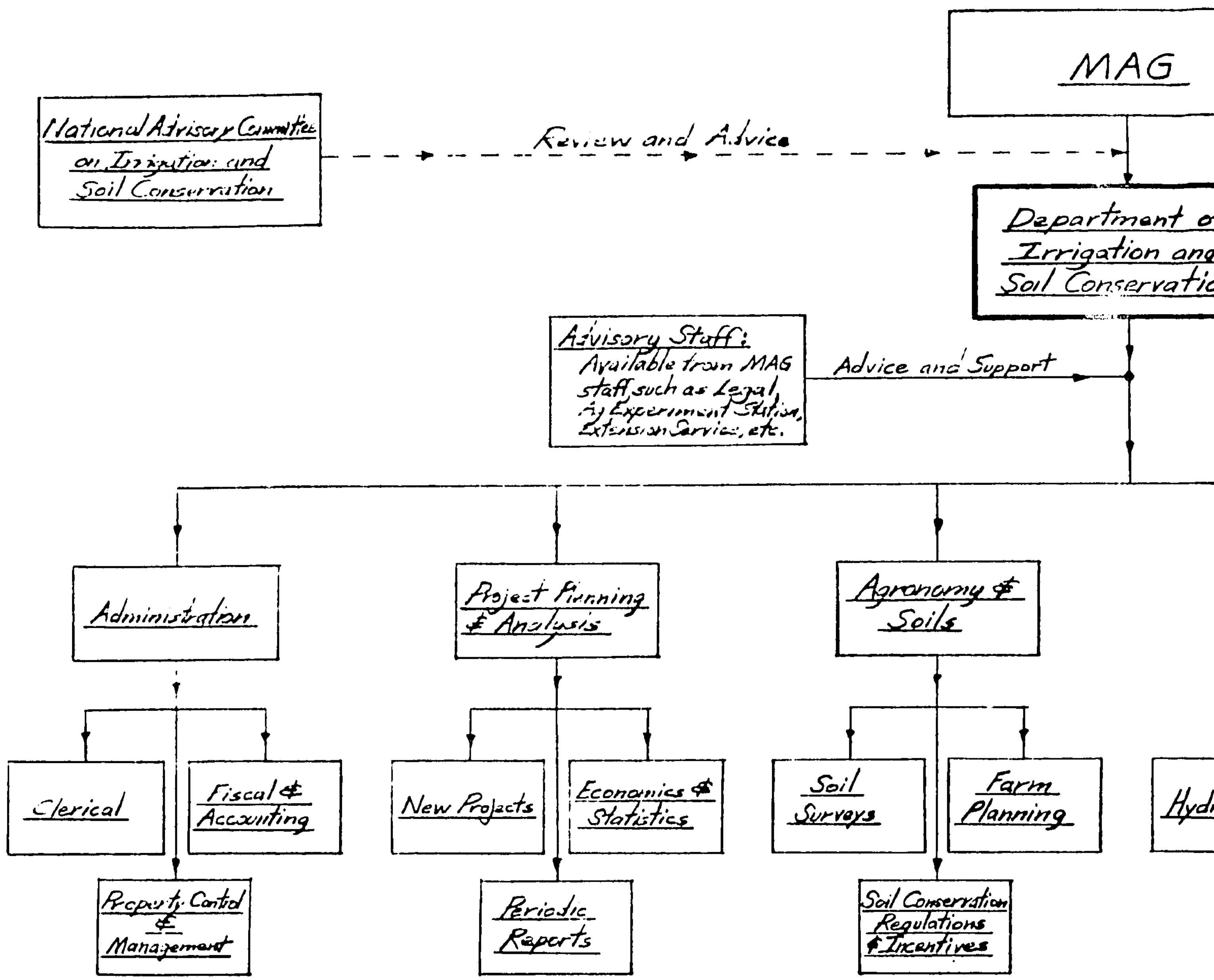


PLATE 1

ORGANIZATION

NEW MAG DEPARTMENT OF IRRIGATI



FLH 18 May 1968

FUNCTIONAL ORGA

NEW NAG DEPARTMENT OF IR

[illegible] →

[illegible] & [illegible] ↓

	1 Conceive New Projects	2 Economic and Feasibility Studies	3 Detailed Feasibility Studies	4 Arrange Financing for Projects	5 Detailed Planning for Design	6 Farm & Agronomic Planning	7 Soil Surveys & Sampling	8 Arrange New Hydrologic Stations	9 Collect Hydrologic Data	10 Collect Water Quality Data	11 Evaluate, Document Hydrologic Data	12 Design Dams	13 Design Irrigation Works	14 Collect & Prepare Maps & Photos	15 Ground Water Studies	16 Well Designs & Spe	17 Cost Estim	18 Construct	19 (
1. ADMINISTRATION																			
Planning		○	○								○				○	○	○	○	○
Budget & Accounting																	○		
Program Control & Management																			
2. PROJECT PLANNING & ANALYSIS																			
New Projects	●	●	●	●	●								△						
Economics & Statistics	△	○	○														○		
Project Reports																			
3. AGRONOMY & SOILS																			
Surveys	△	○				○	●		○	△				△	○			○	
Farm Planning	△	○				●			△	○			○	△	○			○	
Water Applications & Drainage	△																		
4. ENGINEERING																			
Hydrology	△	○		○		○		●	●	●	●	○	○		●	●			
Hydraulic & Structural Design	△											●	●			○	●	●	○
Surveying, Drafting & Topog.														●				○	
5. PROJECT EXECUTION & OPERATIONS					○														
Contract & Procurement					○											△		△	●
Construction																	△	○	○
PROJECT ACCELAITE	△					△	△		△	○				○	○				○
Proj. 1 & 2	△					△	△		△					○	○				-
Proj. 1 & 3	△					△	△		△					○	○				
6. WATER RIGHTS																			
Rights & Ground Water Use										○									
Watermaster Service																			
7. ADVISORY COMMITTEE	△	□	□	□	□														
8. ADVISORY STAFF				△		○									○				△

LEGEND

● Primary Responsibility

△ Secondary

○ Technical Support

□ [illegible]

NIZATION CHART

GATION AND SOIL CONSERVATION

PLATE 2

For potential long-range organization

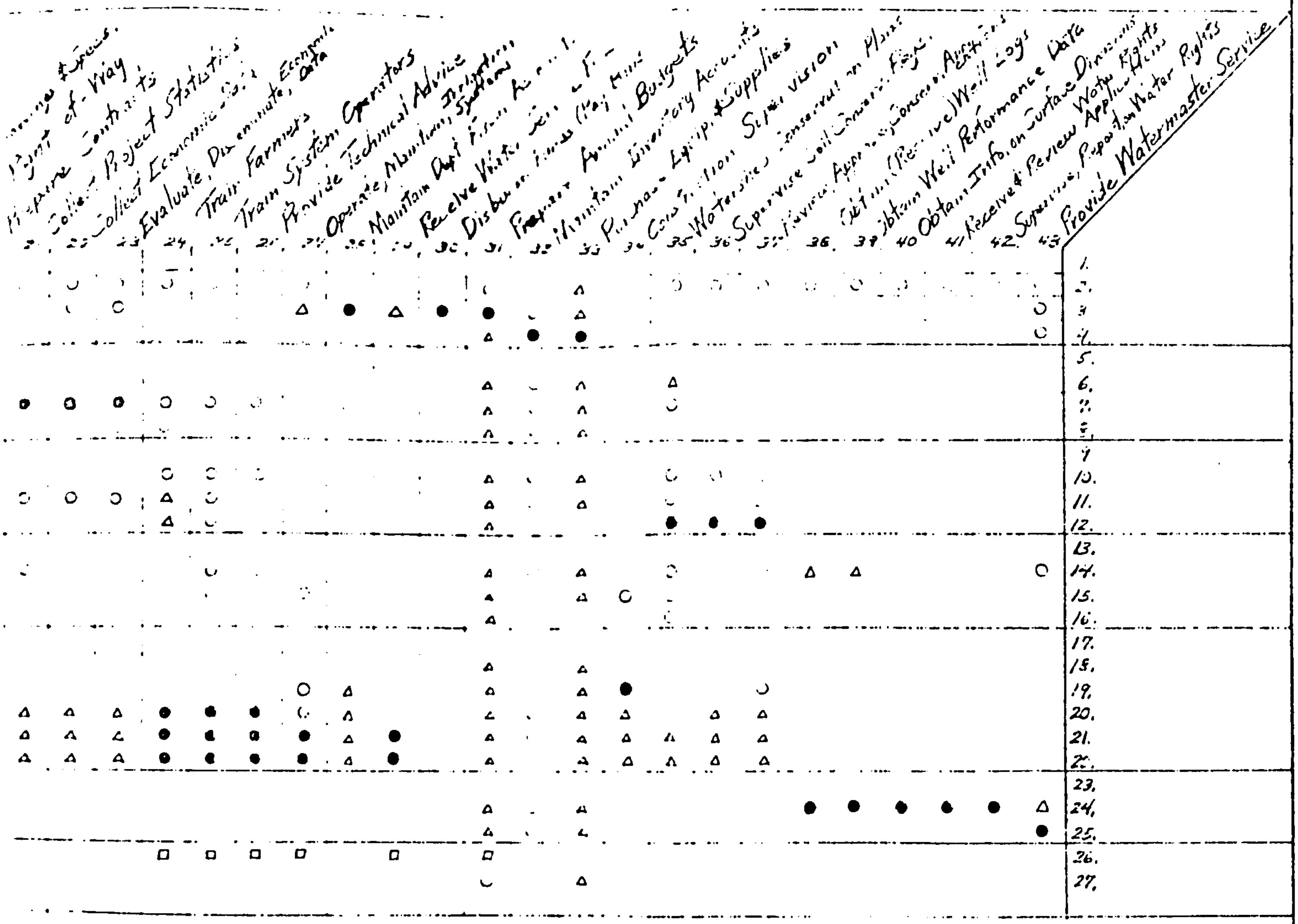
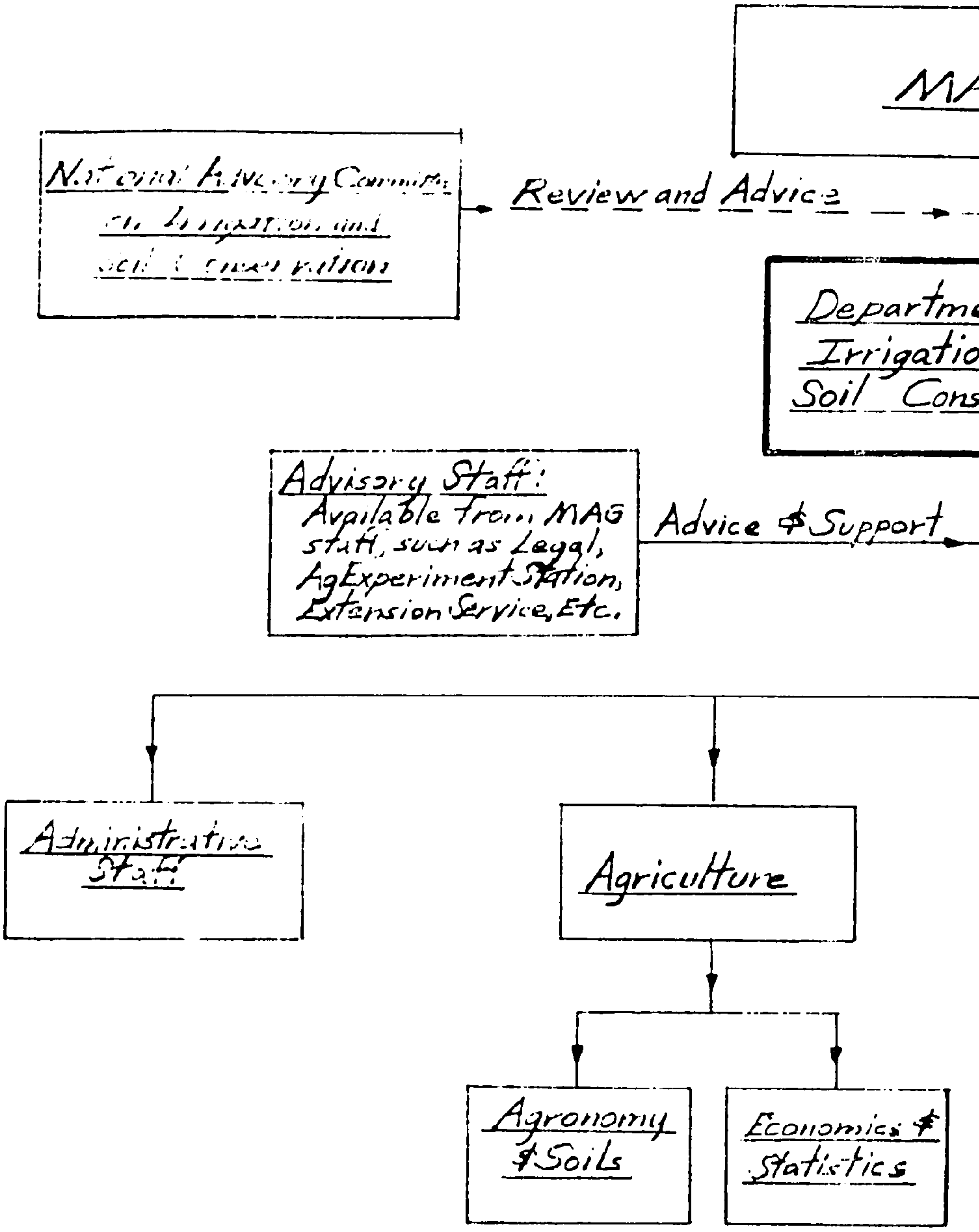


PLATE 2

INITIAL TARGET C

NEW MAG DEPARTMENT OF IRRI



FLH 15 May 1965

RGANIZATION CHART

ATION AND SOIL CONSERVATION

PLATE 3

Potential Short-Range organization.

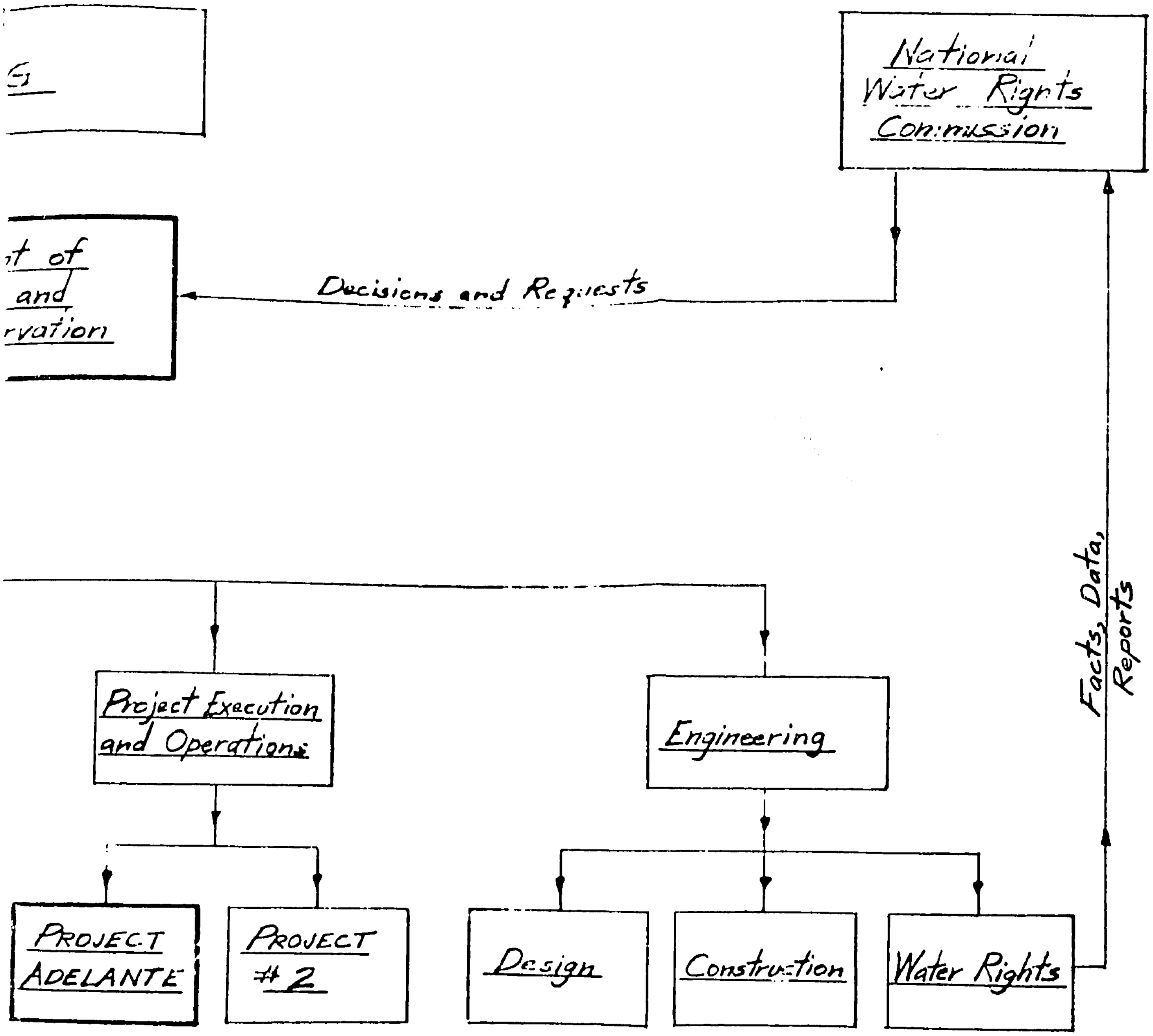


PLATE 3

ORGANIZATION CHART

PLATE 4

For initial target organization

IGATION AND SOIL CONSERVATION

s

rawings & Specs

n Right-of-Way

Prepare Contracts

21 Collect Project Statistics	22 Collect Economic Data	23 Evaluate, Disseminate, Economic Data	24 Train Farmers	25 Train System Operators	26 Provide Technical Advice	27 Operate, Maintain, Irrigation Systems	28 Maintain Dept. Fiscal Accounts	29 Receive Water Service Fees	30 Disburse Funds (Pay Bills)	31 Prepare Annual Budgets	32 Maintain Inventory Accounts	33 Purchase Equip. & Supplies	34 Construction Supervision	35 Watershed Conservation Plans	36 Supervise Soil Conserv. Regs.	37 Review, Approve, Conserv. Applications	38 Obtain (Receive) Well Logs	39 Obtain Well Performance Data	40 Obtain Info. on Surface Diversions	41 Receive & Review Water Rights Applications	42 Supervise, Report on Water Rights	43 Provide Watermaster Service	
○	○	○	○	○		△	●	△	●	●	●	●		○	○	○	○	○	○	○	○	○	1.
																							2.
				○	○					△	○	△		●	●	●							3.
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△	△	△	●	●	●	○	△			△	○	△			△	△							6.
△	△	△	●	●	●	●	△	●		△	○	△		△	△	△							7.
																							8.
					○	○				△	○	△	○	○		○						○	9.
					○	○				△	○	△	●			○							10.
										△		△					●	●	●	●	●	●	11.
			□	□	□	□		□		□													12.
										●		△											13.

PLATE 4

FUNCTIONAL TARGET

NEW MAG DEPARTMENT OF IR

Division & Office ↓ / Function →	1 Conceive New Projects	2 Reconnaissance Feasibility Studies	3 Detailed Feasibility Studies	4 Arrange Financing New Projects	5 Detailed Planning for Design	6 Farm & Agronomic Planning	7 Soil Surveys & Sampling	8 Arrange New Hydrologic Stations	9 Collect Hydrologic Data	10 Collect Water Quality Data	11 Evaluate, Disseminate Hydrologic Data	12 Design Dams	13 Design Irrigation Works	14 Collect &/or Prepare Maps & Photos	15 Ground Water Studies	16 Well Designs & Spec	17 Cost Estima	18 Constructio	19 Obt	
1. ADMINISTRATIVE STAFF		○	○	○	○	○	○				○				○	○	○	○	○	○
2. AGRICULTURE																				
3. Agronomy and Soils	△	○				●	●			△			○	△	○					
4. Economics & Statistics	△	○																		
5. PROJECT EXECUTION & OPERATIONS																	○			
6. Project Adelante	△									△				○	○					
7. Project #2	△									△				○	○					
8. ENGINEERING																				
9. Design & Planning	●	●	●		●	○		●	●	●	●	●	●	●	●	●	●	●	○	○
10. Construction																				
11. Water Rights																	○	○	●	●
12. NATIONAL ADVISORY COMMITTEE	△	□	□	□	□															
13. ADVISORY STAFF				●		○									○				△	△

LEGEND:

- ● Primary Responsibility
- △ Secondary "
- ○ Technical Support
- □ Advice

FLH 19 Nov, 1965

SPECIAL SUPPLEMENT TO APPENDIX I

(DECREE PREPARED BUT NEVER PUBLISHED)

MINISTRY OF AGRICULTURE AND LIVESTOCK
MANAGUA, D.N.

(DECREE PREPARED BUT NEVER PUBLISHED)

MINISTRY OF AGRICULTURE AND LIVESTOCK 20 August 1968
MANAGUA, D. N.
Director of "La Gaceta"
Official Journal

Director:

For your immediate publication, I hereby transmit the following integral Decree which literally states:

Decree No._____

President of the Republic,

Considering:

1. That it is necessary for the economy of the Country a rational utilization of our natural resources consisting of soil and water, by virtue of planning, establishment, direction, administration and heedfulness of systems of irrigation and drainage, with the object of assuring and increasing agricultural production.
2. That, in order for the objectives to be realized, it is indispensable the creation of an assessing and coordinating organization which has clearly defined duties and responsibilities and with the necessary authority to know and carry out the operations connected with irrigation and drainage, in accordance with the executive power.

Wherefore:

In the use of the authority vested by Articles 70 and 195, 3 Cn. and Decree No. 746 dated 20 September 1962, published in "La Gaceta," Official Journal, No. 220 of the above cited year.

Decree:

Article 1. To create an advisory organization of the Ministry of Agriculture & Livestock that would be called "National Commission of Irrigation and Drainage" which shall hereafter be called simply "The Commission."

Article 2. The Commission will be responsible for the study, planning, coordination, regulation and vigilance of the irrigation systems that are established for agricultural and livestock purposes in the Republic and by virtue of their criterion will be considered as a public service.

Article 3. The Commission will be composed of the following members: The Minister of Agriculture and Livestock will be its President; the President of the National Bank of Nicaragua, as vice-president; the Director of the Agrarian Institute of Nicaragua, the Director of the National Light and Power Company (ENALUF); two farmer representatives chosen by the Minist of Agriculture and Livestock and one member of a Minority Party that will be chosen in conformity with Article 333 Cn. The elected members will have their respective alternates. The term of office shall be two years for the Farmer Representative and Member of the Minority Party, with the right of being re-elected.

Article 4. The Commission will ordinarily meet twice a month or oftener as deemed necessary by the President or by a majority of the members. In each case members will receive a fee of two hundred and fifty cordobas per session.

Article 5. At all sessions, a quorum will consist of the President and four additiona members and all resolutions will be voted on by majority vote. In the cas of a tie vote the President will have a double vote.

Article 6. When one or more of the Commission members representing the farmers or Minority fail to attend three consecutive meetings, their alternates shall be duly summoned to take their places. If absences are not justified, the President of the Commission shall proceed to replace the member or members representing the farmers. In the case of the minority representative, he shall notify the group he represents to enable the group to select a new candidate.

Article 7. The Secretary of the Commission shall be the Chief of the Department of Soil and Water Conservation of the Ministry of Agriculture and Livestock.

Article 8. The principal functions of the Commission will be to: oversee, control and coordinate the irrigation systems that may be considered as a public servic undertaken, organized or administrated by:

(a) native persons or lawfully organized irrigation firms even though they may not be recognized as such.

(b) by the Government of the Republic or its agencies that perform these types of projects.

Article 9. The Commission will determine the standards to which the projects and the public service Irrigation firms must ascribe to, in connection with their execution, administration, organization, etc., and submitting these to the Executive Council of the Agricultural and Livestock section for their approval.

Article 10. Transitory: While the specific laws toward this goal are being promulgate the Commission will be empowered to:

a) Determine the establishment, organization and distribution of water for irrigation purposes.

b) Help organize irrigation and drainage firms.

c) Regulate the use and distribution of surface, subterranean, river and lake waters.

d) Comprehend and dictate contracts between irrigation and drainage firms, cooperatives or governmental projects, private or associates.

e) Establish water and drainage rights in irrigation and drainage zones and in adjacent zones that have been decreed as such.

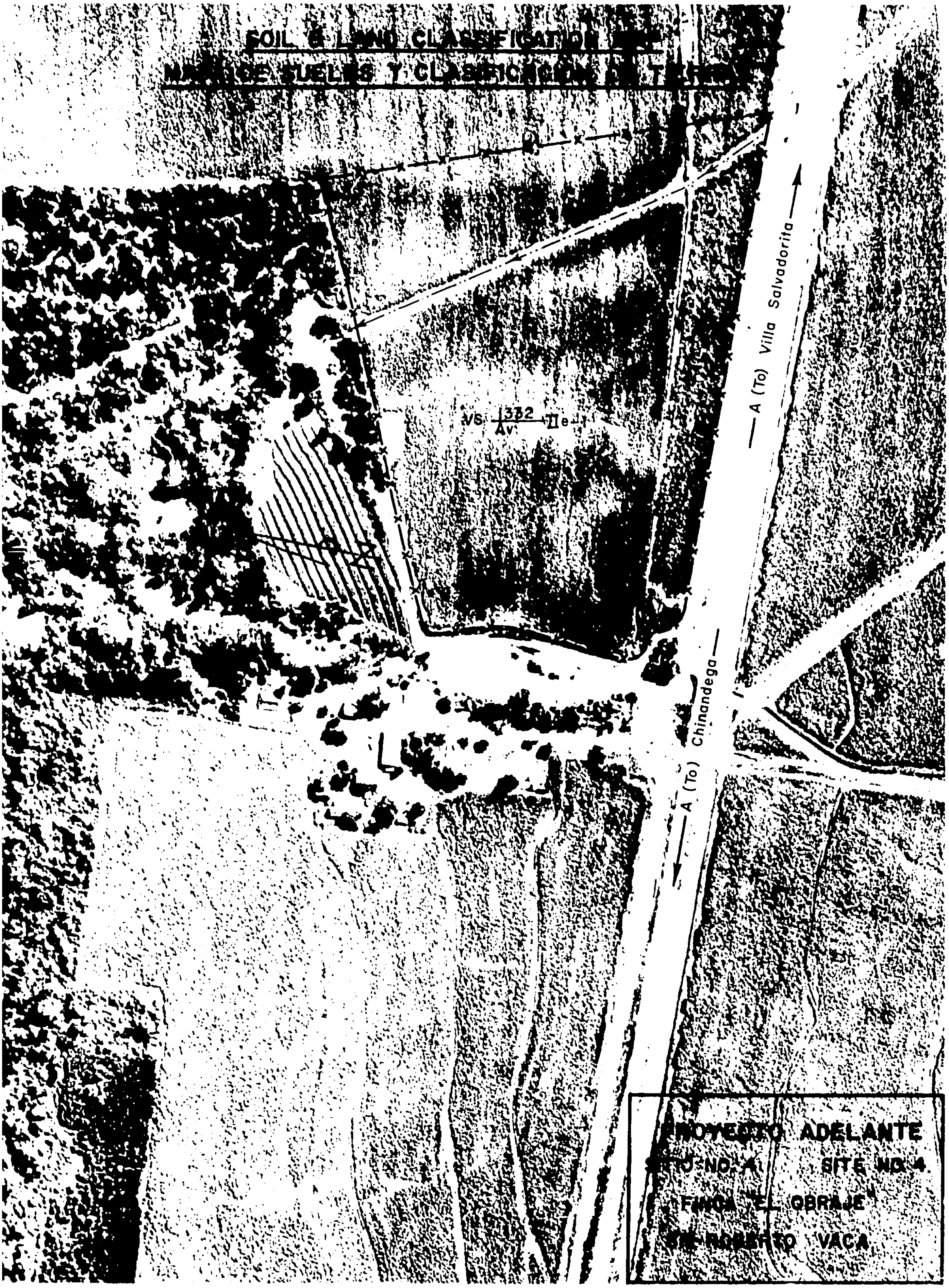
f) Understand, establish and dictate all complaints arising from the utilization of water and drainage, applying in each case corresponding sanctions, which shall be the object of regulation while no specific legislation exists for this purpose.

Article 11. The present Decree shall become effective following its publication in "La Gaceta," the Official Journal.

Given in the Presidential House, Managua, National District, on 20 August 1968. A.Somoza D. President of the Republic - Alfonso Lovo Cordero, Minister of Agriculture and Livestock.

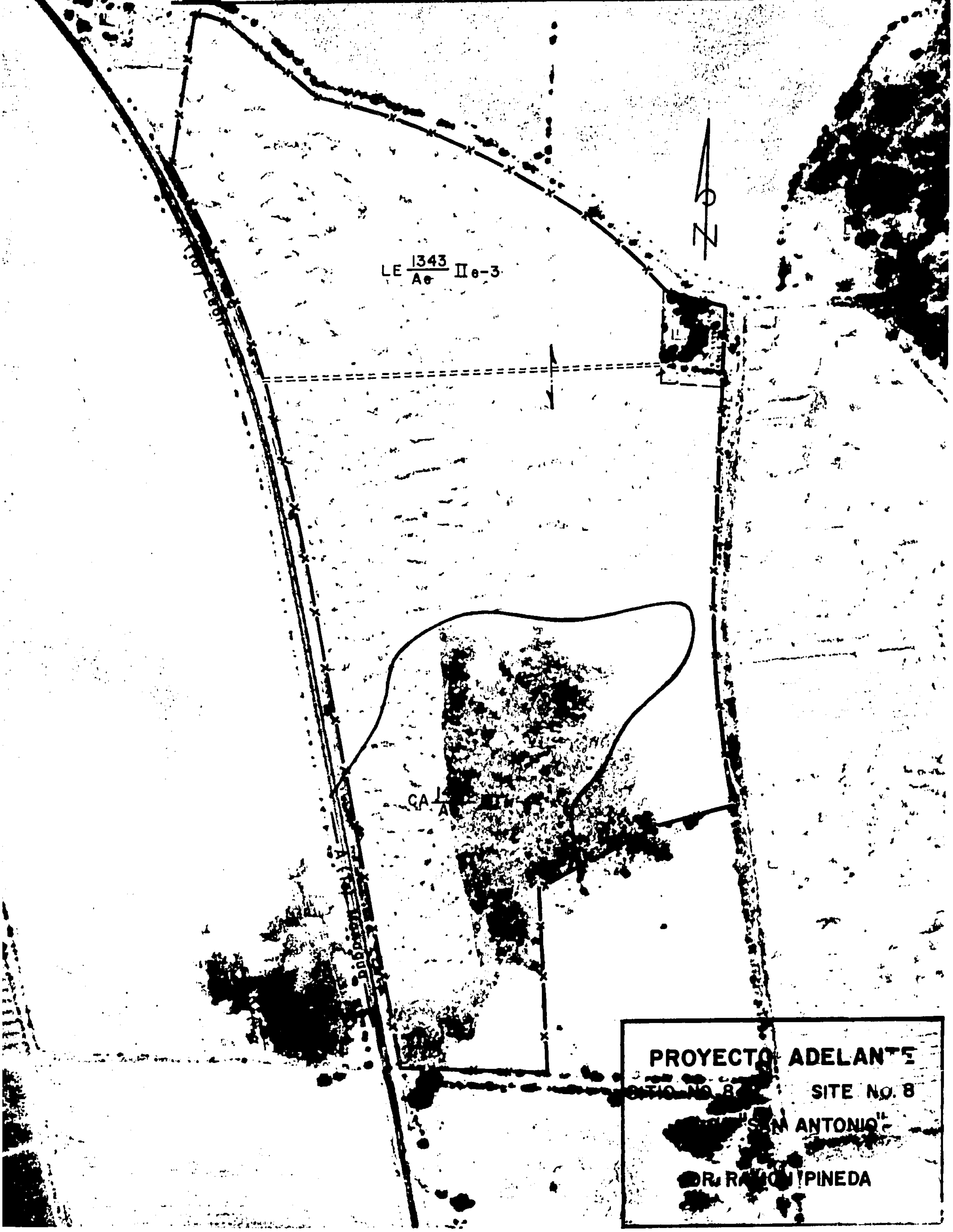
APPENDIX II - SOILS

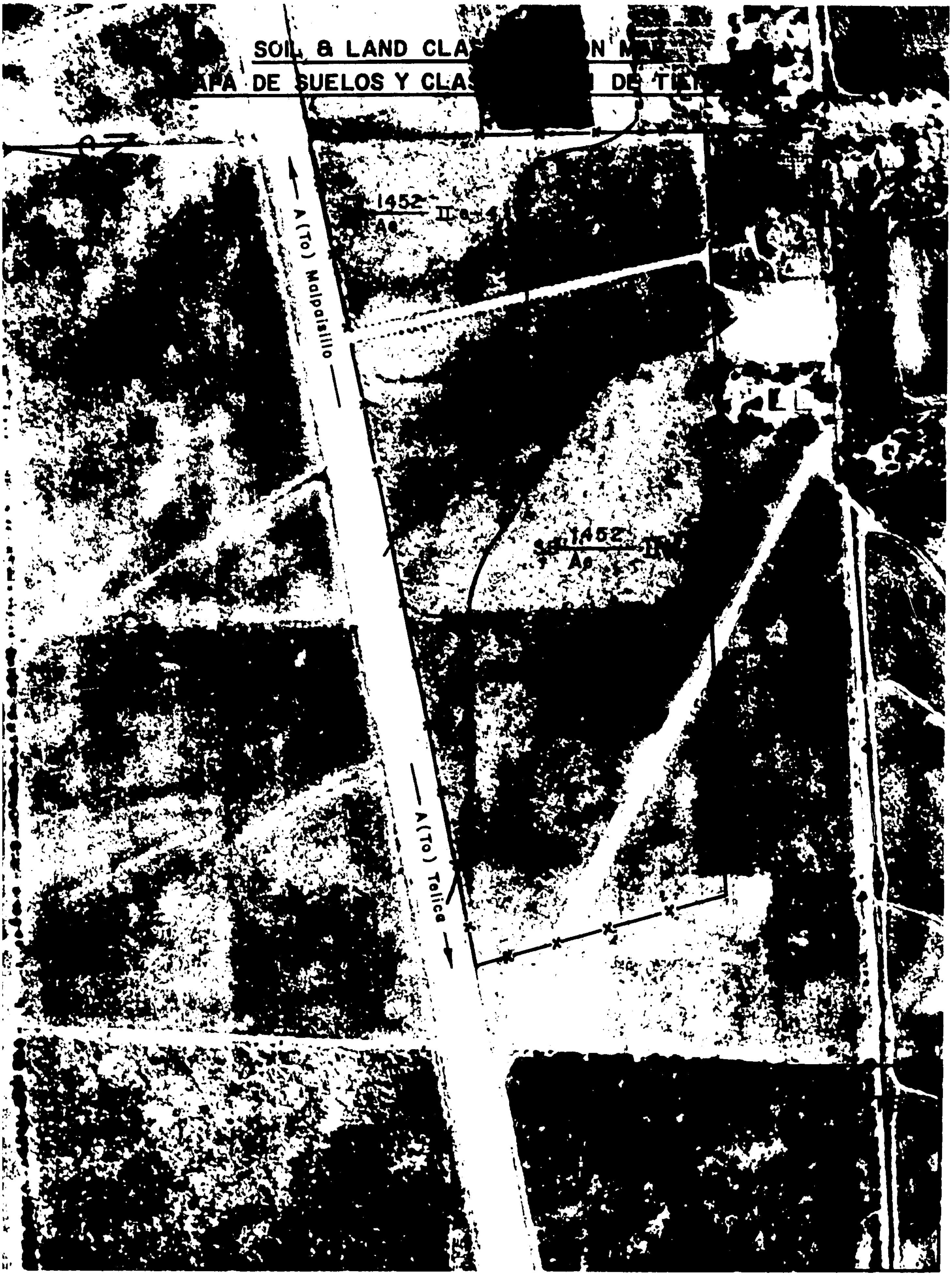
TABLE OF CONTENTS


SOIL & LAND CLASSIFICATION MAP
MAPA DE SUELOS Y CLASIFICACION DE TIERRA
VS 332/Av IIe
A (To) Villa Salvadorita
A (To) Chinandega
PROYECTO ADELANTE
SITIO NO. 4
SITE NO. 4
FINCA EL OBRAJE
SR. ROBERTO VACA

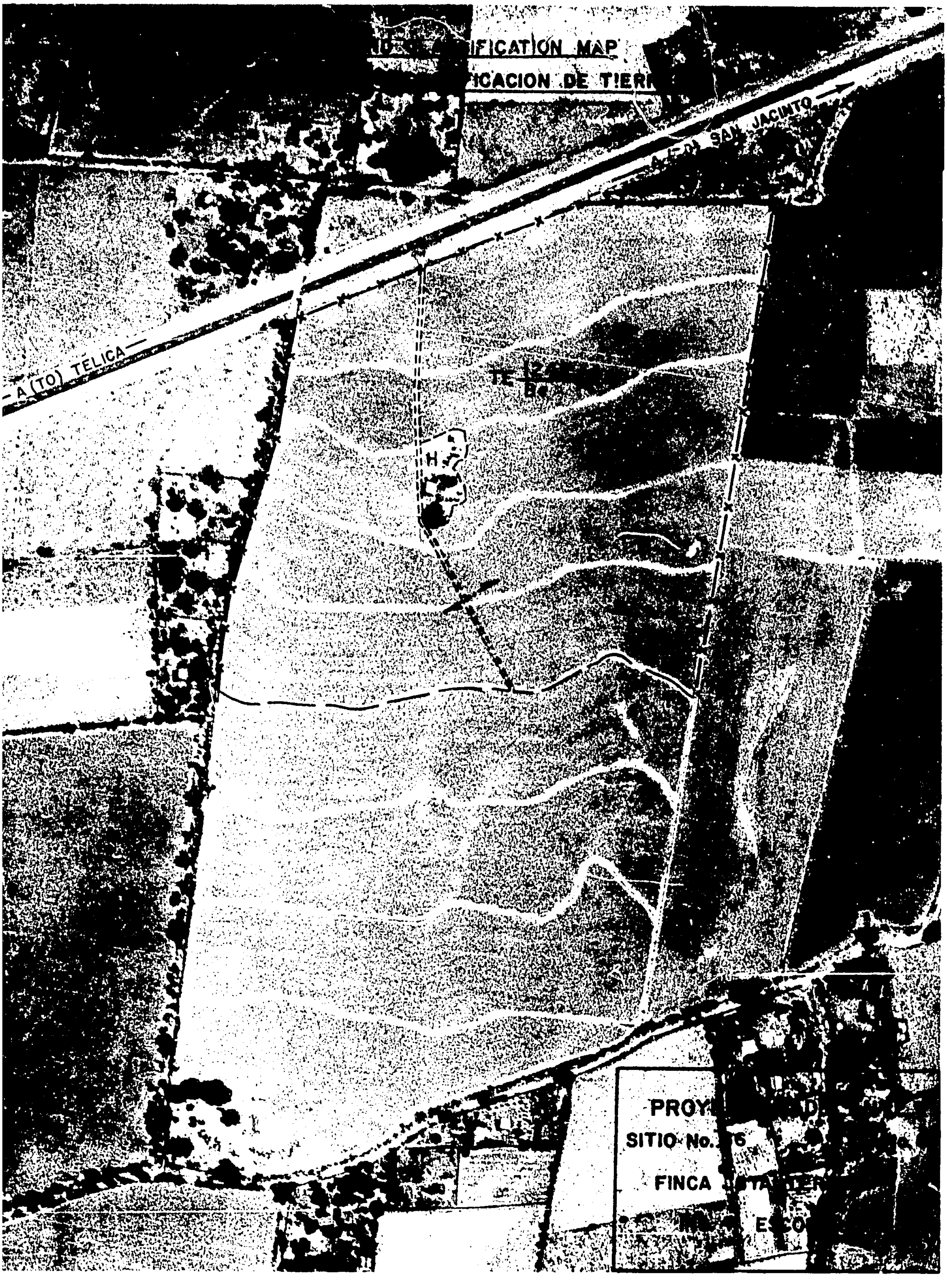
SOIL & LAND CLASSIFICATION MAP

MAPA DE SUELOS Y CLASIFICACION DE TIERRAS




SOIL & LAND CLA N MA
APA DE SUELOS Y CLAS N DE TIE
A (To) Malpaisillo
1452 / Ae IIe-4
Sa 1452 / Ae II
L
C
A (To) Telica

SOIL & LAND CLASSI
MAPA DE SUELOS Y CLASIFI
AO 1442/A I
VC 1553/Awi II e 2
GY 1453/Bw IIe
A (a) León
A (10) Ingenio San Pedro
N
PROYECTO ADELANTE
SITIO NO.
FINCA "EL CARMEN"
SR. JULIO FONSECA


IFICATION MAP
ICACION DE TIERR
A (TO) SAN JACINTO
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SITIO No. 6
FINCA
E CO

APPENDIX II

SOILS

II.0 - NATURE AND EXTENT OF SURVEY

The principal task performed at the start of the program was to carry out a general visual reconnaissance of the project area as a means to locating several potential farm sites from which would be selected five or six sites to serve as project demonstration farms.

For this purpose, the tentative sites had to meet certain minimum conditions, among the important conditions being as follows: sites should be located, if possible, near major population centers; be easily accessible and near well-traveled roadways; and be representative of conditions in the general area in which they are located in terms of soil and topography.

Within six months from the start of the project, over ninety sites meeting the above criteria had been tentatively selected. Interviews were subsequently held with the owners of the sites to determine their interest in the program and to assess their capability and means to satisfy other important requirements of the program. Following these interviews a large percentage of the tentative sites were eliminated, either because of lack of interest shown on the part of the owner or due to the fact that the owner could not satisfy other relevant project requirements.

Out of the original 90-plus sites initially selected, 15 remained on which were conducted semi-detailed soil surveys as a further means of choosing the best five sites for use as project demonstration farms. On the basis of these soil studies, together with other important considerations, five sites were chosen as Project Demonstration farms.

Following final selection of these five farm sites, soil surveys of a more detailed nature were subsequently made. The soils were examined at numerous locations within each site to a depth of five feet by means of auger borings and, where possible, on profile observations at road cuts and channel banks on or adjacent to the property.

Soil characteristics considered important to the sustained use and management of the soils were noted and recorded at each auger boring.

Upon conclusion of the field survey work, soil maps of each site were prepared showing the delineation of the different kinds of soils found at each site. These maps are found immediately preceding this page.

II.1 - GENERAL DESCRIPTION OF PROJECT SITES

II.10 - Location and Extent of Site Areas

The project sites are located in the Departments (States) of Leon and Chinandega on the Pacific Zone of Nicaragua. The cities of Leon and Chinandega are the seats of Government of the respective Departments.

Major state highways connect these cities with each other and with the smaller outlying villages of Villa Salvadorita, Telica and Malpaisillo where four of five project sites are located. These paved roads permit easy and rapid access to sites from project headquarters in Leon. The time spent in reaching the sites by vehicular travel varies from 15 minutes to the nearest site (Nº8) to one and one-half hours to the farthest site (Nº4) located near Villa Salvadorita in the north central part of the project area.

The one exception to the above general statements is in regard to Site Nº50, which unlike the others, is located approximately 8 kilometers northwest of Leon along unimproved road that connects Leon with the village of Ingenio San Pedro. During the dry season, access to this site is possible but slow due to the dusty and rough surface condition of the road.

The general location of these project sites, relative to roadways and villages mentioned above, are shown in Fig. 1-1. Additional site information is presented below.

Site Nº	Name of Farm & Owner	Location	Size of Demonstration Parcel Used (Mz)
4	El Obraje - Roberto Vaca S.	Villa Salvadorita	7
8	San Antonio - Dr. Ramon Pineda	Leon	17
13	La Esperanza - Oscar Galo	Malpaisillo	16
50	El Carmen - Julio Fonseca L.	Leon	15
86	Santa Teresa - Ing. Ramiro Escobar	Telica	19

II.11 - General Physiography of Areas

The project area lies within a vast alluvial plain formed in geologic times by the deposition of alluvial sediments. In more recent times, comparatively speaking, volcanic activity from the chain of active and once-active volcanoes which presently occupy the central part of the project area, have added to these alluvial deposits in the form of fine ash and other volcanic ejecta.

The plain is characterized by having nearly level to gently sloping relief. The volcanic range, with a maximum elevation of 1745 meters, is the prominent land feature which punctuates the otherwise near-level landscape. A few isolated tongues of Lava occur east of the highway between Telica and Chinandega. These, however, are not extensive and for the most part are of short length, width and height.

II.12 - General Geology

The project area lands are located within two of four major geologic-physiological regions in Nicaragua, namely, the Pacific Coastal Plain area and the Nicaraguan Depression. The former consists of a narrow strip of land lying between the Southwestern margin of the depression and the Pacific Ocean, and extends from Coseqüina Peninsula across the plains of Chinandega and Leon along the Sierras de Carazo to the isthmus of Rivas[1]. The plain is bounded on the

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[1] Volcanic History of Nicaragua by Alexander R. McBirney and Howel Williams, University of California Publications in Geological Sciences, Vol. 55, 1965.

northeast by the Marabios Range and the fault system along the Pacific side of the Nicaraguan depression. Thick deposits of generally hard, dense and fine-grained andesitic, basaltic and dacitic rocks with interbedded pyroclastic rocks cover the northwestern end and northeastern boundary of the Coastal Plain. A broad belt extending Southeastward from Chinandega consists principally of tuff, pumice, ash, clay, silt, volcanic scoria and sand interbedded with hard and dense basaltic and andesitic rock. Older sedimentary rocks of Tertiary and Late Cretaceous age are exposed along a continuous strip near the Coast between Poneloya as far south as the Costa Rican border.

Within the Nicaraguan Depression and northwestern portion of the Plains Area, a thick mantle of unconsolidated alluvium, lake sediments, and deeply weathered volcanic ash covers all except a few scattered hills of Tertiary volcanic rocks. The thickness of this Quatenary material is unknown but is thought to exceed 1000 meters in the center and along the southwest side of the Depression.

II.2 - SOILS

II.20 - General Characteristics of Project Area Soils

The soils of the project area sites occur on the vast alluvial coastal plain of Nicaragua that is characterized by deep, fertile soils having gently sloping to nearly level relief. A chain of dormant and active volcanoes that trend in a north-westerly direction occupies the central portion of the project area. Deposition of material from past and present volcanic activity has contributed materially to the alluvial mantle deposited in geologic times resulting in many cases in the formation of relatively recent soils underlain by older buried soils.

The soils of the project farm sites are characteristic of those found and mapped by "Catastro" during their recent soil survey of the Pacific Coastal Plains Area. They are generally very deep (more than 4 feet in depth) with occasional small areas underlain by duripans of variable thickness consisting of cemented volcanic material.

Surface textures vary from sandy loams to clay loams with colors ranging from dark browns to dark grayish-browns. Except for the heavy montmorillonitic clay soils known locally as "sosoquite", the surface soils possess a crumb to granular structure and a friable consistence when moist. Several of the soils examined contained a thin plow pan at depths ranging from 15 to 20 cms. below the surface, the result of disking to the same depth year after year.

Subsoils are generally finer in texture and range from sandy loams to clays. They are usually more compact than the surface soils. Colors vary from dark browns and grays to dark yellowish browns. Massive to angular blocky structures predominate.

With exception of the "sosoquite" soils, of which none were mapped on the project cooperator farm sites, the soils are moderately well drained. Permeabilities range from slow to moderate while surface runoff is generally slow but is medium to moderately rapid in areas having stronger slopes and finer surface textures.

The soils are neutral to slightly acid in reaction in the surface and subsurface and are free of harmful concentrations of salts and alkali. Surface content of organic matter is low to moderate whereas levels of phosphate and potassium are medium to low and medium to high, respectively. The soils were primarily under cotton culture but are adaptable to a wide range of climatically adapted crops. Most will respond to balanced applications of fertilizers.

A generalized soil map showing broad soil groupings is presented in Chapter 3 of this report. This map was prepared on the basis of on-site visual reconnaissance of the project area, information gathered on soils from auger borings made at selected locations within the project environs and by photo interpretation using aerial photographs of the project area. The map was prepared during early phases of the project and over the past two years has been modified as more was learned of the area.

II.21 - Typical Profiles

Detailed descriptions of typical soils mapped on the Cooperator farm sites are presented below. Since minor variations in characteristics can occur in a given soil within short distances, each description includes other relevant information about the series other than just the profile characteristics.

The detailed profile descriptions presented herein, were prepared by members of the "Catastro" staff.

ARGOLLA SERIES (AO)

The Argolla Haplustolls of the nonacid, fine silty, montmorillonitic isohyperthermic family. The soils have a very dark grayish brown, thick, mollic A horizon over dark brown but more reddish colored cambic B horizon. The soils are deep, moderately high in organic matter, moderately permeable and well drained.

Typical pedon:

Ap 0-14 cm.	Very dark grayish brown (10YR3/2) loam, dark grayish brown (10YR4/2) dry; moderate medium and fine granular, slightly hard, friable, slightly sticky, slightly plastic, abundant fine roots; many fine and very fine interstitial pores; pH 6.3; gradual smooth boundary.
A11 14-32 cm.	Very dark brown (10YR2.5/2) loam, dark brown (10YR3/2.5) dry; moderately coarse, medium and fine subangular blocky slightly hard, friable, slightly sticky, slightly plastic, plentiful fine and very fine roots; common fine tubular pores; pH 6.5; gradual smooth boundary.
(B1) 32-83 cm.	Very dark grayish brown (10YR3/2) loam to clay loam, brown (10YR4/3) dry; moderate coarse, medium, and fine subangular blocky; slightly hard, friable, slightly plastic, slightly sticky; plentiful fine and very fine roots; common fine tubular pores; pH 6.5; clear smooth boundary.

II (B2) 83-116 cm. Dark brown (7.5YR3/3) clay loam, brown (10YR4/3) dry, strong coarse, medium and fine subangular blocky; hard, friable, slightly plastic, slightly sticky; few very fine roots, few very fine tubular pores; pH 6.6; gradual smooth boundary.

IIB3 116-130+ Dark brown (7.5YR3/3) heavy clay loam to clay, dark yellowish brown (10YR4/4) dry; strong coarse, medium and fine subangular blocky; hard, friable, sticky and plastic; few very fine roots, few very fine tubular pores.

Location: About 5 Km north and 6 Km west of Center of Leon, between ordinates 1397 and 1380 and between abscissas 506 and 507. The sample site is on line 25 photo 84 about 300 meters south of the Hacienda Goyena.

Range in characteristics: Texture of the A horizons range from loam to light-textured clay loam. Depth to the redder II(B2) horizon ranges from 45 to 90 centimeters and depth to the dark gray clay ranges from 80 to more than 120 centimeters. The dark-colored horizons which are moderate to moderately high in organic matter range from 70 to about 100 centimeters in depth.

Competing series and their differentiae: Goyena soils, Aquic Haplustolls, differ principally in being less well drained and having characteristics associated with wetness.

Setting: The soils are developed in volcanic ash deposites on smooth, nearly level to gently sloping plains near the city of Leon. They occur, accordingly to Holdridge, in the Subtropical Moist life zone where the average annual temperature is 26.25°C with a minimum in December of 25.22°C and a maximum in April of 27.8°C. The elevation is about 72 meters above sea level and the average annual rainfall is about 1520 millimeters. This falls between May 15 and Nov. 15. The rest of the year is dry.

Principal associated soils: Associated soils include the following series, León, Telica, Guadalupe and Argolla.

Drainage and permeability: Argolla soils are moderately permeable and well drained. Runoff ranges from slow to moderately rapid depending on slope.

Use and vegetation: The original tropical forest trees have been removed and the soil used principally for growing cotton. Other crops include, corn, sorghum and pasture. High yields are reported. Limited analyses indicate high levels of potassium, a range from low to high levels of phosphorus in the surface 30 centimeters and low levels below 30 centimeters. The soils are well suited to a wide range of climatically adapted crops.

Distribution and extent: These soils occur principally northwest of the city of Leon.

Comments: Series suggested by Ing. Miguel A. Cáceres, 1970.

CHACARA SERIES (CA)

Chácara soils comprise Typic Argiaquolls of the nonacid, fine loamy, mixed montmorillonitic, isohyperthermic family. The soils have a mollic epipedon, an argillic B horizon, and characteristics associated with wetness. Permeability is moderately slow. During the wet season the water table may be not more than 60 or 70 centimeters below the surface. Organic matter content is moderately high to a depth of 36 centimeters, moderate to a depth of 55 centimeters. The content of allophane is very low.

Typical pedon:

A11 0-36 cm. Black (10YR2/1) clay loam, dark grayish brown (10YR4/2) dry; strong medium and coarse granular; hard, firm, plastic and sticky; plentiful fine roots; many fine interstitial pores; pH 5.9; clear smooth boundary.

A12 36-57 cm. Very dark gray (10YR3/1) fine-textured clay loam, grayish brown 10YR5/2) dry; weak medium subangular blocky; hard, friable, very sticky and very plastic; plentiful fine roots; common fine tubular pores; pH 5.8 gradual smooth boundary.

(B2) 57-83 cm. Very dark gray (5Y-3/1) clay, gray (10YR6/1) dry; moderate coarse and medium subangular blocky; hard, firm, very sticky, very plastic; plentiful fine roots; few fine tubular pores; pH 5.9; clear smooth boundary.

C1 83-103 cm. Dark gray (5Y4/1) sandy clay loam, gray (10YR6/1) dry; massive; hard, friable, very plastic, very sticky; very few very fine roots; very few very fine tubular pores; pH 5.9; abrupt smooth boundary.

IIC2 103-123 + Dark gray (5Y4/1) loamy sand or light textured sandy loam, light gray (5Y6/1) dry; massive; soft, very friable, nonplastic, nonsticky; very few very fine roots; very few very fine pores; pH 6.2.

Location: About 5 kilometers S.E. of Leon and about 1/2 kilometer south of highway. Between ordinates 515 and 516 and abscissas 1370 and 1371.

Range in characteristics: The surface soil ranges in color from (10YR3/1) to (10YR2.5/2). Depth to the sandy horizon ranges from 75 to 110 centimeters.

Competing series and their differentiae: No other typic argiaquolls have been observed in Nicaragua. The La Esperanza soils have some similar characteristics but have higher chromas and are not so gray in the substratum. Some vertic soils, undifferentiated, have very similar characteristics but differ in having finer textures and are usually less well drained.

Setting: Chácara soils occur on smooth nearly level, broad plains and occupy the periphery of lowlying basins or drainage ways. The parent material is of volcanic origin, dominantly volcanic ash. The soils occur at an elevation of approximately 80 meters above sea level and, according to Holdridge, they are in the Subtropical Moist Forest life zone. The average annual temperature is about 26.25°C; 25.22°C in December and 27.6°C in April. The average annual rainfall is 1511 millimeters. This falls between May 15 and November 15. The rest of the year is practically dry.

Principal associated soils: Associated soils include vertisols and vertic soils at lower elevations and La Experanza and Guadalupe soils at immediately higher elevations.

Drainage and permeability: The soils are between moderately well and imperfectly drained. Water stands within 60 or 70 centimeters of the surface for much of the growing season, and during short periods of unusually high rainfall the water table may be at or near the surface from periods of a few days to few weeks. Permeability is moderately slow and runoff is slow.

Use and vegetation: Most Chácara soils are used for growing cotton. Some corn, vegetables and plantains are grown and very limited areas are in pasture. A small idle area supports a stand of trees, genizaro and olives. Good yields should be obtained with drainage and good management. The soils are high in bases 60 to 90 percent, high in potassium, but low in available phosphorus.

Distribution and extent: The soils are located at a few kilometers southeast of the city of Leon. About 4 square kilometers have been mapped.

Previous name: These soils were mapped as "Chácara Humeda" in the 1966 Pilot Project survey.

GOYENA SERIES (GY)

Goyena soils belong to the Aquic Haplustolls of the non-acid, mixed montmorillonitic, isohyperthermic family. The soils are moderately deep, are slowly permeable and occur on nearly level relief. They possess a moderately thick, dark A horizon consisting of clay loams to clay and a weakly developed B horizon that is dark yellowish brown in color and clay in texture.

Typical pedon: Goyena clay (colors are for moist and dry conditions, respectively)

A11 0-20 cm Very black to brown (10YR2/1.5) and very dark grayish brown (10YR 3/2) light clay; coarse, strong subangular blocky structure; firm, plastic and sticky; abundant roots; abundant pores; boundary diffuse and smooth.

A12 20-50 cm Very dark brown (10YR 2/2) and dark grayish brown (10YR4/2) light clay; coarse, moderate subangular blocky structure; friable, plastic and sticky; abundant roots and pores; boundary abrupt and smooth.

(B21) 50-71 cm Dark yellowish brown (10YR3/4) and brown to dark brown (7.5YR4/4) heavy clay loam; coarse, moderate subangular blocky structure; friable, plastic and sticky; abundant roots and pores; boundary gradual and smooth.

(B22) 71-80/94 cm Dark yellowish brown (10YR3/4) and dark yellowish brown (10YR4/4; moderate to weak coarse subangular blocky structure; friable; very sticky and very plastic; abundant roots and pores; boundary abrupt and wavy.

IIAb 80/94+cm Dark gray (10YR4/1) and dark grayish brown (10YR 4/2); heavy clay; angular blocky; very sticky and very plastic.

Location: About 5 kilometers Southeast of El Ingenio San Antonio between ordinate 1380 and 1381 and abscissas 497 and 498.

Range in characteristics: Color and thickness of the A horizon may vary between very dark brown to black and thickness from 25 to 50 cm. respectively. The B horizon may contain textures that vary from clay loams to clay.

Competing series and their differences: Although the El Ingenio soils vary considerably from the Goyena soils, the former possess more characteristics that are similar to the Goyena than any of the other soils. Both are underlain by clay material but the El Ingenio soils are better drained and have loam to clay loam textures.

Setting: These soils occur on broad, level to nearly level plains. They occur at elevations of 20 to 40 meters above mean sea level and according to Holdridge, are in the Subtropical Moist Forest life zone. The average annual precipitation is about 1800 millimeters and average annual maximum and minimum temperatures are 32.5°C and 19.6°C, respectively.

Principal associated soils: Associated soils include El Ingenio, and Guadalupe or with Vertic and Vertisols.

Drainage and permeability: The Goyena soils are typically moderately well drained. Permeability and runoff are both in the slow range.

Use and vegetation: The Goyena soils are used principally for the growing of sugar cane and cotton. Some areas are being used for grazing and for pasture.

Distribution and extent: Isolated large bodies of this soil are to be found between Quezalguaque and north of El Ingenio San Antonio and between Nogualapa and Colonia Angelica de Shick. This soil is moderately extensive.

LA ESPERANZA SERIES (LE)

The soils of this series have been tentatively classified into the order of the Inceptisols. These soils have a very dark grayish brown (10YR3/2) Ap horizon consisting of loam with a neutral reaction; the A horizon consists of a very dark grayish brown (10YR2.5/2) loam with a neutral reaction whereas, a tentatively classified IIb horizon is dark yellowish brown (10YR3/4) in color with a loam texture and a neutral reaction.

Typical pedon: La Esperanza Loam (colors for moist and dry conditions, respectively.)

Ap 0-19 cm Very dark grayish brown (10YR3/2) and dark gray-brown (10YR4/2) loam; weak to moderate subangular blocky structure and a friable to firm consistence; slightly plastic and slightly sticky when moist; neutral in reaction; abundant roots; smooth abrupt boundary.

A_1 19-35 cm Very dark gray to very dark grayish brown (10YR2.5/2) when moist and dark grayish brown (10YR4/2) when dry; loam; weak, fine to medium subangular blocky structure; friable consistence; slightly plastic and sticky; neutral; plentiful roots; clear smooth boundary.

IIb 35-50 cm. Dark yellowish brown (10YR 3/4) when moist, to brown (10YR 5/3) when dry; loam; weak, fine to medium subangular blocky structure; friable consistence; slightly plastic and sticky when moist, neutral; plentiful roots; clear smooth boundary.

IIIAb 50-74/80 cm. Dark grayish brown (10YR 4/2) when moist, and light grayish brown (10YR 6/2) when dry; clay; weak fine to medium subangular blocky structure; friable to firm consistence; very plastic and sticky when wet; neutral; plentiful roots; clear smooth boundary.

IIIB1b 70/80-95 cm. Dark grayish brown (10YR 4/2) and light grayish brown (10YR 6/2) clay; weak, fine to medium subangular blocky structure; firm consistence; very plastic and sticky when wet; neutral; few roots; abrupt smooth boundary.

IIIB2b 95-118 cm. Dark gray (10YR 4/1.5) when moist and light gray (10YR 7/1) when dry; clay; strong medium subangular blocky structure; very firm consistence; very plastic and sticky when wet; neutral; very few roots.

Location: Approximately 6 kilometers southeast of the City of Leon between ordinates 517 and 518 and abscissas 1369 and 1370.

Range in characteristics: Depth to and texture of the IIIB1b horizon varies from 0-95 cms. and textures from loams to clay loams to clays.

Setting: La Esperanza soils occur on smooth nearly level topography with slopes of 0.5% to 1.0%. They have been formed principally from volcanic materials and overlie older burried soils.

Principal associated soils: Associated soils include Chácara, Guadalupe, León, La Ceibe, and some vertisols and alluvial soils.

Drainage and permeability: The soils are well drained. Permeability is moderately slow and surface runoff is very slow.

Use and vegetation: These soils have been used largely for cotton. Limited areas have recently been sown to sorghum.

Distribution and extent: A small area of this soil is located approximately 4 to 6 kilometers southeast of the City of Leon.

Previous name: These soils were mapped as "Chácara seca" in the 1966 Pilot Project Survey.

MALPAISILLO SERIES (MP)

The soils of the Malpaisillo series are classified as Vitrandepts according to the 7th Approximation. They are weakly developed sandy soils from volcanic ash and are underlain by older deposits of coarser material.

Typical pedon: Malpaisillo sandy loam (colors for dry conditions, as noted).

Ap 0-20 Dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist, massive to very weak medium and fine subangular blocky structure; slightly hard, friable, slightly plastic and non-sticky; few roots; many pores; abrupt smooth boundary.

A3	20-35	Dark yellowish brown (10YR4/4) fine sandy loam, to very dark grayish brown (10YR3/2) moist; massive to weak medium and fine subangular blocky structure; slightly hard, friable, slightly plastic and non-sticky; few roots; many pores; gradual smooth boundary.
B	35-68	Yellowish brown (10YR6/6) fine to very fine sandy loam, dark yellowish brown (10YR3/4) moist, massive to very weak medium and fine subangular blocky structure; slightly hard, friable, slightly plastic and slightly sticky; few roots; common pores; gradual smooth boundary; pH 6.6.
IIC	68-95	Olive brown (2.5Y4/4) sand to fine and very fine sandy loam, very dark grayish brown (10YR3/2) moist; massive; slightly hard to soft, very friable, non-plastic and non-sticky; few roots; many pores; clear smooth boundary; pH 6.8.
IIC2	95-150	Very dark gray (7.5YR3/0) sand, with many fine and very fine gravels; black (7.5YR2/0) moist; singlegrain; loose, non-plastic and non-sticky; few roots; many pores; pH 6.8.

Type location: Two kilometers N. West of Malpaisillo in the Department of León; between ordinates 533-534 and abscissas 1393 and 1392.

Range in characteristics: Thickness of the soil is generally more than 100 cms. Texture of the A horizon is fine sandy loam, or loam. It's structure ranges from massive to weak subangular blocks and it's thickness ranges from 20 to 55 cms. The B horizon is fine sandy loam; it's thickness ranges from 20 to 50 cms. The texture of the upper parts of the C horizon ranges from fine sandy loam to fine sand.

Competing series and their differentiae: The Malpaisillo series are somewhat similar to the León, Momotombo, and Cerro Negro series, but differ from them in having a cambic B horizon which is characteristic of the Malpaisillo Series.

Setting: Nearly level plains with slopes of 0 to 4%. According to Köppen the climate is Tropical Savanna.

Principal associated soils: The soils of the Olocotón and San Gabriel Series occur in the same area.

Drainage and permeability: Malpaisillo soils are well drained, with medium run-off, and a rapid permeability.

Use and vegetation: The soils of the Malpaisillo series are cultivated for cotton. The native vegetation has been all removed, but some scattered big trees as Ceiba, Laurel and Guanacaste, still occur locally.

Distribution and extension: The Malpaisillo series occupy an extensive area surrounding the town of Malpaisillo.

Remarks: The present description of the series is by Miguel A. Cáceres, April 18, 1969.

SAN GABRIEL SERIES (SB)

The soils of the San Gabriel series are classified as Haplustalfs that have developed from relatively recent volcanic ash over older coarser materials. They are well developed soils that have an A horizon that is very dark gray in color, massive structure and a clay loam texture. The B horizon is typically a dark reddish brown clay with strongly developed structure. The upper part of the C horizon is medium textured and is generally dark yellowish brown in color.

Typical pedon: San Gabriel clay loam (colors for dry and moist conditions, respectively)

Ap	0-18 cms	Very dark grayish brown (10YR3/2) and very dark brown (10YR2/2); clay loam to clay, massive, hard to very hard; very firm, plastic and sticky; few roots; very porous; boundary abrupt and smooth.
B21t	18-36	Dark reddish brown (5YR3/2), clay, thick and continuous clay films; very strong, angular and subangular blocky structure; very hard, very sticky and plastic; few roots, many pores, clear and smooth boundary.
B22t	36-60	Dark brown (10YR3/3) and dark reddish brown (5YR3/2), clay with fine to very fine dark brown gravel (7.5YR5/6), thin and continuous clay films; very strong, medium to fine angular blocky structure; hard to very hard, very firm, very plastic and sticky; few roots, very porous, boundary abrupt and smooth.
B23t	60-92	Brown to dark brown (7.5YR4/4) and dark redish brown (5YR3/3); clay with few gravels; coarse, angular blocky structure; very hard and firm; very plastic and sticky; very few roots; very porous; smooth clear boundary.
C	92-125	Yellowish brown (10YR5/4) and dark yellowish brown (10YR3/4) loam; massive, slightly hard; firm, plastic and sticky; very few roots; very porous.
	125-148*	Same as above horizon except that sand content increases.
	148-210*	Fine sand; light yellowish brown (2.5Y6/4) and light gray brown (2.5Y6/2) color; with medium size gravels.

*These characteristics observed from deepening pit with an auger.

Location: Department of León, 1 kilometer west of the town of Malpaisillo, along road to La Paz Centro. Approximately between Ordinates 535 and 536 and abscissas 1392 and 1391.

Range in characteristics: The soils of this series are deep. Texture of the A horizon varies from clay to clay loam and colors from very dark grayish brown to dark brown at depts between 15 and 60 cms. In truncated profiles where part of the B horizon has been incorporated into the topsoil, color variations in the dark brown range exist. The B horizon, to depths of 80 to 120 cms, can be either dark reddish brown or dark brown depending upon the physiographic position of the soil

Competing series and their differentiae: El Estero and Olocotón. El Estero Series soils are similar to the San Gabriel but differ from the latter in that they lack the B23t horizon and occupy distinctly different physiographic positions than the San Gabriel. The Olocotón Series have a greater number of horizons but with a less intense level of illuviation.

Setting: These soils occur on flat relief; some phases can be found occupying slopes of 5%. According to Köppen classification, the climate is Tropical Savannah.

Principal associated soils: The Olocotón, El Estero and Malpaisillo soils occupy the same general areas.

Drainage and permeability: The soils are well drained with medium surface drainage and moderately slow permeability.

Use and vegetation: All of the soils within this series are used for growing cotton.

Distribution and extent: The soils are found east, northeast and Southeast of the town of Malpaisillo. The series is quite extensive in area.

TELICA SERIES (TE)

The soils of the Telica Series are classified as Vitrandepts. They developed from relatively recent volcanic ash and are underlain at less than 1.5 meters by old buried soils. Typically, the soils have a friable sandy loam A horizon which is very dark brown when moist. The B horizon is moderately fine textured, friable, massive to weakly developed, and dark yellowish brown in color when moist. The C horizon consist of a hardpan of stratified volcanic cinders; it is very dark brown when moist.

Typical pedon:	Telica, sandy loam, (colors for dry and moist conditions, respectively.)
Ap 0-18	Dark grayish brown (10YR4/2) sandy loam, to very dark brown (10YR2/2); many fine gravels; weak coarse, medium and fine subangular blocky structure; slightly hard, friable, non-plastic and non-sticky; common roots; diffused and smooth boundary.
A1 18-31	Dark brown to brown (10YR4/3) sandy loam, to very dark brown (10YR2/2); weak coarse, medium and fine subangular blocky structure; loose, friable, nonplastic and nonsticky; few roots; clear smooth boundary.
IIB 31-84	Yellowish brown (10YR5/4) sandy clay loam, to dark yellowish brown (10YR3/4); massive to weak coarse subangular blocky structure; slightly hard, friable, slightly plastic and slightly sticky; few roots; diffused and smooth boundary.
IIB3 84-108	Yellowish brown (10YR5/5) clay loam with a few strong brown (7.5YR5/8) gravels, to dark yellowish brown (10YR4/4) dry; massive to weak coarse subangular blocky structure; slightly hard, friable, slightly plastic and slightly sticky; few roots; clear smooth boundary.

IIIC 108-134	Yellowish brown (10YR6/6) layer of scoria, to strong brown (7.5YR5/8)

Location: Department of León, north of the town of Telica; approximately between ordinates 515 and 516 and abscissas 1386 and 1385.

Range in characteristics: The soils of this series are very deep. The A horizon is sandy loam, sandy clay loam, or clay; its thickness ranges from 30 to 60 cms. The B horizon ranges in thickness from 70 to 110 cms, and has colors between 10YR3/2 and 10YR3/4 on the Munsell Chart; it is clay to sandy clay loam. The escoria layer is about 30 cms. thick but is much thinner at the junction with other series.

Competing series and their differentiae: The León, Chinandega, El Trianón, and Aegelia series are similar soils, but the Telica soils differ from them in having a clay loam texture and in being underlain by escoria.

Setting: The typical relief is flat to nearly flat with slopes of 0 to 3%. In some areas, however, slopes are as much as 15%. According to Köppen the climate is Tropical Savanna.

Principal associated soils: The León, Las Colinas, Chinandega, El Trianón, and Guadalupe soils occur in the same general area.

Use and vegetation: The Telica soils are used for cotton and to a small extent for corn and sorghum. All the native vegetation has been removed; however, scattered big trees of cedar, guanacaste, and guacimo are found locally.

Extension and distribution: The Telica soils occupy an extensive area surrounding the town of Telica.

Remarks: Field observation indicate that the layer of escoria below the B horizon does not impede root penetration. Description prepared by Miguel A. Cáceres, April 18, 1969.

VILLA SALVADORITA SERIES (VS)

Villa Salvadorita soils comprise typic Eutrandepts, members of the nonacid, thixotropic, isohyperthermic family. The soils are deep, moderately permeable, well drained, very dark grayish brown, moderately high in organic matter, over dry bulk density is less than .85, and the content of Allophane is small to moderate.

Typical pedon: Villa Salvadorita loam in a field of cotton.

Alp 0-11 cm	Very dark grayish brown (10YR3/2) loam, brown (10YR5/3) dry; moderate medium and fine granular; slightly hard, very friable, slightly plastic, slightly sticky; abundant fine roots; many fine and very fine interstitial pores; pH 7.0; clear smooth boundary.

A12 11-29 cm Similar in color and texture to surface horizon; weak medium and fine subangular blocky; slightly hard, very friable, slightly sticky, slightly plastic; plentiful fine and very fine roots; many very fine tubular pores; pH 7.5; clear smooth boundary.

B1 29-59 cm Very dark grayish brown (10YR3/2) loam, yellowish brown (10YR5/4) dry; weak medium and fine subangular blocky; slightly hard, very friable, slightly plastic and slightly sticky; plentiful very fine roots; many very fine tubular pores; pH 7.7; clear smooth boundary.

B21 59-84 cm Dark yellowish brown (10YR3/4) silt loam, light yellowish brown (10YR6/4) dry; moderately weak medium and fine subangular blocky; slightly hard, friable, slightly plastic, slightly sticky; few very fine roots; many very fine tubular pores; pH 6.7; clear smooth boundary.

B22 84-116 cm Dark brown (7.5YR4/4) silt loam, light yellowish brown (10YR5/4) dry; with few small (silica?) cemented fragments that are brown (7.5YR4/4) moist and pink (7.5YR7/4) when dry; moderately developed weak medium and fine subangular blocky; slightly hard, friable; slightly plastic; slightly sticky; few very fine roots; many very fine tubular pores; pH 6.7; abrupt smooth boundary.

IIC 116-120/130 cm Brown (7.5YR4/4) very fine gravelly sand, light yellowish brown (10YR6/4) dry; massive; loose, very friable to loose; non-plastic and non-sticky; very few very fine roots, many fine and very fine interstitial pores; pH 6.7; abrupt wavy boundary.

IIR 120/130 + cm Reddish brown basalt bedrock.

Location: Within the town limits of the settlement of Villa Salvadorita.

Range in characteristics: Depth to the soil ranges from 80 to about 130 centimeters. The thickness of the dark colored A horizon ranges from 15 to 40 centimeters due to wind and water erosion.

Competing series and their differentiae: Other typic Eutrandepts include the following series -- Argelia, Telica, Palo Alto, Nindirí, Nagarote, La Concepción, Rancherías. Argelia, Palo Alto, and La Concepción occur on different life zones where rainfall is higher and/or the average annual temperature is cooler. These soils contain more organic matter. Rancherías soils differ principally in having a gravelly coarse-textured substratum. Telica soils that occur in the Subtropical Moist Forest life zone are somewhat lower in content of organic matter. Nagarote soils are developed in ashy fine sandy loam over a substratum of somewhat older material of clay loam to clay texture. Nindirí soils that have a comparable quantity of organic matter are developed in cindery parent material.

Setting: The soil occur on nearly level to gently sloping plains where volcanic ash has fallen on basaltic lava. The elevation is approximately 40 meters above sea level and the average annual rainfall about 1400 millimeters. According to Holdridge the soils are in a moist transition of the Subtropical Dry forest life zone.

Principal associated soils: Associated soils include those of the Rancherías, and Olocotón series and unnamed vertic soils.

Drainage and permeability: These soils are moderately permeable and well drained. Runoff is medium.

Vegetation and use: Native vegetation which consisted of Tropical forest has been removed and most of the soils are used for growing cotton.

Distribution and extent: These soils occur near the settlement of Villa Salvadorita. A total of ______ square kilometers has been mapped.

VERTISOLS UNDIFFERENTIATED (V)

The undifferentiated vertisols comprise areas generally less than four square kilometers in extent. The larger areas have been mapped as soil series. Vertisols in Western Nicaragua are extensive in depressions, flats, and among nearly level lands where runoff has been low. They also occur on slopes ranging up to 15 percent where the soil has formed from basalt and other rock materials high in bases and easily weatherable material.

The wet-dry climate seasons of Western Nicaragua contributes to rapid weathering of rock materials and favors the development of soils high in bases and high in montmorillonitic clay minerals.

A total of 1400 to 1800 millimeters of rainfall would be sufficient to leach most exchangeable bases from the soils if the precipitation were evenly distributed throughout the year. The leaching effect is low, because runoff is high following downpour of rain and most of the precipitation in Western Nicaragua occurs during thunder storms.

Vertisols undifferentiated in Western Nicaragua are characteristic of the nonacid, very fine clayey, montmorillonitic, isohyperthermic family. The soils are generally deep, very slowly permeable, have black or very dark brown subangular blocky surface soils that are moderate to moderately high in content of organic matter. The soils have cracks that range from 3 to 10 centimeters wide and from 50 to more than 100 centimeters deep during the dry season. Slickensides are common but gilgai relief is not common.

Typical pedon:

A11	0-55 cm	Black (10YR2/1) clay, very dark gray (10YR3/1) dry; strong coarse prisms that break to coarse angular blocks; extremely hard, extremely firm, very sticky, very plastic; common slickensides; plentiful fine and very fine roots; few very fine tubular pores; pH 6.8 abrupt smooth boundary.
A12	55-87 cm	Similar in color and texture to the surface horizon but contains a few fine hard white (10YR7/1) calcium carbonate concretions; strong coarse angular blocky; extremely hard, extremely firm, very plastic, very sticky; common to few fine and very fine roots; few very fine tubular pores; pH 7.5: abrupt smooth boundary.

AC	87-102 cm	Dark gray (10YR4/1) clay, gray (10YR5/1) dry; moderate medium angular blocky; very hard, very firm, very plastic, very sticky, no roots, no visable pores; strongly calcareous; pH 8.0; abrupt smooth boundary.
C	102-110 cm	Light brownish gray (10YR5/2) clay, light gray (10YR7/1) dry; massive; slightly weathered rock; strongly calcareous; pH 8.2.
R	110 +	Light brownish gray (10YR6/2) extremely hard tuff.

Location: 6 kilometers northeast of Malpaisillo, abscissa 40.3 and ordinate 93.3.

Range in characteristics: The range in characteristics is narrow in texture, structure and development of slickensides. Most vertisols have 55 or more percent of 2 micron clay. The pH ranges from 5.8 to 7.5 in the surface horizons and from 6.5 to 8.2 in the subsoil or substratum. Some vertisols are noncalcareous and among others the depth to free calcium carbonate ranges from 20 to 85 centimeters. The content of organic matter ranges from moderate to moderately high on similar slopes with precipitation and temperatures in the different life zone. It is generally not more than moderate on slopes of more than 1.5 percent. Depth of effective soil material ranges from 50 to more than 150 centimeters.

Competing series and their differentiae: Vertic soils differ principally in content of clay; they usually contain 35 to 50 percent of 2 micron clay; they differ also in having slightly higher permeability and surface horizons that are not so difficult to cultivate. Other vertisols such as El Caimito and Mecatepío are less variable in profile characteristics.

Setting: These soils occur generally in depressions, flats or on nearly level areas where they receive runoff from adjacent or higher lying lands. In these positions, the soil has developed from different kinds of parent material, volcanic ash, tuffs of different kinds, andesite, basalt and to some extent from sedimentary formations. Vertisols occur also on smooth slopes that range up to nearly 15 percent. Here they have developed principally from the underlying basalt and less extensively from ignimbrites and other types of tuffs. The vertisols occur in most of the life zones except those that remain comparatively cool, such as the Premontane moist Tropical Forest life zone and in other cooler and moister life zones.

Principal associated soils: Many soils series and vertic soils are associated with vertisols.

Drainage and permeability: Permeability is very slow and on flat or nearly level areas, water often stands on the surface for short periods following rains in September and October. Drainage ranges from well drained for some sloping areas in the lower rainfall zones to very poorly drained in a few lower lying areas that receive much runoff from adjacent higher lands. Most of these vertisols are imperfectly or poorly drained. Runoff is generally very slow but is medium to moderately rapid on the areas of stronger slopes.

Use and vegetation: Most of the vertisols are used for pasture. Jícaro trees with grasses is a common cover for large areas. A few areas are used for growing irrigated rice and yields are favorable.

SOILS WITH CHARACTERISTICS OF VERTISOLS (VC)

These soils have in common an underlying layer of cemented sands. They have been given the name of vertics due to their having gray-colored upper horizons, the product of poor drainage and fluctuating water tables. They occupy depressional areas. Where the soils occupy slightly higher relief, textures vary from loams to clay loams and colors from brown to dark brown.

Typical pedon: The following description is from an auger boring made near La Hacienda Pénjamo on land having a gradient of 1/2 % and cropped to cotton.

0 - 20 cm	Dark brown (7.5 YR3/2) loam
20 - 30 cm	Black (10YR2/1) clay
30 - 50 cm	Very dark gray (10YR3/1) clay
50 - 60 cm	Dark grayish brown (10YR4/2) sandy clay
60+	Dark grayish brown (10YR4/2) sand

Location: Within La Hacienda Pénjamo, approximately 200 meters north of the main house.

Range in characteristics: Surface textures vary from loams to clays whereas colors range from dark browns to black. The content of sand increases at a depth of 30 to 40 cm. until reading a sandy loam texture at lower depths. At a depth of approximately 60 - 70 cms. is encountered a layer of cemented sand.

Setting: These soils are generally found in low depressioned areas having nearly level relief. Parent material appears to consist of cemented sands of volcanic origin. Average annual precipitation and temperature is 1,626 mm and 26.25°C, respectively.

Associated Soils: Associated soils include those of the León, Amatitán and Guadalupe series.

Drainage and permeability: Soils within this group having loam textures and those that occupy higher relief are moderately well drained. The soils that occupy depressions and those having fine texture are imperfectly drained. Surface drainage is slow whereas permeability is moderately slow.

Vegetation and use: The majority of these soils are cropped to cotton with a small percentage being in pasture.

Distribution and extent: These soils are quite extensive and are generally found in small localized area between Managua and León.

II.22 - Soil Survey Designations

A fractional symbol consisting of a combination of letters and numbers was used to denote important soil profile characteristics and surface conditions associated with each of the different soils mapped. The relevant characteristics include the following: effective soil depth; surface texture; subsoil texture; restrictive material within five feet; permeability; degree of slope and erosion; and modifying conditions such as flooding, salinity, alkalinity, high water table and etc.

Capital letters (two) preceeding the fractional symbol were used to denote the series name whereas a Roman numeral following the fractional symbol was used to indicate the land capability unit of the soil.

An example is given below to illustrate the order and arrangement of the various symbols as they appear on the cooperator's soil maps attached at the end of this report. Since not all of the conditions listed above were found to be present on all of the study sites, the example shown is considered typical of dominant soil and associated land conditions found on the cooperator farm sites.

Example: LN $\frac{2331}{A}$ IIe-1

Where: LN = Series name of the soil

IIe-1 = Land capability unit

Numerator
2 = Effective soil depth (60-90 cms)
3 = Texture of the surface soil (plow depth)
3 = Texture of the subsoil
1 = Internal drainage

Demoninator A = Slope class (0-1.5%)

Definitions and limits for symbols used on the project site soil maps are presented below. This material was extracted from applicable sections of "Leyenda Para Mapas de Suelos del Proyecto "Catastro" - Nicaragua - Noviembre 1969".

MAPPING LEGEND

Effective depth

Map Symbol	Depth (cm.)	Descriptive term
1	More than 90	Deep
2	60 - 90	Moderately deep
3	40 - 60	Slightly deep
4	25 - 40	Shallow
5	Less than 25	Very shallow

Texture

Map Symbol		Descriptive term
0	Very Coarse:	Coarse sand, gravels
1	Coarse:	Very fine sand, fine sand, medium sand, loamy sand except very fine loamy sand
2	Moderately Coarse:	Includes very fine loamy sand and sandy loam except very fine sandy loam
3	Medium:	Very fine sandy loam, loam, silt loam and silt
4	Moderately Fine:	Includes sandy clay loam, clay loam and silty clay loams

Slope

Map Symbol	Range in % Slope	Descriptive term
A	0 - 1.5	Nearly level
B	1.5 - 4	Very slightly to slightly undulating
C	4 - 8	Slightly undulating to undulating
D	8 - 15	Strongly undulating or broken
E	15 - 30	Moderately steep to hilly
F	30 - 75	Steep to very steep
G	75+	Mountainous or extremely steep

Internal Drainage

Map Symbol	Descriptive term
0	Excessively drained
1	Slowly to moderately excessively drained
2	Well drained
3	Moderately well drained
4	Imperfectly drained
5	Poorly drained
6	Very poorly drained

Erosion

Map Symbol	Descriptive term
no symbol	None to slight
e	Moderate erosion
ee	Strongly eroded
E	Severe erosion
v	Slight to moderate wind erosion

Water Table

Map Symbol	Descriptive term
w	Crops slightly affected by fluctuating water table for short periods of time during the year
ww	Water table is at 60 cm. or less during most of the year and root development of crops is severely affected

II.23 - Representative Analysis of Project Soil Samples

During early phases of the program, soil samples were collected from several farm sites which were then under study and being considered as potential cooperator sites. This work was done concurrently while soil surveys were being conducted on these sites. The samples were subsequently sent to the soil testing laboratory at La Calera and Catastro where the following tests were made.

Chemical Tests - La Calera	Physical Tests - Catastro
pH	Moisture retention @ 1/3 and 15 atmospheres
Phosphate level in ppm	
Potassium level in ppm	
Calcium + magnesium levels in m.e./100 ml.	
Aluminum levels in m.e./100 ml.	
Organic matter in percent	

The chemical and moisture retention data of project samples is presented in Table II-1.

In-as-much as the data presented is far from being complete - in terms of total analysis customarily run on samples from new survey areas - the data shows the soils to be neutral to slightly acid in reaction. Phosphate levels range from medium to low whereas levels of potassium generally range from medium to high.

II.3 - LAND CLASSIFICATION

II.30 - Type of Classification

The Project lands were classified in accordance with the system presently employed by the National Cadastral Soil Survey and Land Classification Section of Nicaragua, who are in final stages of completing soil surveys and classification of lands in the western (Pacific) zone of Nicaragua. The system, known as the Capability Classification, was patterned after the system described in Agricultural Handbook No. 210 and is one which is used nationally by the Soil Conservation Service of the United States Department of Agriculture.

The definitions and descriptions of the various categories of the system, as described and presented herein, were extracted in whole or in part from "Definitions of Capability Classes" prepared by Mr. W. George Harper, Consultant to Proyecto "Catastro", Nicaragua.

II.31 - Description of Classification Units

The capability classification is an interpretive classification made of soil mapping units or of groups of mapping units primarily for agricultural purposes. The soils are grouped into capability classes according to their potentialities and limitations for sustained production of cultivated crops that do not require specialized site conditioning or site treatment. Soils not suited to long-time sustained use for cultivated crops are grouped and classified according to their potentialities and limitations for the production of permanent vegetation and according to risks of soil damage if mismanaged. Definitions of the various categories of the system are as follows:

TABLE II-1

PROYECTO ADELANTE

SOIL ANALYSIS (ANALISIS DE SUELOS)

Site N°	Lab. N°	Depth (in.)	pH	PO_4 p.p.m.	K p.p.m.	Ca/Mg me/100 ml.	Al me/100 ml.	% Organic Matter	Moisture Retention	
									1/3 atmos.	15 atmos.
1	7	---	6.4	18	530	13.0	0.05	3.5	--	--
3	11	---	6.6	100	690	17.6	0.05	5.2	--	--
4A	66	0-12"	7.0	100	500	--	--	---	43	20
4A	67	24-36"	6.9	100	500	--	--	---	31	22
4B	68	0-12"	6.9	100	500	--	--	---	38	17
4B	69	24-36"	6.8	76	442	--	--	---	39	23
5	9	---	6.3	15	510	17.6	0.05	1.6	--	--
8A	70	0-10"	6.9	11	195	--	--	---	38	19
8A	71	10-20"	6.9	6	42	--	--	---	54	20
8A	72	20-30"	7.0	10	48	--	--	---	59	37
8B	73	0-10"	6.8	5	238	--	--	---	38	16
8B	74	10-20"	6.7	6	150	--	--	---	50	14
8B	75	20-30"	6.8	1	48	--	--	---	69	26
11	8	---	6.3	34	450	11.7	0.05	3.7	--	--
14	5	---	6.7	24	960	14.2	0.05	1.9	--	--
15	2	---	6.8	34	1060	17.9	0.05	4.7	--	--
44	6	---	6.6	4	440	12.6	0.05	1.9	--	--
50	3	---	7.1	34	1650	17.4	0.05	3.3	--	--
53	1	---	8.7	73	860	18.4	0.05	2.3	--	--
57	4	---	6.9	4	670	15.7	0.05	3.1	--	--
?	10	---	6.9	100	1220	17.2	0.05	2.8	--	--

Soil Mapping Unit

The soil mapping unit, usually a soil type or a phase of a soil type, is a portion of the landscape that has similar characteristics and qualities. Its limits are fixed by definition. The soil mapping unit provides detailed information about soil properties and is the unit about which the most precise statements and predictions can be made. Because many mapping units of different soil series are quite similar, they can be grouped into capability units for purposes of use, management and conservation practices.

Capability Unit

The capability unit consists of a group of mapping units that have similar potentials and continuing limitations and hazards. The soils of a capability unit are sufficiently uniform to produce similar kinds of cultivated crops and pasture plants with similar management practices, require similar conservation and management practices under the same kind and condition of vegetative cover and have comparable potential productivity.

Capability Subclasses

A capability subclass indicates the kind of conservation problem or limitation involved. Subclasses are groups of capability units within one class that have the same major conservation problem. The subclasses are designated by the following small letter symbols: (e) for erosion; (w) for excess water; and (s) for soil and/or root zone limitations. Climatic limitation usually denoted by the symbol (c) was not used in this survey.

Capability Classes

Capability classes are groups of capability subclasses or capability units that have the same relative degree of hazards or limitations. The risks of soil damage or limitations in use becomes progressively greater from Class I to Class VIII. Capability Classes I through IV are differentiated from each other after a summation of the degree of limitations or risks of soil damage that affects their management requirements for long time sustained use for the common cultivated crops. Descriptions of the eight Capability Classes are presented below.

Class I

Soils in Class I have few limitations that restrict their use, and they are suited to growing a wide range of crop plants. The soils are nearly level, and erosion hazard is low. They are generally deep, well drained, and easily worked. They hold water well and are either well supplied with plant nutrients or are highly responsive to inputs of fertilizer. In this survey, extensive areas of Class I soils developed in volcanic ash and cinders differ in some respects from Class I land mapped elsewhere in the world. Most class I land in this survey has a slope of less than 1%, but on soils developed from volcanic cinders and ash, the erosion hazard is greater than on soils developed on most other kinds of parent material having similar slopes. One of the reasons for this is that the soil aggregates are so light in weight (bulk density generally less than 1) that they are easily moved and transported by water, even though they are quite stable and the soils are readily permeable. The torrential rains, that are common during the wet season, especially those in October that occur after the soils are saturated, are apt to move the surface soil under clean cultivation on practically all slopes of less than 3/10 of one percent.

Several areas of Class I land in irrigated areas of this survey would not be classified Class I elsewhere because of uneven microrelief.

Class II

Class II soils have some limitations that reduce the choice of plants or require simple conservation practices. The limitations are few and the practices are easy to apply. Limitations of Class II soils may be single or a combination of the following: slopes of 1.5 to 4%; slight to moderate erosion; less than ideal soil depth; somewhat unfavorable soil structure, texture or workability; slight to moderate quantities of salts or exchangeable sodium; occasional damaging floods; or moderately high water table conditions that occur for a short period during the growing season.

Class III

Soils in Class III have more restrictions that those of Class II, and when used for cultivated crops the conservation practices are usually more difficult to apply and to maintain. Limitations may result from the effects of a combination of one or more of the following: slopes generally 4 to 8%; moderate to severe water erosion; wetness due to flooding, high water table, or imperfect drainage; moderately shallow effective depth of soil; moderate moisture-holding capacity; low fertility not easily corrected; moderate salinity or sodic conditions; or fine clay textures. Each soil in Class III has one or more alternative combinations of use and practices required for safe use, but the number of practical alternatives for average farmers is less than that for Class II soils.

Class IV

Soils in Class IV have severe limitations that restrict the choice of plants and/or require very careful management or specific kind of management. Soils of Class IV may be well suited to only two or three of the common crops grown in the area or the yields may be low in relation to inputs. Adaptability to cultivated crops is limited due to one or more of the following unfavorable features: slopes of 8 to 15%; shallow depth of effective soil material or root zone (25-60 cm); coarse textures (sandy and loamy sands) or very gravelly textures; fine clay textures (40-60% 2-micron clay); moderate stoniness; wetness caused by somewhat poor drained conditions; high watertable or flooding for moderately long periods during the growing season.

Class V

Land in Class V has restrictions that preclude growing the general farm crops, but the soils can be used for pasture, range, woodland, or wildlife and cover. The soils are nearly level to gently sloping but have severe limitations due to one or more of the following conditions:

A water table at or near the surface during most of the year, high accumulation of salts, high exchangeable sodium, and frequent flooding. The land that is used for pasture can generally be improved, and benefits from proper management can be expected.

Major improvements such as drainage, leaching of salts, replacing sodium with calcium in sodic soils, and construction of levees to prevent flooding would improve the soil so that the common or adapted crops could be grown. It was generally not possible for the soil mapper to determine the feasibility of drainage and reclamation of such land. This usually requires additional study by drainage engineers and agricultural economists.

After the land is reclaimed, the capability classification may be upgraded.

Class VI

Class VI soils have limitations that make them generally unsuited to cultivation. Nevertheless, the physical condition of the soil is such that it is practical to apply range and pasture improvements, if needed. These include seeding, fertilizing, and water control by use of furrows, drainage ditches, diversions, or water spreader.

Soils are Class VI because of moderately steep slopes, generally 15 to 30% where erosion would be severe if cultivated crops were grown; shallowness, depths about 25 centimeters; coarse texture (sand); excessive wetness due to flooding or poorly drained conditions; or stoniness.

Some Class VI soils may be safely used for the common crops provided unusually intensive management is used. This is true in the Premontane Tropical Moist Forest life zone where extensive areas of Class VI land are used for growing coffee in the shade of native trees or under banana trees that prevent severe erosion on moderately steep slopes. Other tree crops could be grown here and on many areas of Class VI land in other life zones if planted on the contour, a good cover established, and protective structures used to control runoff and prevent erosion.

Most Class VI soils are used for grazing cattle during the rainy season and for the first 8 to 12 weeks of the dry season until the pastures dry out.

Class VII

Soils in Class VII have very severe limitations that make them unsuited to cultivation and restrict their use largely to grazing, woodland or wildlife. Where these soils are used for grazing, woodland or wildlife, it is generally impractical to apply pasture or range improvement such as seeding, fertilizing, and water control. Soils are in Class VII because of one or more of the following continuing limitations: steep slopes, generally 30 to 75%; severe erosion hazard; wetness, shallowness, less than 25 centimeters; very coarse texture; stoniness.

Some soils in this class may be used for special crops under unusual management practices. In this project area moderately extensive areas are used for growing coffee in the shade of native vegetation.

Class VIII

Soils and land types in Class VIII have limitations that preclude their use for commerical plant production and restrict their use to recreation, wildlife, water supply, or to esthetic purposes.

Soils and land types in Class VIII cannot be expected to return significant on-site benefits from management for crops, grasses, or trees, although area-wide benefits from wildlife use, watershed protection, or recreation may be possible.

Areas of rocky land, lava flows, sandy beaches, gravel pits, mangroves and very steep land with slopes of more than 75% are in Class VIII.

II.32 - Description of Land Capability Units

Descriptions of the various Land Capability Unit symbols appearing on the Project Soil and Land Classification Maps of each Cooperator Farm Site are presented below. These descriptions were prepared by Catastro and are presented unchanged in order to avoid any possible chance of misinterpreting the original data for each of the units.

Capability Unit I-4

Nearly level, deep, well drained clay loams that have a friable clay subsoil of good structure. These soils have moderately slow permeability and moderate available moisture capacity.

Project soils in this unit are -

(AOa) Argolla clay loam, 0 to 1.5% slopes

Use and management - The soils are of average suitability for a wide variety of annual and perennial row crops. The Amatitán and Goyena soils, which are in a slightly moister zone than the Olocotón soils, are well suited to sorghum, corn, cotton, rice, fiber crops and castor beans. Fertilizers are needed for optimum yields of all crops on these soils.

The soils can be cultivated continuously with little or no loss of the soil, if crop residues are returned to the soil. Minimum tillage is necessary during seed bed preparation to avoid pulverizing the soil; in this condition it is susceptible to wind and water erosion.

Capability Unit IIe-1

Nearly level to very gently sloping, deep, well drained loams, silt loams, and fine sandy loams, that have moderate permeability and high available moisture capacity. These soils also have a high content of organic matter in the surface, and some even in the subsoil. Most of the soils are slightly eroded.

Project soils in this unit are -

(TEb) Telica loam, 1.5 to 4% slopes

(VSa2) Villa Salvadorita loam, 0 to 1.5% slopes, slightly eroded

Use and management - The soils are well suited to practically all acclimated crops. Under irrigation, they are also well suited to bananas and plaintains and to sugar cane. For optimum yields, fertilizer is needed.

Runoff from these soils is slow to medium, and the erosion hazard is slight to moderate. Simple practices, such as cultivation on the contour, minimum tillage, and two-way tillage, are necessary to conserve the soil. For intertilled annual row crops, the return of crop residues is also necessary in order to maintain organic matter and reduce the hazard of erosion. Where feasible, wind strip cropping at right angles to the direction of the wind is desirable.

Capability Unit IIe-2

Nearly level to very gently sloping, deep to moderately deep, well drained sandy loam and loams that have moderate to moderately rapid permeability and moderately high available moisture capacity. Most are underlain at some depth by a coarse-textured substratum.

Project soils in this unit are -

(MPa) Malpaisillo sandy loam, 0 to 1.5% slopes, slightly eroded

(MPb) Malpaisillo sandy loam, 1.5 to 4% slopes

Use and management - The soils are well suited to most intertilled annual row crops, fiber crops, and castor beans, but are of low suitability for pineapples. Under irrigation, they are moderately well suited to sugar cane, bananas, and plantains. Fertilizer is essential for optimum yields of these crops.

For the production of most intertilled row crops, complex conservation practices, such as terraces with grassed waterways for outlets, are required. For cotton, corn, sorghum, and perennial row crops, simple measures, such as contour farming, return of crop residues to the soil, and minimum tillage, are sufficient to conserve the soil. To protect the land against wind erosion, wind strip-cropping, wind-break plantings, and the use of mulches are desirable.

Capability Unit IIe-3

Nearly level to very gently sloping, deep loams and clay loams that are well drained to moderately well drained. Most have moderately slow permeability and moderately high available moisture capacity.

Project soils in this unit are -

(LEa) La Esperanza loam, 0 to 1.5% slopes

Use and management - The soils are moderately well suited to most intertilled annual and perennial row crops but well suited to corn and cotton. They are well suited for rice, both irrigated and nonirrigated, and for irrigated sugar cane. Fertilizer is required for optimum yields of these crops. No special practices are required for perennial row crops. Intertilled annual crop require simple conservation measures such as contour farming, minimum tillage, and the use of crop residues. On long slopes that have gradients greater than 1.5%, terraces may be needed to conserve the soil. In irrigated fields, field ditches and drainage mains or laterals may be needed.

Capability Unit IIe-4

Nearly level to very gently sloping, deep to moderately deep, well drained soils that have mostly a clay loam surface and a friable clay subsoil of moderately high available moisture capacity.

Project soils in this unit are -

(GYb) Goyena clay loam, 1.5 to 4% slopes

(SBa2) San Gabriel clay loam, 0 to 1.5% slopes, slightly eroded

The San Rafael soils are developed from sandstone and shale and contain a moderate amount of bases (25 to 45% base saturation).

Use and management - The soils in this unit are moderately well suited to most row crops and generally well suited to sorghum, corn, cotton, dryland rice, kenaf, irrigated sugar cane, and castor beans. Fertilizer is required for optimum yields of these crops.

No special conservation practices are needed for most perennial row crops. For intertilled annual row crops, contour farming, minimum tillage, and the use of crop residues are necessary to conserve the soil. On long slopes that exceed 1%, terraces may be required.

Capability Unit IIIw-1

Nearly level, moderately well drained loams and silt loams that are deep and moderately deep. The soils have moderately slow permeability, owing to the presence of a fine-textured substratum. They also have a high water table for a few weeks during the rainy season in October. Some also are slightly saline in the subsoil.

Project soils in this unit are -

(CAa2) Chácara clay loam, 0 to 1.5% slopes

Use and management - The soils have a low suitability for most acclimated crops except rice and irrigated sugar cane. They are unsuited to beans, bananas and plantains. The soils are easy to work except when wet. They are wet generally for longer periods than the surrounding soils in the same field. Drainage ditches may be needed in some fields to remove surface waters. Where these soils are extensive, drainage mains or laterals may be required.

Capability Unit IIIw-2

Nearly level to very gently sloping, dark-colored clays that are moderately well drained, deep to moderately shallow, and slowly permeable.

Project soils in the unit are -

(VCa2) Vertic soils, moderately well drained, deep and moderately deep, 0 to 1.5% slopes

The soils have some of the properties of Vertisols (swelling black clays) but are generally more friable in the surface layer, better drained, and somewhat easier to work.

Use and management - The soils are suited to sorghum, corn, irrigated sugar cane, and rice both irrigated and unirrigated. They are also suitable for pasture grasses. Fertilizer is needed for satisfactory yields.

The soils are somewhat difficult to work, owing to their heavy texture, and they are slow to dry out after prolonged rains. The conservation hazard for crops is slight to neglible. Field ditches and drainage mains are needed where surface drainage is inadequate.

APPENDIX III

INDEX FOR MONTHLY REPORTS, PROJECT ADELANTE

Nos. 1 through 28 -- February 1968, - May 1970

This alphabetical index has been prepared to assist persons interested in reading additional details on certain aspects of Project Adelante work which have been presented in the regular monthly Project reports. Photographs, as well as textual material, have been listed.

Monthly reports were prepared in both the English and Spanish languages, and are in the files of MAG, U.S. AID/Nicaragua, Uniconsult, Inc. in Lafayette, California, and Agriculture Industries, Inc. in Davis, California.

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APPENDIX IV

SAMPLE COOPERATOR AGREEMENT FORM

GOVERNMENT OF NICARAGUA

MINISTRY OF AGRICULTURE AND LIVESTOCK

PROJECT ADELANTE

COOPERATOR AGREEMENT

FOR

____

1968

USAID - COOPERATING
MANAGUA, NICARAGUA

UNICONSULT
LEON, NICARAGUA

TABLE OF CONTENTS

COOPERATOR AGREEMENT

I. GENERAL CONDITIONS

A. Description - Project Adelante is an overall comprehensive plan to gather and compile all facets of irrigation information under realistic operating conditions and carry out on-farm demonstration activities. The Project includes the areas surrounding the cities and/or towns of León, Chinandega, Villa Salvadorita, Malpaisillo and Telica. See attached map - Fig. No.___. The following agreement outlines the responsibilities of each party.

B. Definitions - The following terms as used in this agreement are respectively defined as follows:

1. PROJECT - All persons or individuals assigned on a permanent basis to Project Adelante and also representing the agencies or firms of the Ministry of Agriculture and Livestock, the U.S. Agency for International Development and Uniconsult, Inc.

2. LANDOWNER - All persons, partners or individuals either landowners (or tenants) who are specifically authorized to represent said "Landowner" in further contractual obligations, alterations, terminations, etc.

3. FARM - All locations of agricultural endeavor (regardless of size), (May vary from a small percentage of a manzana to several hundred manzanas) where the various practices of planting, cultivation, irrigation, harvesting and marketing may be engaged for the purposes of carrying out the provisions of the agreement.

4. OFFICE - The place of business designated by the Project to represent the official point of contact between the two parties of this agreement.

5. OFFICIAL ADDRESS - The official address shall be given as:

Project Adelante
Apartado 140
León, Nicaragua

Second floor of Departamento de Administración de Rentas (Government building).

C. Materials, Services and Facilities - It is understood that all materials, services and facilities not specifically mentioned as being supplied by the Project will be furnished by the landowner and the omission of said materials, services, or facilities does not relieve the landowner of such responsibility.

D. Insurance - Is a policy of economic import executed by whatever company that operates in the Country to settle eventual risks that can take place in the fulfillment of contracts.

E. Guarantee or Warranty - The guarantees or warranties provided by contractors, subcontractors or manufacturers under the terms of a service or supply contract shall be limited to such terms expressly provided and any failure of performance beyond these limitations shall be deemed to be the responsibility of the farmer.

F. Termination or Abandonment - In the case of non-performance or a mutual understanding to terminate the agreement, the following procedures shall be adhered to:

1. Written Notice - Either party may initiate termination proceedings in the initial stages, i.e., before loan applications have been approved; or, substantial amounts of technical assistance has been expended.

2. The disposition of materials, equipment or value of services must be mutually agreed upon or be submitted to arbitration.

   In arbitration, each party will select one referee and the two thus selected will in turn select the third member. Both parties must agree in advance to abide by the decision of the arbitration trio.

3. Termination initiated by either party does not relieve the landowner of the obligation incurred by him in securing a loan from a financial institution for the purpose of purchasing materials, equipment or services as in the case of a well, pump and/or sprinkler system equipment.

II. THE PROJECT AGREES TO:

A. Provide Technical Assistance to include the following:

1. Engineering - Surveys, design, supervision of construction --- for installation of an irrigation system.

2. Soils - Physical inventory plus various chemical tests as determined to be required by the project technicians, for example: pH, O.M., N.P.K., exchangeable cations, Ca, Mg, K, Na, Mn, cation exchange capacity and mechanical analysis.

3. Cropping - Working out detail cropping plans suited to the individual cooperator.

4. Farm Management - Guidance in decisions regarding dates of planting, means of cultivation, pesticidal, and herbicidal application, etc.

5. Purchasing - Assistance in purchasing blocks of seeds, fertilizers, chemicals and assistance to securing transportation to market.

6. Farm Enterprise Accounting - Provide guidance in setting up a farm enterprise accounting system to determine inputs of production.

7. Marketing - Provide guidance on how to enter favorable markets.

B. Credit Assistance - Provide assistance in securing credit (for both long and short term) at the lowest possible rate of interest.

C. Training - The entire Project staff (Nicaraguan technicians, resident and part-time specialists) will provide nearly constant training of the cooperators; their assistants, or other designated personnel, in the various aspects of irrigated agriculture.

D. Capital Investment Assistance (Sprinkler System) - The Ministry of Agriculture and Livestock will provide the use of a sprinkler system where applicable for a maximum area of 20 - 25 manzanas to be used for the balance of the agreement. Make arrangements for transfer of title at a cost of the depreciated value of the portable system. See depreciation schedule below.

If the transfer takes place at a time that does not correspond to the end of a year, as shown below, the cost shall be determined by direct interpolation of costs borne during the year in which the transfer is made.

PERIOD OF USE	DEPRECIATION VALUE IN % OF ORIGINAL COST
One Year	100%
Two Years	50%
Three Years	35%
Four Years	25%
Five Years or more	10%

However, the maintenance of the system and the acquisition of replacement parts following initial installation of the system shall be the responsibility of the landowner.

II. THE FARMER AGREES TO:

A. Provide land in the area of____manzanas as outlined on the accompanying map continuously over a period of two years or that short period thereafter to permit the harvesting of crops planted during the initial contract period; providing, however, that this short period in any case cannot exceed six months.

B. Provide capital investment in a well, pump and power facilities to serve the design area so described in paragraph A above. To provide for operation and maintenance of the well, pump and power unit above described and also assure the maintenance and purchase of spare parts for the irrigation equipment required for the Project.

C. Provide the means of production by making available farm equipment adapted to the various agricultural operations such as; land operation, planting, cultivation, fertilization, application of insecticides or herbicides, and harvesting.

D. Provide the day to day supervision of the means of production as described above.

E. Provide day to day supervision of the laborers, either contractual or hourly workers, and agree to abide by the rules and regulations of the minimum standards of wage and other benefits as required under Nicaraguan law.

F. Provide the materials of production such as seeds, fertilizers, fumigants, insecticides, herbicides, defoliants, etc., to produce the crop as specified in the cropping program described.

G. Provide a small percentage (not less than 10%) of the means and materials of production for trial testing as follows; variety, fertilization, water application, etc.

H. Provide protection to the demonstration area crops from such enemies as; animals (rodents), chemical drift, by whatever means deemed prudent and necessary.

I. Follow the detailed cropping program so as to give the on-farm demonstration trials that degree of success normally accorded farming operations in this vicinity.

J. Provide access to the farm or demonstration areas and permit access to other individuals, groups, etc., for the purpose of holding public meetings to disseminate the findings of the project according to the directions of the MAG. To permit photos to be taken of the project activities for practical application in other areas. To permit the erection of suitable signs marking sites as a cooperative project between the Ministry of Agriculture and Livestock (MAG) and the United States Agency for International Development (USAID).

K. Make arrangements so as to guarantee the length of tenure as well as the intimate details of the contract provisions should a change of ownership occur due to any cause, notwithstanding, sale, court decree or death.

L. Guarantee to provide the inputs of production as enumerated above; or, in the absence of such provisions, agree to let the project assume such responsibility and have these costs thus be regarded as lien against the crops thus produced.

IV. REVISIONS, EXTENSIONS, ETC.

We, the Project and the Landowner, hereby agree to the right of extension of the original two year agreement for an additional three year period with conditions remaining the same, providing notice to the contrary is not given thirty days prior to the expiration of the original contract period as described in paragraph F above.

This Agreement, made this ____________________day of____________, 1968, by

and between (1) ____

hereinafter called the "Project", and (2)_________________________________

hereinafter called "Landowner".

WITNESSETH: that for and in consideration of the technical assistance and services rendered by the "Project" the "Landowner" hereby agree to carry out the supply of material, equipment and services to the best of his ability and resources.

IN WITNESS WHEREOF, the parties to these presents have executed this contract in six (6) counterparts, each of which shall be deemed an original in the year and day first above mentioned.

_________________________________	_________________________________
(PROJECT)	(LANDOWNER)
_________________________________	_________________________________
(WITNESS)	(WITNESS)