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ASSESSMENTS AND COMMENTS ON SOIL PROPERTIES AFFECTING VEGETABLE AND FRUIT PRODUCTION IN ORANGE WALK AND COROZAL DISTRICTS

BELIZE COMMERCIALIZATION OF ALTERNATIVE CROPS
CONTRACT NO. 505-008-C-00-6063-00
PROJECT NO. 505-0008

SUBMITTED TO:

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and

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
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SECTION I

INTRODUCTION

In order for the commercialization of Alternative Crops (CAC) project in Belize to be successful, there must be an integrated approach to remove the inherent identified constraints to production and export of quality fruits and vegetables. This must entail continual cooperation between the on-site team and other agribusiness specialists.

Total Integrated Production Systems (TIPS)* must be developed for each crop. Soils, water management, pest management and harvesting/marketing aspects must be given equal emphasis. Other aspects to receive equal attention may include, but may not be limited to: infrastructural components such as packing sheds, cooling facilities, farm-to-market roads, and export facilities.

To a large degree, the success of the project depends not only on whether or not vegetables or fruits will grow well in Belize, but also on whether or not the farmer's attitude can be affected. If the farmers can see the fruits of their labor in the form of quality produce marketed, the project team will have made a major step forward.

Overall project success will depend on strict attention to detail, a cooperative effort technologically, as well as support by political and financial institutions that can encourage and facilitate the project goals.

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*TIPS (Total Integrated Production Services, and Total Integrated Production Systems) is a proprietary acronym for services I offer to individual growers. A.T. Christiansen

A. Investigational Procedures

The assessment of vegetable production potential for the CAC project has proceeded as follows:

- Establishment of site selection guidelines. The goal was to examine all the major potential vegetable producing soils in the northern districts of Orange Walk and Corozal.

- Crop selection. Crop selection criteria are discussed elsewhere in this report.

- Grower selection. A list of standards for participating growers was established. The process of selection is discussed in Section I of this report.

I thoroughly studied the soils maps that were available to me in order to gain some general view of the areas and soils under study. The investigation then proceeded to the farm level where soil samples were taken and specific observations recorded. District and zone agricultural officers were helpful in acting as guides to the farmers who had been tentatively selected.*

B. Goals of the Investigation

My primary goal was to determine the feasibility for vegetable production in the northern districts of Belize, using my guide, the Scope of Work for the study. Experience shows that one cannot separate soil characteristics from other aspects of production. I, therefore, attempted to evaluate the soils thoroughly to determine if there were any overriding physical or chemical limitations to vegetable production.

C. Site Selection Criteria

Criteria were developed for primary site selection. Many factors were considered and a compromise list of considerations was developed. These included:

- Soils suitable for vegetable production. No obvious overriding physical, i.e., chemical limitations.

- Irrigation water of satisfactory quantity and quality suitably located.

- Attitude of the farmer, which is, of course, strictly subjective.

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*I was assisted in my sampling by a BCA student, Javier Santos, who is on a work-study grant from BABCO. I thank him for his help. I believe the experience was also a learning opportunity for him, for it is young men like him who will be managing the future vegetable industry in Belize.

Table 1 APPROXIMATE LOCATION OF FIELDS SAMPLED

ORANGE WALK DISTRICT

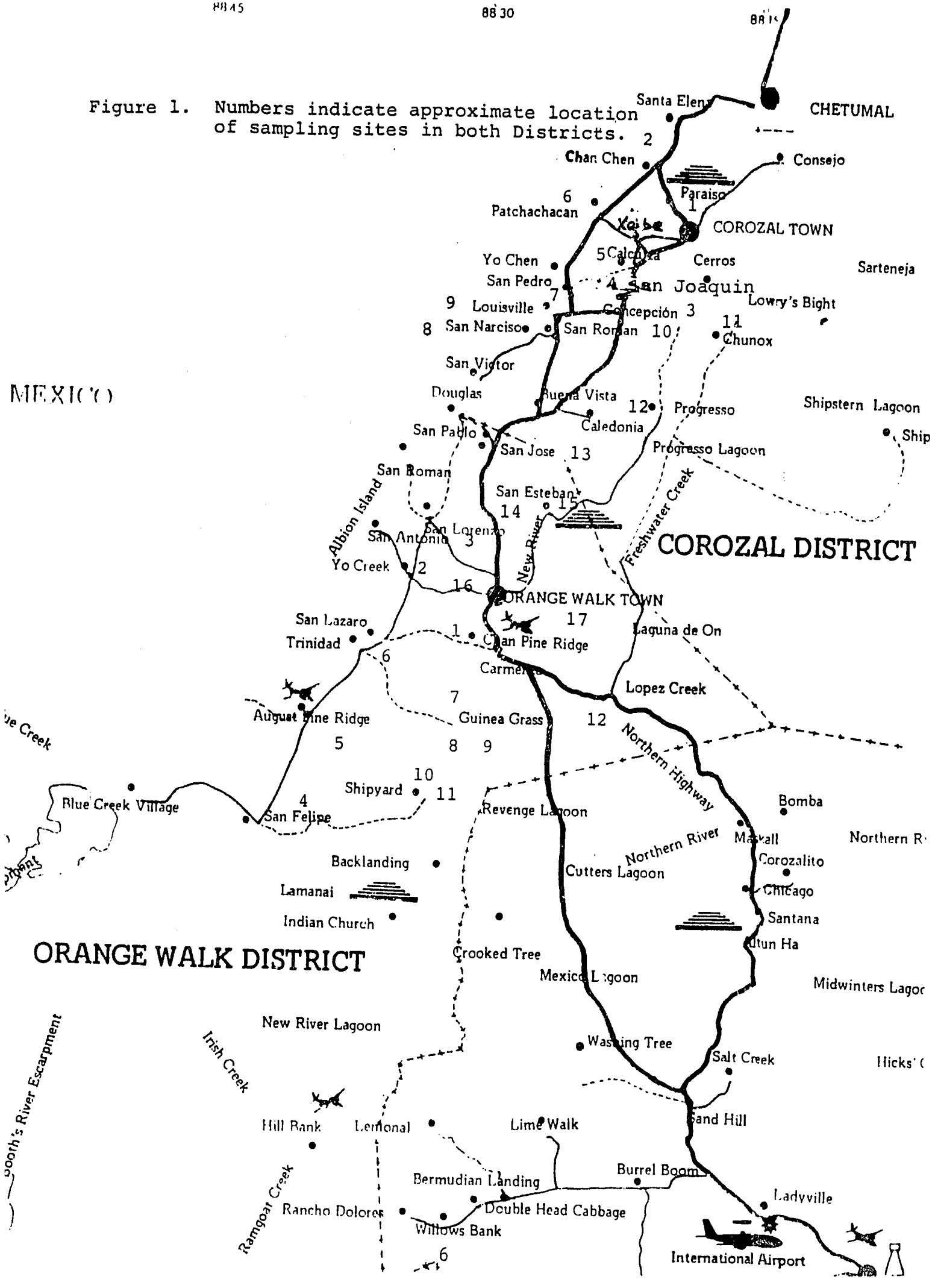
	NAME	VILLAGE
1.	J. Chell	Chan Pine Ridge
2.	G. Pech	Yo Creek
3.	R. Cal	Yo Creek
4.	G. Novelo	San Felipe
5.	A. Medina	August Pine Ridge
6.	A. Carrillo	San Lazaro
7.	E. Camara	Guinea Grass
8.	R. Leiva	Guinea Grass
9.	E. Santos	Guinea Grass
10.	B. Toledano	San Luis
11.	E. Guiterrez	San Estevan
12.	A. Castillo	San Estevan
13.	G. Hernandez	Orange Walk
14.	V. Ayuso	Orange Walk
15.	E. Klassen	Camp 16
16.	P. Neuster	Camp 11
17.	J. Buddan	London Camp

Table 1 (Continued)

COROZAL DISTRICT

	NAME	VILLAGE
1.	B. Vasquez	Paraiso
2.	C. Chan	Chan Chen
3.	R. Correa	San Joaquin
4.	C. Cowo	San Joaquin
5.	F. Fabro	Calcutta
6.	G. Sosa	Patchakan
7.	J. Cobb	San Pedro
8.	P. Campos	San Narciso
9.	A. Keme	San Narciso
10.	G. Espiritu	San Roman
11.	E. Wiltshire	Chunox
12.	G. Kiso	Progresso

Figure 1. Numbers indicate approximate location of sampling sites in both Districts.



D. Crop Selection Process

Consideration was given to plots within each zone in both districts. The following criteria were used to select crops which may be grown this season:

- Marketing advantages. Are there true windows? What are the seasonal harvest times? In the US? Do they complement or compete with the same crop in the US? What level of consumer acceptance?

- Alternative uses. If export is not possible or the market decreases, is there another use for the crop? What about processing potential? Livestock feed? Local Market? Other possibilities?

- Local farmer experience. Have they grown the crop in question or one like it before? Are chemicals and other inputs available for pest control?

After considering a long list of crops and subjecting them to the considerations mentioned above, a short list was developed. Quality control was a major consideration in the selection process. The list was discussed with the farmers visited, and they were given the opportunity to choose which crop they might prefer to grow. The final list awaits the input of U.S. agribusiness entities who are responsible for selling what is produced.

Table 2 lists the major criteria discussed. It is not meant to be a comprehensive analysis of either the production or the marketing of these crops. Although these crops were discussed with farmers, they are not bound to the production of the crops discussed, since the final crops list may change.

E. Grower Selection Process

District agricultural officers developed a list of farmers who met the criteria. They further evaluated the growers with these additional considerations:

- A "progressive" attitude

- Grower's location

- Whether or not the grower lives on his farm to provide security for equipment and produce

From a list of almost sixty farmers, twenty-eight were selected for further evaluation and personal visits. The goal was to have farmers participating in the project from each zone within the two districts. There are, at this writing, 29 growers who were interviewed and met the criteria. This by no means suggests that there are not others who are equally qualified to

Table 2

CROP	MARKETING POSSIBILITIES	ALTERNATIVE USES	GROWER EXPERIENCE
Blackeyed peas	• US market with high quality off-season supplies	• Limited local market • Dried • Processing	• Limited with this type of beans
Cucumber	• US market with high quality off season supplies • Could be shipped partially processed	• Limited local • Processed	• Yes
Lima Beans	• US market with high quality consistent supplies	• Local use could be developed. • Processed (frozen) • Dried	• None
Hot Peppers	• US market	• Limited local market • Processing	• Yes
Melons	• US market. Off season.	• Limited local market • Processing	• Yes
Okra	• Specialty vegetable • Needs merchandising to develop consumer acceptance	• Limited local market	• Yes
Snap beans	• US with high quality off-season supplies	• Limited local market • Dry beans • Processing possible	• Limited
Squash Zucchini	• US with high quality	• Limited local • Possible processing	• Limited
Sweet Corn	• US with off-season consistent, high quality supplies	• Local market could be developed • Processing • Livestock feed	• Yes with field corn

Table 2 (Continued)

CROP	MARKETING POSSIBILITIES	ALTERNATIVE USES	GROWER EXPERIENCE
Tomatoes	• Salad bars in US, Off-season with high quality	• Limited local market • Processing possible	• Yes, with other varieties
Papaya	• "Exotic" fruit. US market if high quality	• Local market • Processed (jam, jellies)	• Yes, not on export scale
Pineapple	• US market	• Local market • Processed (juices, etc.)	• Yes, not of export quality

Table 3

Orange Walk District

ZONE & FARMER	VILLAGE	SOIL TEXTURE	CROPS PROPOSED	OBSERVATIONS AND COMMENTS
ZONE 1				
J. Chell	Chan Pine Ridge	Sandy loam Over clay loam	Squash, Melons	Experienced in vegetables. Recognizes need for Tech. assistance. Well adequate for irrigation. Could handle drip system.
G. Pech	Yo Creek	Silty clay Over clay	Sweet corn, beans	Previous crop-sorghum. Rolling topography. Only drip or sprinkler irrigation will be possible. Will use for "dry control".
R. Cal	Yo Creek	Sandy clay loam Over clay		Good vegetable site. Flat. Has good well. Could use drip irrigation. Markets through family outlet in Belize City.
ZONE 2				
G. Novelo	San Felipe	Clay loam Over clay Sandy loam/ sandy clay loam	Coco yams	Water source not reliable. Rough road would limit moving any tender vegetables
A. Medina	August Pine Ridge	Sandy loam Over sandy clay	Melons, Squash	Topography suitable for irrigation. River water (slough) 150 yds from field. 20 ft. lift. Furrow irrigation.
A. Carillo	San Lazaro	Sandy clay loam sandy loam over limestone	Any Crop	Excellent young farmer. Eager for technological help. Well available. Topography satisfactory for any type of irrigation. Could handle drip system. Has own machinery.
ZONE 3				
E. Camara	Guinea Grass	Sandy clay loam	Cucumbers, Sweet corn	Anxious to be involved. Appears to be a good farmer. Now using a simple furrow system. Will be upgraded.
R. Leiva	Guinea Grass	Sandy loam Over sandy clay	Peppers tomatoes	Stream across road. Will dig well on site. Excellent soil. Furrow if stream used. Drip if well is supplied This farmer has worked in US for Campbell Soup Co. in 1984. A good candidate for project assistance.

Table 3 (continued)

ORANGE WALK DISTRICT

ZONE & FARMER	VILLAGE	SOIL TEXTURE	CROPS PROPOSED	OBSERVATIONS AND COMMENTS
E. Santos	Guinea Grass	Sandy loam	Cooc yams (non-irrigated) Okra, Squash	Big farmer. Irrigation available from New River (swamp). Experienced vegetable grower. Furrow.
E. Klassen	Camp 11	Clay loam	Any crop	No well but has drilling rig. Excellent topography. Spanish speaking Mennonite farmer, good farmer. mechanized.
P. Neuster	Camp 16	Loamy sand	Any crop	Excellent soil. Well available. English speaking Mennonite farmer, topography good for furrow. Could handle drip technology easily.
J. Buddan	London Camp	Sandy clay	Any crop	Pond available for water. Topography good for furrow irrigation.
ZONE 4				
B. Toledano	San Luis	Clay loam over Clay	Sweet corn, beans	Good slope for furrow. Well adequate. Good soil.
E. Guiterrez	San Estevan	Clay loam over clay	Squash, beans	Good experience in vegetable production. Well near field. Gentle slope good for furrow.
A. Castillo	San Estevan	Clay loam	Sweet corn, okra	Has one acre measured. Topography excellent for furrow. Good well. Good farmer.
ZONE 5				
G. Hernandez	Orange Walk	Clay to clay loam over clay	Sweet corn, beans	Experienced vegetable grower. Will participate as "non-irrigated" control. Soil will hold water well. Internal drainage marginal.

Table 3 (continued)

ORANGE WALK DISTRICT

ZONE & FARMER	VILLAGE	SOIL TEXTURE	CROPS PROPOSED	OBSERVATION AND COMMENTS
V. Ayuso	Orange Walk	Clay loam to silty clay loam	Peppers, okra	Furrow irrigation. Old well to be improved. Slope satisfactory. Two possible sites.

Table 3 (continued)

COROZAL DISTRICT

ZONE & FARMER	VILLAGE	SOIL TEXTURE	CROPS PROPOSED	OBSERVATIONS AND COMMENTS
ZONE 1				
B. Vasquez	Paraiso	Red clay loam over clay limestone unconsolidated	Okra	Well available. Suited for any type of irrigation. Sprinkler is a possibility.
C. Chan	Chan Chen	Red-brown clay over clay Gravelly limestone subsoil	Melons, Tomatoes	Furrow irrigation. Good slope. Appears to be conscientious farmer. Has some citrus.
ZONE 2				
R. Correa	San Joaquin	Clay loam over clay	Cucumbers Squash	Located in town. Will dig well. Some vegetable experience. No expansion possibilities.
C. Cowo	San Joaquin	Clay loam to sandy clay over limestone	Tomatoes,	Will dig well. Topography good for furrow irrigation.
F. Fabro	Calcutta	Clay	Peppers, Okra	Heavy infestations of Root Knot Nematodes. May limit crop choices. Well available. Furrow irrigation.
ZONE 3				
G. Sosa	Patchakan	Red clay loam	Peppers, Tomatoes	Excellent farmer! Voted Farmer of the Year for 3 years, Will be capable of handling any type of irrigation system. Good drip prospect.
J. Cobb	San Pedro	Clay with lime intrusions over clay	Tomatoes, Peppers	Topography good for furrow irrigation. Water available.

Table 3 (continued)

COROZAL DISTRICT

ZONE & FARMER	VILLAGE	SOIL TEXTURE	CROPS PROPOSED	OBSERVATIONS AND COMMENTS
ZONE 4				
P. Campos	San Narciso	Heavy clay	Coco yams, Okra	Non-irrigated plot. Intensive inter cropping program. Drainage poor.
A. Keme	San Narciso	Clay	Any crop	Zamorano graduate. Good farmer. Well available. Vegetable experience. Could expand. Topography good for furrow or could easily handle drip tech.
G. Espiritu	San Roman	Clay	Cucumber, Squash	Progressive young farmer. Eager to learn. Can handle irrigation. Well available. Good possibility for drip.
ZONE 5				
E. Wiltshire	Chunox	Clay loam Over gravelly Clay	Tomatoes, Peppers	Adaptable to irrigation technology. Well available. Can handle furrow irrigation. Topography and soils satisfactory.
G. Kiso	Progresso	Clay loam Over clay	Melons, Cucumbers	Well available, but undeveloped. Topography satisfactory for furrow system. Soils reasonably well drained.

SECTION II

SOIL INVESTIGATIONS - GENERAL

A. Review of Published Surveys

Several teams and individuals have spent time in Belize surveying soils. These groups may or may not have had the same goals in mind and it appears that some duplication has occurred.

Much of the early work in soil surveys could be considered basic. Perhaps the most comprehensive and widely-referenced work done on the soils of Belize was done by Wright, et. al. in 1959. By the very nature and magnitude of the task, their report serves best as a base from which others may begin. The published report was reviewed and a photocopy of the text and maps has been in-included in the reference library for the project. The study describes the general distribution of soils, discusses the vegetation forms which contributed to the soil properties observed, and includes a soils map, a land use map, and a vegetation map which served as a resource as I examined the soils in the Orange Walk and Corozal districts.

Although most of the surveyors left a good record of their work, there were not many of them. Most were looking at soils with a specific question in mind, often the soils' suitability for sugar cane. The reports are not catalogued, making it difficult to complement previous efforts. Some surveyors have not left copies of their reports in Belize. Mr. Elias A. Awi, the librarian at Central Farm's Agricultural Library and Information Center, deserves compliments for his efforts to publish bibliographies of research work done in Belize and to preserve and file some of the early publications.

Charter discussed soil properties from the perspective of sugarcane production. He described in reasonable detail the profiles of some of the major soil types in Belize. I concur in his observations concerning the origin and development of soils, i.e., weathered limestone materials. In his report he grouped soils into six broad descriptive categories:

1. Black clay over crisp white marl.

2. Red clay over ochrous white marls with pink patches.

3. Grayish clay over ochrous limestone white marls cemented by gypsum.

4. Black sandy loams over white silicaceous marl.

5. Plastic gray clays of variable depth.

6. Gray-black soils over plastic gypsiferous gray clays.

There have been some more recent efforts to survey the soils in Belize. McCormack, a USDA/FAO researcher, was in the country recently. Unfortunately his work was not available for review; however, when his report is published a copy should be obtained for the project library, if at all possible.

I spent several hours at the BSI reference library at Libertad. Much work has been done by the staff there on fertility investigations for sugar cane. They have identified several problems which will be of importance to our project, namely, the fixation of phosphorous by the clayey and limey soils in the area and some unpublished work on lime-induced chlorosis (iron-deficiency). Their work has been concerned primarily with fertility trials with N, P, and K on the Louisville and Pixoy soils.

Mr. A. Cawich has a NASA-LANDSAT photomap which he is preparing to have enlarged (integrated) by a geographer from Edinborough University. He has indicated his willingness to let us use the enlargements for our project when they are completed. This will enable us to locate our plots exactly and to evaluate their expansion possibilities.

The work by Frost, while not specifically directed toward agricultural production, nevertheless gives an insight into fertility differences between sites in their virgin state and those that have been influenced by man. He sampled paired sites and determined that a decrease in nutrient level occurred with agricultural use. He noted differences in fertility as influenced by vegetation and/or previous cropping practices. He found an inverse relationship between pH and soil nutrients with rainfall. He also noted, as would be expected, high levels of calcium and magnesium from the parent material. Phosphate levels were low as would be expected with high lime soils.

B. Soil Development

It is beyond the scope of this report to go into great detail concerning the geologic origin and development of the major soils of Belize. The soils for the most part have originated from sedimentary materials which have subsequently been uplifted, eroded, and redeposited where the "soil development" has taken place. There are some igneous intrusions evident and some metamorphism has occurred to the previously deposited sedimentary materials.

The original minerals were both coarse-textured and fine-textured. As these materials were eroded and deposited by water, the coarser particles (sand fractions) settled out nearer the source of the erosion and the finer particles (clay and silt fractions) remained suspended longer and settled out as the water

became more still. This process accounts to a large degree for the extreme variability of the soils examined. Currents of water vary in speed and in particle-carrying capacity. Small eddys, ponds, or slower moving streams deposited the finer materials, and thus the clayey soils came to be. The fine-textured igneous and metamorphic materials were the parent materials of many of the soils of Belize. The other primary parent material was limestone. Most of these were calcitic. These materials generally weather to produce fine textured (clayey and silty) soils which are generally quite fertile.

The deposition of these eroded materials over previously developed limestone materials resulted in soils of clayey texture over the consolidated or unconsolidated limestones (marl) which are so common. Fertility is generally good, but productivity depends on proper management of the developed physical properties.

1. General observations

The soils in the districts where the CAC project has been directed to work are primarily fine-textured soils. With proper management, all of the soils can be productive. Appendix 1 gives a brief discussion of the difference between a "fertile" and a "productive" soil. Some limitations to management of heavy clay soils are discussed in Appendix 2.

2. Physical properties

The texture of each sample was classified by the "feel" method. Suffice it to say that most of the soils are clay and clay loam textures in the Corozal District. Some sites tended toward sandy clay and sandy clay loams most of which are found in Orange Walk District.

Water intake and subsurface percolation are relatively slow due to the clay content of the soils. Infiltration is estimated to be about 0.50 to 0.20 inches/hour in the surface soil and mostly at the lower end of that range in the subsoils at most sites. This means that irrigation scheduling and time must be accounted for in the irrigation design. Too much water will result in runoff. Appendix 3 discusses some aspects of irrigation/soil relationships.

Water-holding capacity of clay soils can be advantageous or at times, disadvantageous. Clay soils generally hold adequate moisture (in the range of 15% to 20% available) to supply moisture to plants until the next significant rainfall comes--at least in Belize. The problem is that in order to maintain quality in vegetable production, the soil moisture content must be relatively uniform. As discussed in Appendix 4, rainfall is not often uniformly distributed and most vegetable production areas need supplemental irrigation.

Table 1a

ORANGE WALK DISTRICT

ZONE & FARMER	VILLAGE	SOIL SERIES REPRESENTED
ZONE 1		
1. J. Chell	Chan Pine Ridge	Lazaro Sandy Clay
2. G. Pech	Yo Creek	Lazaro Sandy Clay
3. R. Cal	Yo Creek	Lazaro Sandy Clay
ZONE 2		
4. G. Novelo	San Felipe	Felipe Loamy Sand
5. A. Medina	August Pine Ridge	Pixoy Sandy Loam
6. A. Carillo	San Lazaro	Lazaro Sandy Clay
Zone 3		
7. E. Camara	Guinea Grass	Pixoy Sandy Loam
8. R. Leiva	Guinea Grass	Pixoy Sandy Loam
9. E. Santos	Guinea Grass	Pixoy Sandy Loam
10. E. Klassen	Camp 11	Puletan Loamy Sand
11. P. Neuster	Camp 16	Puletan Loamy Sand
12. J. Buddan	London Camp	Jobo Sandy Clay
Zone 4		
13. B. Toledano	San Luis	Pixoy Sandy Loam
14. E. Guiterrez	San Estevan	Pixoy Sandy loam
15. A. Castillo	San Estevan	Pixoy Sandy Loam
Zone 5		
16. G. Hernandez	Orange Walk	Pucte Clay
17. V. Ayuso	Orange Walk	Pucte Sandy Clay

Table 1a (Continued)

Corozal District

ZONE & FARMER	VILLAGE	SOIL SERIES REPRESENTED
ZONE 1		
1. B. Vasquez	Paraiso	Xaibe Clay Loam
2. C. Chan	Chan Chen	Remate Clay
ZONE 2		
3. R. Correa	San Joaquin	Louisville Clay
4. C. Cowo	San Joaquin	Louisville Clay
5. F. Fabro	Calcutta	Xaibe Clay
ZONE 3		
6. G. Sosa	Patchakan	Xaibe Clay
7. J. Cobb	San Pedro	Louisville Clay
ZONE 4		
8. P. Campos	San Narciso	Louisville Clay
9. A. Keme	San Narciso	Louisville Clay
10. G. Espiritu	San Roman	Louisville Clay
ZONE 5		
11. E. Wiltshire	Chunox	Clay
12. G. Kiso	Progresso	Remate Clay

Table 1b.

ORANGE WALK

Soil Textural Class - Series Site Number	Infiltration rate estimated in./hr.	Available moisture percentage	Drainage
Lazaro sandy clay 1, 2, 3, 6	.15 - .20	10 - 15	Moderate
Felipe sandy loam	.15 - .20	8 - 10	Moderate
Pixoy sandy loam 5, 7, 8, 9, 13, 14, 15	.15 - .20	18 - 20	Good
Pucte clay	.05 - .10	18 - 20	Poor
Pucte sandy clay	.15 - .20	10 - 15	Moderate
Puletan loamy sand	.15 - .20	8 - 10	Good
Clay	.10 - .15	15 - 18	Moderate
Jobo sandy clay 12	.15 - .20	10 - 15	Moderate
		COROZAL	
Xaibe clay loam 1	.12 - .15	14 - 18	Moderate
Xaibe clay 5, 6	.05 - .10	18 - 20	Poor
Remate clay 2, 11, 12	.05 - .10	18 - 20	Poor
Louisville clay 3, 4, 7, 8, 9, 10	.05 - .10	18 - 20	Poor

A physical limitation to vegetable production in most of the sites examined will be water management, i.e., drainage. If the irrigation is properly designed and the grower is properly instructed in its use, excess water from that source will not occur. There can be other problems; for example, if the grower irrigates one day and the next day it rains several inches, drainage will be a problem. I have suggested that the growers adopt a bedding up program as standard practice, raising the beds and providing for the removal of excess water from the root zone before it has a chance

- Grower's location

- Whether or not the grower lives on his farm to provide security for equipment and produce

From a list of almost sixty farmers, twenty-eight were selected for further evaluation and personal visits. The goal was to have farmers participating in the project from each zone within the two districts. There are, at this writing, 29 growers who were interviewed and met the criteria. This by no means suggests that there are not others who are equally qualified to

to infiltrate. Realistically however, some farmers will adopt these suggestions and some will not. Crop TIPS on preparation of raised beds is provided in Appendix 3.

C. Fertility Investigations

1. Soil Sampling Procedures for Fertility Analysis

Sampling proceeded on the sites according to the techniques described in Appendix 1. Soil variability was accounted for when necessary. Each soil sample sent for analysis was taken from a thoroughly mixed composite of an appropriate number of subsamples.

Samples were taken in two depth increments: 0 to 10 inches (noted as "topsoil") and 10 to 18+ inches (noted as "subsoil"). Depth to consolidated limestone was sometimes a limitation for the lower depth.

Samples were air-dried and were delivered to Central Farm's soil laboratory and to Harris Laboratories, Inc., Lincoln, Nebraska. Completed soil test report sheets are attached to this report as Appendix 8.

2. Basis for Making Fertility Analyses

The value of a soil test lies in making efficient fertilizer recommendations to growers. The primary goal is to assess the nutrient status of the soil and use those results as the basis for a fertilizer program that will result in the highest yield with the least fertilizer cost.

This objective is not easy. When one works with a system as complex as the soil and attempts to correlate and calibrate field nutrients responses with the variables of crop physiology and climate, its a wonder that it is as effective as it is.

In brief, it is impossible to predict with absolute certainty the ability of a soil to supply a given nutrient for crop production because of the high degree of variability of soil and climate. However, with proper correlation of data and experience, soil testing is a valuable tool for making fertilizer recommendations.

In a country such as Belize where fertilizer costs are high, one must use every tool available to maximize efficiency. It is assumed that appropriate records will be kept on crops and soils grown under project auspices so that yield/fertility information will be enhanced.

Soil sampling techniques have been explained in Appendix I, but for emphasis, the important points are mentioned again below:

- Soil samples must be collected from the field to represent the soil nutrient levels of the field.

- Laboratory analyses must be precise and reproducible and must provide a meaningful estimate of nutrient levels.

- This analytical information must be effectively utilized to predict the amounts of fertilizers that will maximize production profit.

In choosing a soil testing laboratory, one should look for rigid professional standards to assure quality of results. It is necessary to adhere to approved methods, extracting procedures, reagents, and instrumentation. All responsible laboratories spend much time, energy and money to develop better analytical procedures, and quality control standards.

Generally, variations that occur among results can be attributed to one or more of the following:

- Different analytical methods used by one laboratory versus another.

- Quality control in the laboratory or technician carelessness.

- Different reporting units (ppm vs lbs/acre).

- Combining subsamples with different fertilizer or cropping history into one composite sample.

- Mixing unlike areas into one composite sample.

- Insufficient subsamples to represent the field.

- Mixing of sample identity.

- Using contaminated containers or allowing the sample to become contaminated.

- Drying samples at high (+105°F) temperatures.

Harris Laboratories, Inc., Lincoln, Nebraska, is a consistent and reliable soil testing laboratory that maintains computerized vegetable fertility recommendations. Since the crops and soil sites were not matched up at the time of this writing, the results were not printed out on the computer.

Table 4

NUTRIENT STATUS OF SOME SOIL SERIES IN NORTHERN BELIZE

SOIL SERIES	% Om	P P M								pH	mmhos/cm Soluble Salts	% Saturation Na	Excess Carbonat
		P	K	Mg	Ca	Zn	Mn	Cu	Fe				
LAZARO SANDY CLAY	4.2	9.5	188	276	7498	1.5	2.6	0.3	9.2	7.8	.38	29	V H
FELIPE LOAMY SAND	2.2	5	24	15.	2921	0.2	2.2	0.3	20.2	7.4	.20	18	M
PIXOY SANDY LOAM	2.9	10	114	275	5430	0.5	3.4	0.3	13.0	7.7	.26	22	M
PUCTE CLAY	4.3	9	181	333	7709	0.25	5.7	0.6	14.3	7.4	.25	30	M
XAIBE CLAY LOAM	4.4	11	786	278	7961	0.4	6.0	0.6	8.6	7.9	.39	26	V H
LOUISVILLE CLAY	4.3	7.5	586	337	8981	0.4	5.2	0.6	11.8	7.7	.42	28	V H
REMATE CLAY	5.0	6	680	341	7357	0.4	13.0	0.65	16.0	7.7	.37	30	M
Deficient		0-4	0-80	0-75		0-.8	0-1.5	0-.2	0-2				
Low-Deficient		5-9	81-110	76-100		.9-1.0	1.6-2.5	.3-4	2.1-3.5				
Low		10-13	111-130	101-120		101-1.3	2.6-3.5	-	3.6-4.5				
Low Adequate		14-17	131-150	121-160		1.4-1.5	3.6-4.5		4.6-5.0				
Adequate		18-30	151-300	161-350		1.6-2.0	4.6-12.0	.5-2.0	5.1-15.0				
Extravagant		31-60	301-700	351-600		2.1-25.0	12.1-50	2.1-7.5	16.1-70				
Excess		760	7700	7600		725 >	750 >	77.5 >	770 >				

	Soluble salts mmhos/cm	Na % of Saturation
Satisfactory	0 - 0.2	0 - 3.7
Satisfactory Possible Problem	0.3 - 0.5	3.8 - 5.0
Possible Problem	0.6 - 0.9	5.1 - 10.0
Developing Problem	1.0 - 1.9	10.1 - 15.-
Severe Problem	> 72.0	>715

Table 5. Soil Nutrient Status by Textural Class

Soil Texture	% Om	PPM								pH	mmhos/cm Soluble Salts	% Saturation Na —	Excess Carbonates
		P	K	Mg	Ca	Zn	Mn	Cu	Fe				
Fine	4.5	8.4	558	322	8002	.36	7.5	.61	12.7	7.7	.38	28.5	M-VH
Medium	3.1	8.2	109	234	5283	.73	2.7	0.3	14.1	7.6	.28	23	M

c. Soil Fertility Recommendations

Soil test sheets will be attached to this report as Appendices 8a to 8g. The individual soil analyses will be filed at the project office and will be available for use by the sub-contractors as crops and soils are matched up.

I will assist in making specific recommendations as needed by growers. I suggest that if some of the same sites are used in subsequent years that samples be taken and the nutrient levels be monitored as cropping continues. The tests we have now should serve as a foundation. It will be of interest to see how nutrient status changes with cropping and fertilizer analyses. At some point these should be stored on the project computer so year-to-year comparisons can easily be made.

SECTION IV

SOIL/CROP RELATIONSHIPS

A. Vegetable Crops

1. With irrigation

All of the crops selected for initial trials will respond to good water management. Different levels of management will be required for each crop. Some are more susceptible to plant diseases than others so they may not be irrigated by a method that wets the foliage. Some may be more prone to root disorders brought about by excess moisture.

Irrigation should be available for all crops, both transplanted and directly seeded. Uniform emergence or establishment results in more uniform stands, which will be important for efficient harvests and quality grades and standards.

Water use by vegetables varies with species. Table 6 lists some vegetables and their approximate water requirements. Irrigation must be scheduled to meet the water needs of specific crops on a particular soil type. Experience and common sense will dictate to a large degree the amount of water to be applied by irrigation. However, as irrigation expertise is developed, a simple method of irrigation scheduling can be devised to assist in educating growers. Responsibility for scheduling irrigation will be with the technical advisor working with the crops.

"Pan evaporation" is simple to set up and serves as a guideline for irrigation scheduling. It is used as follows. Evaporation from the soil and transpiration from the plant both remove water from the root zone. A pan is set near the field from which evaporation losses are measured. It need not be a pan that is used in research work. A simplified version can be used to schedule irrigation successfully. The system works as in the following example. If one inch of water evaporates from the pan's surface, this would be interpreted as one inch of water lost from the soil. A "plant factor" is used to account for transpiration, and from these two observations, the total amount of water to be added through irrigation is estimated. This method, coupled with experience and observation of the appearance of the crop, will assist the grower with his water management. On the other hand, if rainfall adds to the water in the pan, then, of course, no additional water should be added by irrigation.

2. Irrigation Essential for Quality

Most vegetable crops are rapidly growing, relatively short season crops. In order for quality to be maintained, growth must proceed in a uniform manner throughout the growth cycle. This means that moisture levels must be kept as uniform and optimum as possible through the season. Fertility must be adequate at all times. There is a positive relationship between nutrient utilization and moisture relations.

Table 6: Water Requirements and Crop Irrigation Schedule (subject to soil conditions and sound management decisions) Precipitation received during a given week should be taken into account.

Vegetable Crops	
Sweet corn	1/2 to 1 inch after seeding depending on soil conditions. 1-1/2 to 2 inches per week.
Okra	1-1/2 to 2 inches per week. Keep moist during germination or transplanting.
Tomato	1 inch after transplanting or seeding. 1 inch per week if plants show need.
Squash	1-1/2 inches per week. Keep moist during emergence.
Pepper	1 inch after seeding or transplating. 1 inch per week according to plant need.
Snap Beans	1/2 inch to 1 inch at setting. Keep moist but not wet. 1-1/2 to 2 inches per week up to harvest.
Melons	1 inch after seeding or transplating. 1-1/2 to 2 inches per week.
Cucumber	Keep moist during germination. 1-1/2 to 2 inches per week.
Blackeyed peas	(see snap beans).
Lima beans	(see snap beans).
Papaya	1-1/2 to 2 inches per week. Keep well drained with raised beds or furrows.
Pineapple	2 inches per week. Maintain well drained soil.

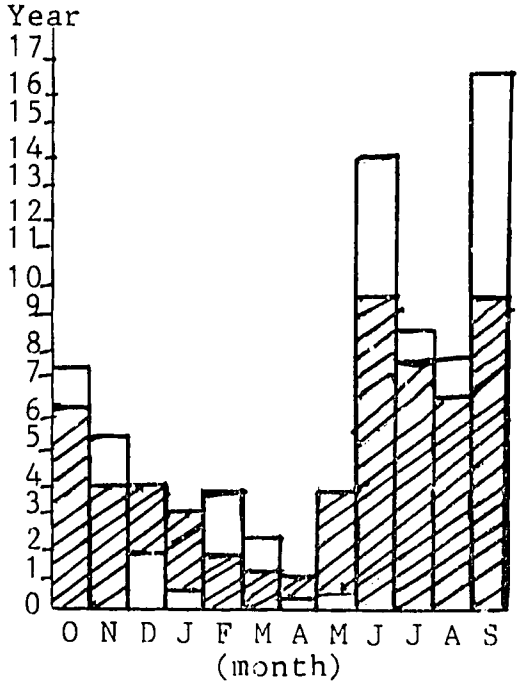
No growth reducing stresses should occur during the growth period. This is particularly true as the crop approaches maturity or the harvest period. Natural precipitation is not uniformly distributed as shown graphically in figures 2 and 3 so moisture levels will fluctuate considerably.

Stress and subsequent growth reduction due to lack of moisture at the proper time will result in poor quality fruits or vegetables. This is one of the major reasons why exportable quality vegetables are seldom grown in an area entirely dependent on natural precipitation.

3. Excess Water a Detriment to Quality

Stresses associated with too much water may be more difficult to manage than those caused by water deficits. It is much easier to add water to a soil than it is to remove it. Excess moisture contributes to root disorders which in turn results in nutrient and moisture stresses. It is interesting to note here that a plant whose roots are in an anaerobic (low oxygen) environment will suffer the same symptoms as if it were in a drought condition. That is, uptake will be inhibited. Oxygen is required by the roots of plants to utilize nutrients and/or water. Surface drainage will be aided by proper land preparation and particularly "bed shaping" which is discussed in Appendix 3.

ORANGE WALK DISTRICT



COROZAL DISTRICT

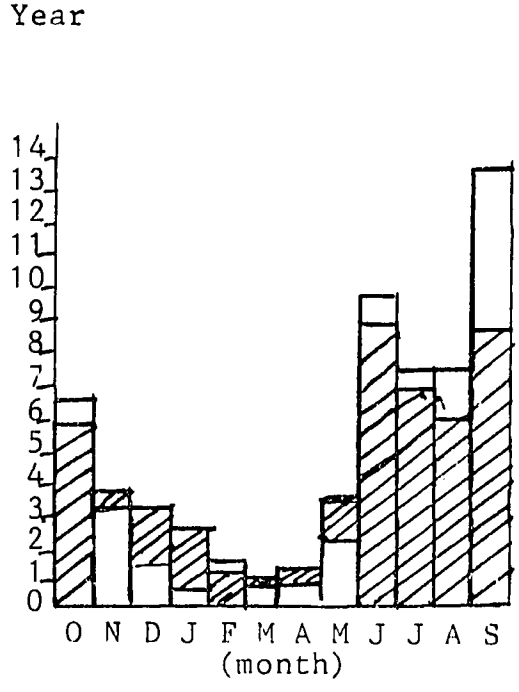


Figure 2. Histogram

Showing 14 year average precipitation and deviation from the average for a typical year.

(Data BSI Reseach Report)

2. Non-irrigated

Some of the crops selected for trial are more drought tolerant than others. They will be placed on "non-irrigated control" plots. It is almost a foregone conclusion, however, that the yield and quality from these plots will not be up to the standards that would be possible with irrigation. It is suggested, nevertheless, that strict attention be given to all other phases of production, especially surface drainage, so that the efficacy of irrigation can be verified. The tendency will be to neglect these plots and let nature take its course. If they are to serve their purpose they must be tended as carefully as any others.

B. Fruit Crops

1. With irrigation

Even deep rooted tree crops will respond to irrigation. Factors previously mentioned in connection with vegetable crops apply equally to fruit crops. Most of the crops, if established under irrigation, will develop different rooting patterns than those previously grown without irrigation. Roots can be "retrained" to proliferate in the zone where growth factors such as moisture, aeration, and fertility are optimized. Of course, there are rooting patterns related to genetics, but roots do not look for water. They just happen to proliferate in areas where moisture is available.

Water management must be tailored to the root distribution patterns of the fruit crop involved. As the rooting pattern changes to conform to the irrigation system, yield and quality of fruit will increase.

Fertigation is a very effective method of dealing with the nutritional needs of tree crops. Drip irrigation is particularly effective for supplying nutrients to the root zone. Tree and fruit crops generally respond well to foliar applications of nutrients which may sometimes be applied through irrigation systems also. Some aspects of fertilizer application which apply to both fruit and vegetable crops are discussed in Appendix 5.

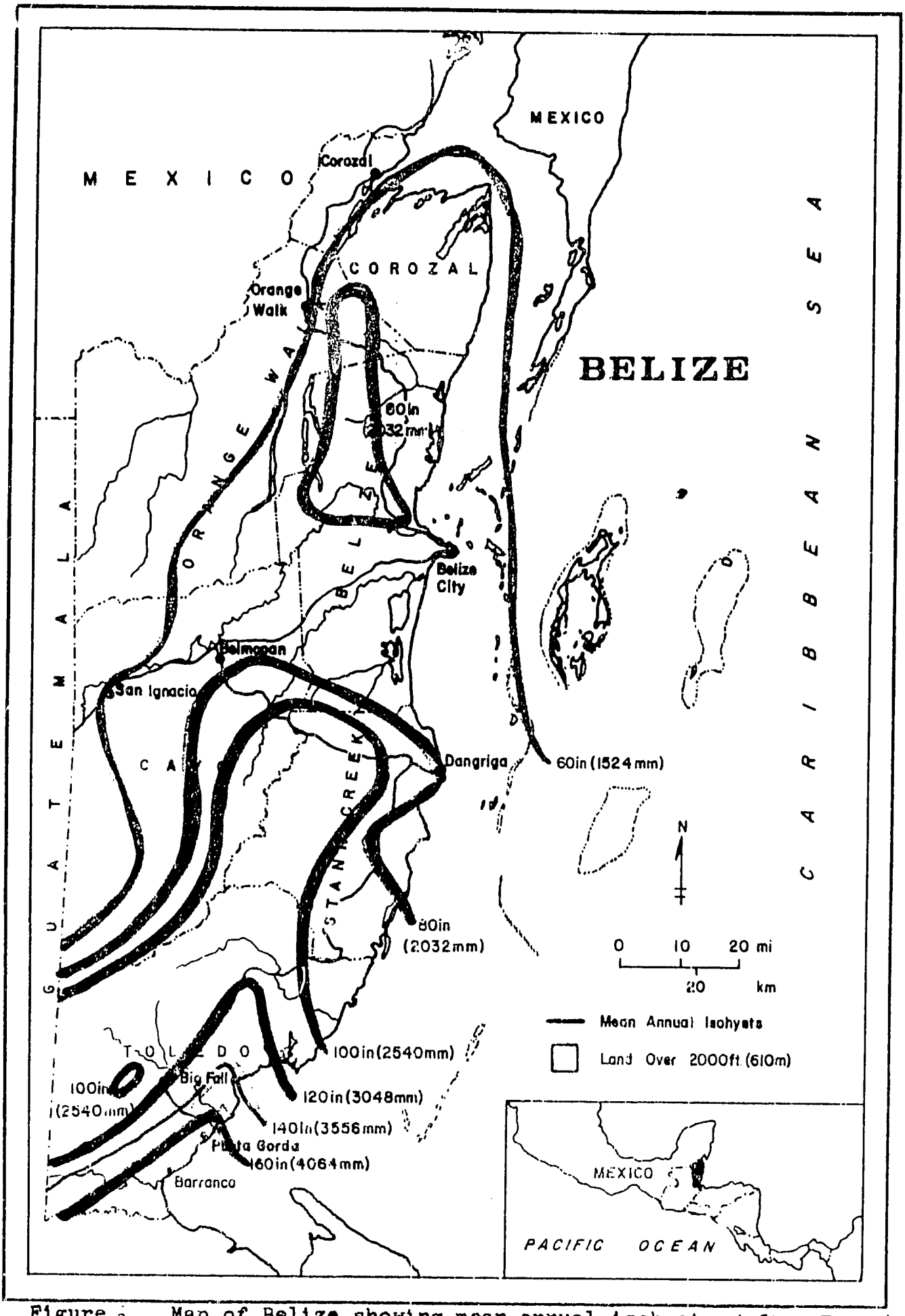


Figure 3 Map of Belize showing mean annual isohyets. (after Frost)

2. Non-irrigated

Stresses occur under dry conditions even though trees may be tapping some subsurface moisture, assuming no physical or chemical restriction to root elongation is present. Quality as affected by water stresses may be delayed. Often the effect will be more pronounced in subsequent harvests.

Tree crops also require well-drained conditions, often more so than shallow-rooted crops. Raised beds and waterways for removal of excess water is very beneficial and can be the difference between the tree's survival and its death. The papaya cooperatives with which we are involved have been asked to bed up for better drainage. Several groups are following our advice and others are not.

Under non-irrigated conditions, the only way to get fertilizers into the root is to place them there. Fertilizer application principles discussed in Appendix 5 are applicable.

SECTION V

PAPAYA COOPERATIVES - SPECIAL PROJECT

A. Summary of Soil and Water Characteristics

LOCATION	SOIL PROPERTIES	COMMENTS
Consejo 1	Shallow clay loam top soil 0-8". Over mostly consolidated limestone	Only brackish water for irrigation. Some risk of exessive salt
Consejo 2	Shallow clay loam top soil 0-6" over mottled light clayey limestone	Same as above
Consejo 3	Very shallow clay loam 0-4" over tight/limestone subsoil	Same as above
Sawyer	Red brown topsoil 0-8" over clay subsoil. Unconsolidated limestone	Two wells. One tested. See Irrigation Report
Duesbury	Black clay 0-8" over poorly drained clay/silt clay	Well available
Marcos	Clay loam/clay 0-10" over unconsolidated limestone	Well available. Water sample taken
Xaibe	Shallow red brown topsoil 0-8" over a clay subsoil 8-12" over iron cemented limestone	Tight subsoil. Well available and tested.

Note: Water analytical data should be in irrigation report.

B. Observations

The first three locations above will probably not be suitable for irrigation because of the poor quality of the water available. All the soils, without exception, must be bedded up as high as possible if papaya culture is going to be successful. Drainage/water management is a must!

Some of the groups have proceeded to bed up according to our suggestions; other are planting on the flat or even in basins, which will cause trouble. BABCO/CAC will not provide technical services to all the cooperatives or their members. Our inputs will only be to those two-acre plots which will be considered part of the CAC fruit investigations. The other members of the co-ops will be advised by the representative from Sun-Solo-Belize, Mr. Manuel Marcial.

SECTION VI

PROPOSALS AND COMMENTARY

A. Organization and Development of Training Programs

1. Training Courses for Agricultural Advisors

Short courses should be developed for all agricultural advisors in both districts in various phases of production. Some subject matter areas could include: Soil and Plant Nutrition, Pest Control and Field Scouting, Irrigation and Water Management, Harvesting and Packing Procedures, etc. The outlines for the training courses should be developed by specialists either in-country or short-term specialists brought in for a specific purpose.

These courses would serve several purposes:

- Bring all agricultural advisors to a basic understanding of vegetable production-oriented subject matter.
- Serve to identify an agricultural advisor who, because of his interest or demonstrated skill in a particular phase, may be singled out for further training.
- Bring the latest in technology to the country.
- Become a vehicle for "certification" to enhance the image of the advisor.

2. Development of Area Specialists

An agricultural advisor with identified skills and/or interests might be assigned across zones or districts to be the Area Extension Specialist (similar to the State or Area Specialists in the U.S. Extension Service). For example: "Area Extension Specialist - Pest Control" or "Area Extension Specialist - Soil Fertility" or "Area Extension Specialist - Water Management." He would have an incentive to upgrade his skills even more if he were working in a phase of production he enjoyed and were given prime responsibility for that part of production.

It seems that such an organization and direction of responsibilities will be imperative if the CAC project is to be successful, particularly if it is to expand to a commercial scale. USAID must leave behind a legacy of educated and enthusiastic advisors who can continue and encourage the growth of the vegetable agribusiness industry in Belize.

3. Farm trials - A Training Approach

Farm trials, which will be conducted this season, are important as demonstrations and vehicles through which new technologies are introduced. In the absence of an experiment station where fertility, variety, irrigation, and pest management tests can be conducted, it is necessary to utilize local farm resources.

The "trial" should not continue indefinitely, however. Growers can get accustomed to the hand-holding that occurs with a trial plot. CHEMONICS/BABCO/USAID could end up doing too much, for too many people, for too long. There should be a transitional period before the project personnel leave when in-country agricultural advisors and growers are doing the work on their own.

B. Grower Commitment and Attitude

In addition to the observations and technical advice in this report, an ongoing program of field work and technical assistance must be a major thrust of the project. This should include a strong public relations approach for participants to keep morale high and maintain enthusiasm for their role in the project.

A vegetable producer is a special breed. Overall, it is a stressful occupation requiring a more constant and consistent commitment than for cane or field crops. In the first place, there is a lot of money committed and labor expended before the first item is harvested. Secondly, the crops are susceptible to the vagaries of weather and pests. Thirdly, the markets are volatile and unpredictable.

Casual observation in my years with the vegetable agri-business complex indicates that the profit cycle runs on a six or seven-year cycle, and one must be able to survive economically and psychologically for that period of time. Often it is either feast or famine in the industry. There will be a period of time when income will not meet costs, and then along will come a good year when prices will more than make up for the previous lean years. Some people can take the economic and psychological stress and others cannot.

I am fearful that a scenario such as the following may take place. Cane prices may go up. Markets and/or prices for vegetable production may go down. A natural disaster or pest/disease problem may wipe out the crop. The farmer will take the path of least resistance and will drift back to cane production.

Even if these problems do not occur, cane farming is a much less stressful type of farming. Vegetable production may take second place to a traditional crop that people are familiar with. A great deal of hand-holding will be required until the vegetable-production mentality is as ingrained as the "milpa"

system is now. The potential for successful vegetable production certainly argues for Belize to be a strong force in the vegetable industry, if farmers can adapt.

C. Quality Emphasized

The standards of quality demanded by the U.S. consumers and supplied by U.S. producers are extremely high. It could be argued that the standards are too high; nevertheless, strict attention to detail is necessary in all aspects of the business. It is extremely difficult to penetrate the market and establish a good reputation. The "new kid on the block" has to prove himself a worthy competitor. Consumers and broker wholesalers/retailers are extremely unforgiving of lapses in quality. Once a reputation is lost it will be virtually impossible to get it back.

Individuals must be given strict responsibility to monitor fertilizer application, irrigation and water management, pest and disease control, and harvest/packing/shipping. A let-down in any one of these aspects of production will be a great detriment to the success of the project. I am not certain that producers outside the U.S. fully appreciate or are aware of such situations. There is virtually no tolerance for errors!

A proposal is attached to this report as Appendix 7 in which a possible way is suggested to help develop a vegetable production or quality-minded attitude.

D. Future Vegetable Production in Belize - A Speculative View

To predict the future of vegetable production in Belize is, at best, a guess. Given the premise, as mentioned previously, that almost any soil can be productive if properly managed, I see production expanding as follows:

- Expansion to areas where soil problems (management contraints) are reduced. This generally means expansion into areas of lighter textured, better drained soils.

- Production by farmers with the fiscal and management ability to accept the volatility of the business.

- Small growers who cannot accept the management techniques and the amount of work expected of someone who is producing for export will end up with small plots of land producing for local use, i.e., farmer's markets, or they may work for larger producers in some capacity.

- Acreage will increase near the population centers that have a reasonable road system, potential harvesting/packing facilities, labor, and an office/communications complex to keep track of the markets.

- The agricultural advisors must grow in expertise to meet the technical requirements of the vegetable industry. Storage/refrigeration/export facilities will have to be built. Overland border crossing arrangements will have to be worked out. All the complementary facilities to support a growing industry will have to be made available.

With strong support from the government and the private sector, Belize has the capability to become an important supplier to the U.S. and Europe. However, lapses in any aspect of production or marketing will result in an industry that will not be competitive and will not survive.

SECTION VII

SUMMARY AND RECOMMENDATIONS

Soil physical and chemical characteristics were examined and tabulated. Soil properties related to irrigation design were discussed with the irrigation specialist. Soils were sampled for fertility analysis. Management procedures were discussed. Some examples are included in the report as appendices. Farmer attitude was subjectively evaluated and observations noted.

Most soils in the two northern districts of Belize tend to be heavy-textured, with moderate to poor drainage. The alluvial origin of the soils causes considerable variability even within small areas. Production will likely expand into areas where soil management problems are more easily handled, namely, the lighter textured, better drained soils.

Fertility is inherently low but can be easily changed with proper fertilizer practices. Fertilizers are readily available, but are relatively expensive. As a result, there may be a tendency to decrease their use. This will be a mistake if yield and quality are to be maintained. Soil tests and strict attention to efficient application practices will help hold costs down while maintaining proper nutrition.

Irrigation will contribute to productivity, but must be properly managed. This will require a training period for what will be, to most farmers, a new technology. Drainage may be the greatest problem as far as water management is concerned. Excess water problems may be alleviated through proper and timely tillage and land forming practices.

Vegetable production on a commercial scale will depend more on grower attitude and adaptability than on soil properties. Almost any soil can be productive if properly managed. What will be more of a challenge to manage are the people problems. Farmer attitude is good at this stage of the project. What remains to be seen is the determination and willingness of farmers to exercise management and fiscal efforts to stay in the business given the stressful, volatile nature of vegetable production compared to cane farming.

An effort must be made to strengthen the role of the Central Farm, its research activities and its soil testing services toward the goals of this project. The agricultural advisory group needs encouragement and help to upgrade its skills in what is essentially a new effort. A strong extension staff that provides support constantly and seeks new information is one of the keys to a successful agribusiness complex.

RECOMMENDATIONS

- Management packages (TIPS) with strict adherence required by participants for participation. Monitored by the A/H.
- Financial commitment from the participants in the form of deposits on equipment, to give incentive and to assure proper care and maintenance. AgE monitor.
- Reporting and recordkeeping protocol from participants. Cost figures for extrapolation to commercial-sized ventures. Monitored by A/H and AgE.
- Attempt to evaluate management expertise with an eye toward expansion. Team monitor and evaluate.
- Machinery and equipment survey. Types, availability and costs (custom operations). A/H and AgE monitor and supervise.
- Non-discrimination for participation. Expand to include Mennonite farmers.
- Upgrade irrigation systems as production and management expertise warrant, A/H supervise.
- Make efforts to strengthen the Ag Advisory services and Central Farm. Team effort.
- Encourage local and national governmental units to increase attention to infrastructure such as roads, electrical services, etc.
- Cooperate with BSI and other agribusiness organizations in research and soil fertility problems. A/H responsible.
- Develop a working relationship with lending institutions for farmer credit. AgE supervise.

APPENDICES

Appendix 1. Guidelines for Soil Sampling and Testing

Introduction

There are several reasons for sampling soils. For example, aspects of engineering, construction, or crop production require soil samples. For the purpose of this paper, soil sampling for analyses related to crop production will be discussed.

Soil samples are used in crop production for one main purpose, i.e., to determine the suitability of a particular soil for crop production from its physical and/or chemical characteristics.

Fertility vs. Productivity

It must be borne in mind that a difference exists between a fertile soil and a productive soil. A soil may be fertile because of its chemical characteristics, but may be unproductive due to physical limitations. On the other hand, a soil may have the potential to be productive because of good physical characteristics, but may be unproductive due to inherent chemical problems.

Chemical limitations are generally more easily changed or modified than physical ones. It is also true that changing one set of properties can have a very beneficial effect on the other and vice versa.

Sampling

A soil sample taken for any purpose must, after analysis, serve the purpose for which it was taken. In other words, as a field is selected for possible crop production, the sample taken for analysis must adequately represent that field.

For this reason, care must be taken in sampling so that the sample is as precise and accurate as possible. One may determine in advance the precision required to serve the purpose intended. For instance, a very detailed research plot requires more extensive sampling than a production field. Except for research purposes, a sample need not represent an area smaller than one intends to treat separately. If areas within a field contain different soil types and are to be treated separately, a separate soil sample should be taken of each soil type. If areas within the field have a different cropping history, they should be sampled separately. Any area that distorts the analysis so that it is not representative of the field should be avoided in sampling. Low spots, high spots, poorly drained spots, and wet spots should all be avoided in sampling because they do not

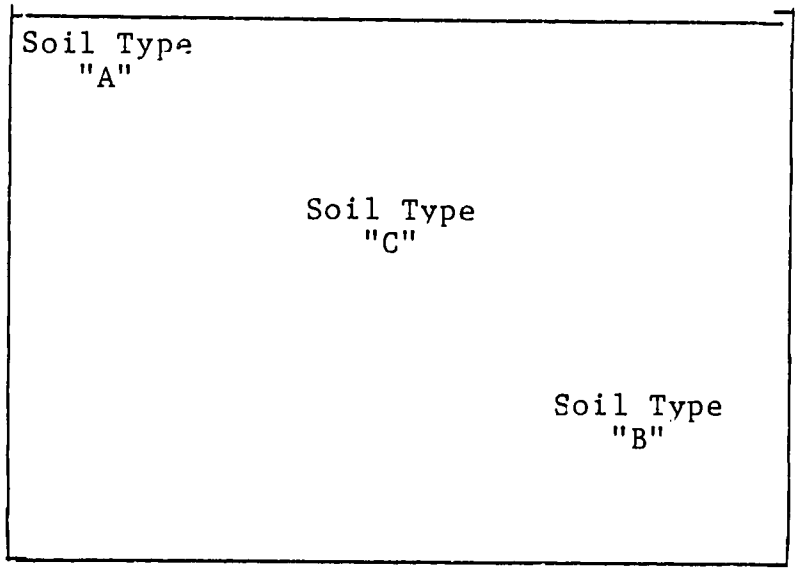
represent the predominant area of the field. On the other hand, if one is intent on improving particular parts of the field, such as the parts mentioned above, they should be sampled and analyzed separately.

A proper soil sample consists of several subsamples. The exact number is determined by:

- The uniformity of the field
- The purpose of the sample
- Time and labor

Generally, a sample may represent an area of no more than 10 acres with at least one subsample per acre composited to make up the sample for analysis. In any case there should be no less than 10 subsamples for any given field. If a field is large with uniform soil, then one or two samples may represent the field. Keep in mind that the more subsamples are included in the final sample, the more precisely that sample will represent the specific field.

Sampling procedure Example



1. If soil type "C" is the predominant type of soil and "A" and "B" are not going to be treated separately, the sample should include proportionately more subsamples from "C" and fewer from "A" and "B".

2. A traverse should be set up with subsamples taken at random over the field as indicated on the above sketch with at least one subsample per acre.

3. If the field is small, take the subsample randomly at smaller distances. Never take fewer than 10 subsamples in a field. Subsamples are gathered in a plastic bucket, thoroughly mixed, and the final sample for the laboratory is taken.

4. Avoid rocks, fresh organic materials, or other extraneous material. The sample should be air-dried away from any possible contamination.

5. Take samples to the depth of the rooting zone of the crop.

- If the soils are shallow, the top soil or "A" horizon may be taken separately from the subsoil or "B" horizon.

- For tree crops, which are generally deep rooted, samples may be taken to 2 to 3 feet deep or more, de-depending on species.

- For shallow root crops, generally the soil sample is taken to the depth of plowing or tillage, generally down to 8 to 10 inches.

- For special information, samples may be taken to any depth that is predetermined to give the information required.

Appendix 2.

A. Tillage Management for Clays or Fine-Textured Soils

The specific characteristics of the soils involved in the BABCO/CAC project are discussed in the report. There are special management techniques required to maintain clay soils in a productive state. This paper will comment on some of the more important considerations.

B. Formation of Clay Soil

In the USDA textural classification, clays are those soil particles less than .002 microns in diameter. Because of the small size, clay particles exert a disproportionate effect on soil physical properties such as plasticity, CEC, water penetrability, ease of tillage, water-holding capacity, etc.

Clay particles result from weathering and chemical decomposition of rocks and minerals which result in a certain distribution of particle-sized fractions in a soil. It is the percentage of each size fraction of sand, silt, and clay which results in soil of a specific texture and is the basis on which the textural classification is based. In soils deposited by water, as most of these soils are, clay particles, because of their fineness, are slow to settle out and so are generally located at a further distance from the source of parent material. The variability of the soils and the clayey soils in certain areas probably results from still or very slowly moving water which allowed the finer particles to settle out.

C. Problems with Clay Soils

1. Compaction

Clays are sub-microscopic particles (.002 mm) and are plate-like when viewed through an electron microscope. Because of this characteristic, they are very susceptible to compaction.

Compaction can be caused by two factors. Natural compaction results from clay particles being pressed together by their own weight or the weight of water on top of them as they settle. Artificial compaction is caused by the vibratory or compressive forces of tillage machinery. Consider a large tractor exerting a force of many pounds per square inch on a soil surface. This can result in a compacted soil. Tillage machinery, for example, a plow or disk, also exerts a compressive effect by its design.

Compressive effects are compounded when soils are tilled when they are too wet. The particles, surrounded by films of water, are "lubricated" so they slide around each other to make a more dense soil. A "vibration" resulting in compaction can be

illustrated by stacking a deck of cards, i.e., plate-like particles, and shaking them or vibrating them to orient the particles (cards) in a more compact manner. Much the same occurs in soils as heavy machinery is driven over a clayey soil, particularly if it is wet.

2. Water Movement

Water moves in soils by gravity and capillary forces. Water movement occurs in large part through larger pore spaces in soils as it is affected by gravity. That amount of water which is held against the forces of gravity in capillary-sized pores is called the "field capacity" of soils. A soil made up of a higher percentage of smaller-sized particles has smaller pore spaces, or the larger pore spaces that exist in a coarse-textured soil may be filled in by small soil particles.

3. Aeration

Air must move through the soil to supply roots with oxygen and move carbon dioxide out. If soils are compacted or water-logged, air movement is restricted and plants are unable to absorb nutrients. Interestingly, in the absence of oxygen, a plant cannot absorb water and may suffer from physiological drought even when standing in a saturated environment. Nutrient and water uptake by plants is in large part an active process which requires that the plant expend energy which is only available if the plant is growing in an environment which has the proper moisture/air relationship.

4. Root Restriction

Roots are the main nutrient and water-absorbing mechanism of any plant. Any physical or chemical limitation on root growth will restrict water and nutrient absorption. Roots have a certain amount of strength influenced by osmotic pressures, so if they contact a hard or compacted soil, they may not penetrate that zone. Roots only grow in an environment in which there is a proper balance of air, water and nutrients.

5. Management/Tillage

Clayey soils are less forgiving of mismanagement than coarser-textured soils. One must prepare or till clay soils at the proper time or clods will form which may make a proper seed bed impossible to obtain. Clods generally form when clay soils are tilled too wet. On the other hand, clay soils tilled too dry may require excessive power and be difficult to break down to seed bed size.

A shovel is the best tool for determining whether or not a clay soil is ready for tillage. Dig to the depth of tillage and determine if the soil is sticky. If it sticks to the shovel or forms a ball that holds together, it is too wet to till. The soil tillage depth should fall apart when handled, or be "friable."

Summary

1. Avoid heavy equipment on wet soils.

2. Avoid excessive tillage which results in breakdown of soil structure.

3. Avoid excessive water application when possible.

4. Provide drainage by raised beds or water ways.

5. Use cover crops or organic materials to "loosen" tight clayey soils.

6. If possible, avoid tillage implements that cause excessive compaction.

7. Examine the soil with a shovel to determine as nearly as possible the proper time for tillage.

Appendix 3.

A. Soil and Water Management for Crop Production in the Tropics

Introduction

Soil and water management for crop production in the tropics is little different from that in other areas of the world, except that climatic conditions requiring special water and soil management techniques may be concentrated. That is, rainfall may be more intensified at certain times of the year. Soil may be subject to more extremes of water/soil interactions.

B. Management techniques

Irrigation

There are very few places in the world where rainfall is adequately distributed to completely eliminate crop growth stresses from insufficient or excessive water. Financial considerations are generally the restraining influences to the introduction of supplemental irrigation. "Will it pay?" is the question that must be answered. This project will concentrate on producing crops under irrigation in an attempt to eliminate or modify at least one of the limitations to soil productivity. Consideration will be given to current and local economic conditions in designing an irrigation system for the local farmers.

Drainage

Drainage must be considered along with any method of irrigation. Some soils by their inherent characteristics are classed as "well drained" and need nothing more than proper irrigation management. On the other hand, many soils need special management techniques to control excess water.

Water Control

Excess water is detrimental to crop production and produces stress, which affects the nutrition and physiology of a crop. Under irrigation, water may be precisely applied according to soil and crop characteristics so that excess water will not be a problem. However, with excessive rainfall, or poor irrigation practices, the soil's natural drainage properties may be exceeded and artificial means must be provided to remove excess water.

Drainage can be classed as surface or subsurface. Subsurface drainage is the type of drainage system where underground water flows laterally to a perforated pipe or tile which then carries the excess water out of the root zone and away from the field.

This paper will consider only surface drainage and will consider management and tillage techniques that may reduce the problem of excess water that does infiltrate.

Bedding

Most crops do not like "wet feet"; consequently any technique that elevates the root out of a zone of excess moisture will be beneficial. This will be particularly important for crops that are susceptible to root diseases or poor aeration.

Raised beds can be used effectively to raise the root zone of a crop and help create a more satisfactory environment for proper growth.

Beds may be formed easily either by hand in the case of small areas or with tillage machinery for large areas. The dimensions of the bed (width and height) may be varied depending on crop spacing requirements.

Making a bed with a one-way mold board plow

1. Determine width spacing desired
2. Pull line or set stakes to maintain straight rows
3. Throw furrows toward each other
4. Width dimension may be limited by size of plow; however, several furrows can be thrown together
5. Height may be increased by repeating operation of moving soil to center
6. Same technique may be used to construct water-ways for surface drainage

Making a bed with a bed shaper

1. Till soil to loose condition
2. Pull soil to a ridge with a lister or furrowing tool
3. Flatten bed out with a bed shaper

Appendix 4

A. Methods of Irrigation

Irrigation can be used in most situations to maintain the proper soil moisture relationships. Rainfall is inadequately distributed in most parts of the world to completely eliminate all stresses associated with water. The main constraint to supplemental irrigation system is financial.

1. Flood

This method of irrigation is very inefficient and can only be used where water is plentiful and the land topography is flat.

2. Furrow

This is an improved variation on flood irrigation where water is guided down a row of ditches or furrows which are generally next to the cultivated crop. Water application efficiency is generally 50% or lower (efficiency can often be improved by proper land preparation, i.e., leveling, by careful selection of the length of the water run, and by conscientious irrigators). This method is widely used where the land is flat, and labor and water are plentiful. The length of the runs is determined by soil infiltration rates related to soil textures.

3. Sprinkler

There are many types of sprinkler systems generally engineered to apply water at or near the infiltration rate of the soil. This method is widely used where soil or topographic conditions do not allow leveling. The technology is several steps above the previously mentioned methods. Pumps, pipes, orifices, and associated hydraulics and mechanics are involved. The systems are relatively simple and effective if properly designed, but repair, modification, or original installation is a specialized area of engineering. Properly designed systems may have water application efficiencies (WAE) in the 75 - 90% range, but must be constantly maintained to keep efficiencies in the satisfactory range.

4. Drip or Trickly Irrigation

This method of irrigation, although not new in concept, has been increasing in popularity in recent years. Advancements in technology have been the impetus for moving drip irrigation into the mainstream of irrigation techniques. It is now used in virtually every part of the world, on every crop, and under every condition. Because of the engineering associated with drip irrigation design, it can be adapted to a wide range of conditions. Generally, though, its popularity is in areas of scarce or poor quality water, shallow or excessively porous soils, high value crops, steep or untillable soils, and limited land area where efficiency of production is of paramount importance. Water Use

Efficiency (WUE) and Water Application Efficiency (WAE) can be greater than 90% in a properly designed system. A limitation to drip irrigation is its initial cost of installation, though with proper consideration of the economic condition of a particular grower, usable systems can be designed rather inexpensively. One can also go to the high tech, automated systems should economics justify such an installation.

Schematics of Drip Systems

Simple First Order System

(a) Components

Drip Tube Emitters
Main Line
Submain
Pump
Valves

Second Order System

(a) Components

Filter
Pump
Main Line
Submain
Drip Line Emitters
Valve

Third Order System

(a) Components

Filter
Pressure Regulators
Timers
Main Line
Submain
Drip Line Emitters
Valve

B. Soil Management under Drip Irrigation

Relationship of Soils to Drip System

Textured: The rate of horizontal and vertical movement of applied water is determined by the texture of the soils on which drip irrigation is to be used.

1. Coarse (sands) etc.

a. Lateral movement limited

b. Downward movement may be excessive

This situation calls for more closely spaced emitters or orifices, for wetting patterns to merge.

2. Medium Texture (loams)

a. Lateral and vertical movement near the same

b. This situation allows for wetting patterns to meet, even with wider spacing or emitters.

3. Fine Textures (clays)

a. Lateral movement may be more rapid than vertical (downward) movement

b. Movement will be slow in any case

c. May require slower application of water for longer time to move downward

Appendix 5

A. Fertilization for Maximum Efficiency and Yield

To maintain yield and quality in vegetable production, proper fertilizer practices must be strictly followed. To obtain maximum benefit from other inputs such as labor, irrigation and pest control chemicals, yield limitations due to fertility must be eliminated as much as possible.

1. Essential Nature of Fertilizer Elements

There are sixteen elements that are considered essential for crop growth. These sixteen, their source and the most common chemical forms in which they are absorbed are as follows:

From air and water plants absorb Hydrogen (H and HOH), and Oxygen (O_2, OH, CO_2, SO_4 and Carbon CO_2).

The primary nutrients from soils and fertilizers are Nitrogen (NH_4 and NO_3), Phosphorous (H_2PO_4 and HPO_4) and Potassium (K^+).

The secondary nutrients absorbed by plants from soils and fertilizers are Magnesium (MG^{++}), Calcium (Ca^{++}) and Sulfur ($SO^{=}_4$).

The micronutrients absorbed by plants from soils and fertilizers are Chlorine (CL^-), Copper (Cu^{++}), Boron (H_2BO_3 and $B(OH)^-$, Iron (Fe^{++} and Fe^{+++}), Manganese (MN^{++}), Molybdenum (Mno_4) and Zinc (Zn^{++}).

Plants use these elements, heat, and light to proceed with their growth processes.

2. Determination of Fertility Status

Soil testing should be a standard management tool for farmers, particularly those who are producing export quality vegetables or fruit. Appendix 1 gives some guidelines for proper soil sampling.

To determine the microelement status of soils and crops, a plant sample may be taken for analysis in addition to the soil sample. Certain parts of the plants, after analysis, indicate the nutritional condition of the plant at that stage in its growth cycle. Guidelines are written to assist in proper plant sampling.

Nutrient levels in soils or plants must be determined by a competent testing laboratory. Those figures are then interpreted by a skilled advisor who will recommend a fertilizer program for a particular soil condition and the specific crop to be grown.

Growers can make the most efficient use of their fertilizer dollar by applying only those elements determined to be necessary for proper crop growth. Fertilizers added, which are not needed, are money and time wasted. Fertilizers not added which are needed bring a reduction in yield and quality.

3. Methods of fertilizer application

Fertilizer Use Efficiency (FUE) should be considered for maximum value from added fertilizer. Fertilizers can be applied by various methods. Some methods may have advantages over others.

a. Broadcasting

Worldwide, more tons of fertilizers are applied broadcast than by any other method. This method is less efficient and may be used where fertilizers are plentiful, therefore less expensive, where acreages are large, and mechanization and labor are available. This method is not particularly advantageous here for the proposed vegetable production project.

b. Banding and sidedressing

Banding or sidedressing is a term used to describe the application of fertilizers in a concentrated band near to, but not directly on, the plants or seed line. For a given amount of fertilizer, banding has a higher FUE than broadcasting. First, the fertilizers are placed near to the seed line or plant roots where the nutrient uptake is maximized; secondly, fertilizers in a band, especially phosphate fertilizer, are protected from fixation/reversion reactions by being concentrated. Banding is especially important for phosphate fertilizers because of their relative immobility in soils. Roots must contact the fertilized zone to absorb P. Phosphate is particularly subject to fixation or reversion to insoluble forms in soils with calcium or iron compounds. Both of these elements are high in most of the soils tested.

Banding fertilizers, aside from the increase in efficiency of application, can be justified in the soils of Belize because the soils generally have high fixation capacity in particular for phosphorous. By concentrating the P in a band, its exposure to soil reactions is reduced, and it stays in an available form much longer.

A variation on banding, with the same principle involved, is placement of fertilizers in discrete spots around a plant or tree. Placing fertilizer on the surface can result in fertilizer losses. It should be placed in holes beneath the surface (in the root zone) by making a hole with any kind of implement, stick, shovel, hoe, etc. This method of fertilizing is labor-intensive, but it makes efficient use of the resource.

4. Specialized methods of application

a. Foliar application

Some elements may be absorbed in sufficient quantities through leaf surfaces. This method of application is particularly suited for microelement fertilization, since these elements are used in small amounts by plants, and the compounds containing these elements are subject to adverse fixation reactions in soils and become less available. They are easily applied with spraying equipment.

b. Application with irrigation water (fertigation)

Irrigation water can be a carrier for fertilizers. The Fertilizer Application Efficiency (FAE) is directly related to:

(1) The solubility of the fertilizer salt

(2) The Water Application Efficiency (WAE) of the irrigation system.

Sprinkler systems are commonly used to apply nitrogen and other fertilizers to corn, smal grains, and other field crops.

Drip irrigation systems can, in many cases, be justified by the fact that soluble fertilizers can be added during the irrigation cycle. The FAE is high because the Water Application Efficiency (WAE) is high and because fertilizers are added in small amounts throughout the irrigation season and in the root zone where uptake is enhanced.

The "hand and glove" analogy is often used to describe drip irrigation and fertilizer application. A drip system is only half complete unless it has been designed to apply fertilizers. Most soluble fertilizers are compatible with drip systems; however, phosphate compounds react adversely with high calcium, iron or sodium compounds and will plug orifices in a drip system. A filter must be in-line between the fertilizer injection and the system to trap any soluble foreign material that may be in the fertilizer to keep the system from becoming plugged.

Summary

This paper has dealt in a general way with some concepts of fertilization. Yield and quality depend to a large degree on the proper use of fertilizers. Technology is available to growers to know what kind, how much, and when to apply fertilizers properly. Advisors will be available to assist local growers in making these important decisions.

Appendix 6.

Guidelines for Transplanting Vegetables and Fruits*

Planting in a seed bed and then transplanting to the field is a very common practice in vegetable and fruit production. There are some people who specialize in providing quality plants for others who transplant them to a commercial field. Transplanting provides a grower with the opportunity to have more uniform plants in his field, which can result in more uniform harvests.

Timing

Generally plants are more able to survive if they are set from the seed bed to the field when they are small. The root system is less likely to be disturbed and the plants will adapt more quickly.

Transplanting

1. Always make the hole larger than the root portion of the transplant. This allows the roots of the newly transplanted seedling to grow in a looser soil than if it were planted in a small hole.

2. Do not disturb or damage the roots of the transplant. The more roots the transplant has, the more readily it will become established in the field.

3. Never let the roots of small seedlings be exposed to the air and sunlight to dry out.

4. Place the seedling in the field at the same depth it was in the seed bed. (An exception to this rule is tomatoes, which can root along the entire stem and may be planted deeper, if desired).

Steps in transplanting

1. Prepare the hole.

2. Fertilize.

Mix a very small amount of fertilizer or rotted manure with the soil from the hole.

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*Written for papaya growers who are concerned about how to plant their seedlings

3. Pour water into the hole to create a moist situation.

A transplant solution can be used if proper soluble fertilizers are available. Use only a very small amount with the water in each hole.

4. Place the plant in the hole to the same depth it was in the seed bed or pot.

5. Carefully fill the soil around the plant roots.

6. Pack it firmly but not too hard.

7. Add more water to settle soil around the roots.

8. Add more soil to the hole if necessary.

Appendix 7. A Learning Opportunity for Selected Belizean Farmers

A. Proposal - Broadly Outlined

1. Introduction and reasons for the proposal

One of the most difficult tasks is to explain a concept to someone whose previous background and experience have not exposed him to the concept. In this report, I have stressed the necessary personal attributes of the vegetable grower. I have suggested that attitude is as important to the success of this project as soils or irrigation and other physical components. Finally, I have discussed the notion of export quality, but what does export quality really mean?

Part of the project intent is to show farmers how to grow produce of export quality. Some have had unfortunate experiences where they have grown produce that "looked good enough to them," but was rejected by the prospective buyer as not being of export quality. In fact, there was really nothing wrong with their produce, but it didn't meet the U.S. consumer's idea of quality.

To show is better than to tell. Therefore, this proposal suggests giving Belizean farmers a learning opportunity to instill in them a "quality-minded" attitude.

2. Previous experiences and successes with similar endeavors

While chairman of the agriculture department of a small college in Salinas, California, I participated in an arrangement with the Japanese Agricultural Training Council to provide intensive horticultural and floricultural teaching to young Japanese farmers. At the culmination of the classroom teaching activities, an extended field trip was taken through the produce-growing areas of California so they could see for themselves what had been taught in the classroom. Without exception, the Japanese farmers considered this event to be the highlight of their stay in the U.S., and it solidified the entire classroom experience.

I propose that a similar tour be organized and conducted for a selected group of Belizean farmers, as follows.

B. Outline for Proposed Educational Tour

1. Tour should last from ten days to two weeks. Could be shortened if financed dictated.

2. Arrangements would be made to visit:

- Vegetable and fruit production units. All appropriate types of operation.
- Packing houses and shipping locations.
- Wholesale and farmers markets.
- Retail receiving docks and outlets.

3. The group could travel by chartered bus from Belize through Mexico to the border. U.S. chartered bus would conduct the US portion of the tour. Depending on the season, visits could be conducted to Texas, Colorado, California, and/or Arizona.

4. Expenses

- Charter buses paid with USAID funds.
- Meal allowance given or meals paid with USAID funds.
- Lodging paid (discount motels, 2/room) paid with USAID funds.
- A minimum allowance to be given to each participant for incidental expenses.

APPENDIX 8.

SOIL TEST REPORT SHEETS

Harris Laboratories, Inc.

TRIPLE OPTION

[illegible]

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

Submitted By
CHEMONICS INTERNATIONAL
2000 M. NW #200

WASHINGTON DC 20036

Submitted For
SELF

Date Received

Date Reported
05-NOV-86

Samples Will Be Stored Until

LABORATORY SAMPLE NUMBERS
211727
THROUGH
211738

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

SUMMARY OF FERTILIZER RECOMMENDATIONS

Your Sample Number	Acres Per Sample	** L-G-S in Tons/Acre	PLANT FOOD NEED (in lbs./acre) FOR: N	P_2O_5	P_2O_5 Bulk	K_2O	K_2O Bulk	Mg	Ca	Mn	Cu	Fe	B	Mo
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
Weighted Average Recommendations for Total Acres														

TO BE ECONOMICAL BULK MAY BE SPREAD OVER SEVERAL YEARS

** L = LIME (100% ECC), G = GYPSUM S = SULFUR IN LBS

IF X APPEARS IN THIS COLUMN REFER TO THE SPECIAL COMMENTS AREA OF THE DETAILED REPORT

CATION EXCHANGE CAPACITY

ACTUAL % OF TOTAL CEC %K	%Mg	%Ca	%Na	%H	Cation Exchange Capacity (CEC)
1.2	5.8	92.7	0.3	0.0	38.3
0.8	5.0	93.7	0.5	0.0	48.1
5.3	5.7	88.4	0.5	0.0	38.1
3.4	4.9	91.3	0.4	0.0	34.0
2.4	10.7	86.0	0.9	0.0	61.8
0.1	1.2	98.2	0.5	0.0	119.9
1.8	8.4	88.4	1.5	0.0	91.4
0.2	2.6	96.4	0.8	0.0	121.3
3.0	11.1	85.7	0.3	0.0	66.8
0.6	2.9	96.3	0.2	0.0	85.2
4.6	4.8	90.4	0.2	0.0	42.8
3.1	4.3	92.4	0.2	0.0	36.9
1.7	5.2	92.5	0.6	0.0	65.4
%K	%Mg	%Ca	%Na	%H	CEC
Weighted Average for Total Acres					
2.1	7-15	20-65	0-5	0-5	

SUGGESTED % OF TOTAL CEC

GRAPHIC SUMMARY OF WEIGHTED AVERAGE TEST RESULTS

EXTRAVAGANT

ADEQUATE

LOW

RATING: Organic Matter, Nitrogen, Phosphorus, Potassium, Magnesium, Calcium, Sulfur, Zinc, Manganese, Copper, Iron, Boron

SEVERE PROBLEM

DEVELOPING PROBLEM

PROBLEM

SATISFACTORY

RATING: pH, Buffer pH, Sodium, Other Cations, Salinity

SUMMARY REPORT OF ANALYTICAL RESULTS

Your Sample Number	Acres Per Sample	Laboratory Sample Number	% Organic Matter	Nitrogen N.O. ppm	Phosphorus pH 5.7-7.1	Phosphorus pH > 7.1	Potassium ppm	Magnesium ppm	Calcium ppm	Sulfur ppm	Zinc ppm	Manganese ppm	Copper ppm	Iron ppm	Boron ppm	pH	Buffer pH	Excess Carbonate	Soluble Salts	Sodium ppm
1		211727	4.1			7	173	269	7108		0.3	4.8	0.7	13.8		7.6	---	VH	0.31	27
2		211728	2.7			8	156	286	9020		0.3	3.9	0.5	14.6		7.7	---	VH	0.32	54
3		211729	5.9			8	794	260	6738		0.4	6.9	0.5	8.3		7.9	---	VH	0.46	46
4		211730	3.5			4	452	198	6202		0.2	9.6	0.6	9.2		7.8	---	VH	0.32	35
5		211731	2.6			6	582	793	10620		0.5	2.8	0.2	7.4		7.8	---	VH	1.84	128
6		211732	0.8			2	53	174	23540		0.3	0.6	0.1	2.8		8.1	---	VH	1.96	145
7		211733	7.0			6	642	916	16160		0.4	1.6	0.1	6.6		7.9	---	VH	2.30	306
8		211734	1.5			1	78	384	23380		0.1	0.6	0.1	3.3		8.3	---	VH	2.14	222
9		211735	5.0			5	772	886	11450		0.2	4.4	0.3	13.2		7.6	---	VH	1.66	44
10		211736	2.5			5	207	292	16410		0.2	2.8	0.2	8.4		7.7	---	VH	1.78	35
11		211737	5.1			5	761	247	7742		0.5	7.1	0.5	9.8		7.8	---	VH	0.86	20
12		211738	3.8			5	441	191	6821		0.3	7.2	0.6	10.3		7.9	---	VH	0.47	20
[illegible]		[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	---	[illegible]	[illegible]	90

Harris Laboratories

624 Peach Street, Box [illegible]

TRIPLE OPTION

For Additional Details Call: 402-[illegible]

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

Submitted By
CHEMONICS INTERNATIONAL
2000 M. NW #200

WASHINGTON DC 20036

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Date Received

Date Reported
05-NOV-86

Samples Will Be Stored Until

LABORATORY SAMPLE NUMBERS
211739 THROUGH 211746

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

SUMMARY OF FERTILIZER RECOMMENDATIONS

Your Sample Number	Acres Per Sample	** L-G-S In Tons/Acre	PLANT FOOD NEED (in lbs/acre) FOR													
			N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build	Mg	S	Zn	Mn	Cu	Fe	B	*
13															
14															
15															
16															
17															
18															
19															
20															
Weighted Average Recommendations for Total Acres			N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build								

TO BE ECONOMICAL, BUILD MAY BE SPREAD OVER SEVERAL YEARS

** L = LIME (100% ECC) G = GYPSUM S = SULFUR IN LBS

IF ★ APPEARS IN THIS COLUMN REFER TO THE SPECIAL COMMENTS AREA OF THE DETAILED REPORT

CATION EXCHANGE CAPACITY

ACTUAL % OF TOTAL CEC					Cation Exchange Capacity (CEC)
%K	%Mg	%Ca	%Na	%H	
0.9	7.0	91.8	0.3	0.0	16.3
0.7	7.5	91.1	0.6	0.0	15.1
0.9	4.0	94.7	0.3	0.0	23.8
0.7	4.1	94.5	0.6	0.0	25.5
0.4	13.0	86.2	0.4	0.0	29.8
0.3	12.4	86.9	0.4	0.0	30.1
0.4	7.2	92.1	0.3	0.0	23.3
0.4	8.2	91.1	0.4	0.0	23.6
0.5	8.3	90.8	0.4	0.0	23.4
%K	%Mg	%Ca	%Na	%H	CEC
Weighted Average for Total Acres					
2.7-7	15-20	65-75	0-5	0-5	
SUGGESTED % OF TOTAL CEC					

GRAPHIC SUMMARY OF WEIGHTED AVERAGE TEST RESULTS

EXCESSIVE

EXTRAVAGANT

ADEQUATE

LOW

DEFICIENT

RATING: Organic Matter, Nitrate, Phosphorus, Potassium, Magnesium, Calcium, Sulfur, Zinc, Manganese, Copper, Iron, Boron

SEVERE PROBLEM

DEVELOPING PROBLEM

PROBLEM

SATISFACTORY

RATING: Soil pH, Buffer pH, Excess Carbonate, Soluble Salts, Sodium

SUMMARY REPORT OF ANALYTICAL RESULTS

Your Sample Number	Acres Per Sample	Laboratory Sample Number	% Organic Matter	Nitrate N ppm	Phosphorus ppm IF pH < 7.1	Phosphorus ppm IF pH > 7.1	Potassium ppm	Magnesium ppm	Calcium ppm	Sulfur ppm	Zinc ppm	Manganese ppm	Copper ppm	Iron ppm	Boron ppm		Soil pH	Buffer pH	Excess Carbonate	Soluble Salts	Sodium ppm
13		211739	3.1		17		55	138	3001		0.2	6.9	0.2	11.0			7.8	---	M	0.29	10
14		211740	2.1		7		44	136	2748		0.1	9.1	0.2	11.8			7.6	---	VH	0.21	22
15		211741	1.8		9		79	113	4503		0.1	2.0	0.1	6.3			8.1	---	VH	0.21	29
16		211742	1.9		8		69	126	4813		0.2	2.4	0.2	10.6			8.1	---	VH	0.27	38
17		211743	4.0		16		44	466	5144		0.4	2.5	0.4	13.4			7.5	---	L	0.32	26
18		211744	3.8		7		35	446	5224		0.2	1.7	0.4	16.4			7.6	---	L	0.32	29
19		211745	2.9		7		33	201	4293		0.2	1.6	0.2	8.1			7.9	---	VH	0.18	17
20		211746	2.5		7		33	232	4299		0.2	1.7	0.2	8.6			7.9	---	M	0.22	19
Weighted Average Results			2.6		10		49	232	4253		0.2	3.2	0.2	10.8			7.8	---		0.25	24
			Organic Matter	Nitrate N	Bray I - $NaHCO_3$ Phosphorus		Potassium	Magnesium	Calcium	Sulfur	Zinc	Manganese									

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TRIPLE OPTION SOIL ANALYSIS SUMMARY

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Date Received

Date Reported
05-NOV-86

Samples Will Be Stored Until

LABORATORY SAMPLE NUMBERS
211748
THROUGH
211759

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

SUMMARY OF FERTILIZER RECOMMENDATIONS

Your Sample Number	Acres Per Sample	** L-G-S: In Tons/Acre	PLANT FOOD NEED (in lbs./acre) FOR: N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build	MgO	Zn	Mn	Cu	Fe	B	★
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
32														
Weighted Average Recommendations for Total Acres			N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build	MgO	Zn	Mn	Cu	Fe	B	

TO BE ECONOMICAL, BUILD MAY BE SPREAD OVER SEVERAL YEARS

** L = LIME (100% ECC) G = GYPSUM S = SULFUR IN LBS

IF ★ APPEARS IN THIS COLUMN REFER TO THE SPECIAL COMMENTS AREA OF THE DETAILED REPORT

CATION EXCHANGE CAPACITY

ACTUAL % OF TOTAL CEC %K	%Mg	%Ca	%Na	%H	Cation Exchange Capacity (CEC)
2.1	7.1	90.3	0.5	0.0	41.6
1.5	7.0	90.8	0.7	0.0	44.1
1.2	5.6	92.9	0.3	0.0	40.5
0.7	5.2	93.8	0.3	0.0	38.3
0.4	7.3	91.8	0.5	0.0	25.2
0.4	8.6	90.3	0.8	0.0	23.8
1.2	5.8	92.5	0.5	0.0	40.3
0.8	5.2	93.6	0.4	0.0	37.9
1.1	8.2	62.7	1.1	26.9	9.1
1.8	13.6	82.3	2.3	0.0	5.2
1.0	8.2	90.5	0.3	0.0	32.8
0.4	5.7	93.5	0.4	0.0	32.9
1.0	6.1	85.1	0.5	7.3	33.2
%K	%Mg	%Ca	%Na	%H	CEC
Weighted Average for Total Acres					
2.3-7	15-20	65-75	0-5	0-5	
SUGGESTED % OF TOTAL CEC					

GRAPHIC SUMMARY OF WEIGHTED AVERAGE TEST RESULTS

EXCESSIVE
EXTRAVAGANT
ADEQUATE
LOW
DEFICIENT

RATING: Organic Matter, Nitrate, Phosphorus, Potassium, Magnesium, Calcium, Sulfur, Zinc, Manganese, Copper, Iron, Boron

SEVERE PROBLEM
DEVELOPING PROBLEM
MODERATE PROBLEM
SATISFACTORY

RATING: Soil pH, Buffer pH, Excess Carbonate, Soluble Salts, Sodium

SUMMARY REPORT OF ANALYTICAL RESULTS

Your Sample Number	Acres Per Sample	Laboratory Sample Number	% Organic Matter	Nitrate N ppm	Phosphorus ppm IF pH ≤ 7.1	Phosphorus ppm IF pH > 7.1	Potassium ppm	Magnesium ppm	Calcium ppm	Sulfur ppm	Zinc ppm	Manganese ppm	Copper ppm	Iron ppm	Boron ppm		Soil pH	Buffer pH	Excess Carbonate	Soluble Salts	Sodium ppm
21		211748	4.1			14	341	353	7518		0.3	3.5	0.4	7.9			7.9	---	VH	0.39	49
22		211749	4.0			9	263	372	7998		0.3	3.0	0.5	9.5			7.9	---	VH	0.33	69
23		211750	4.0			10	188	270	7534		1.5	2.5	0.3	9.0			7.9	---	VH	0.37	29
24		211751	3.1			7	110	238	7188		0.3	2.2	0.3	8.9			8.0	---	VH	0.30	25
25		211752	2.6			8	40	219	4622		0.2	1.6	0.1	8.4			8.0	---	VH	0.18	30
26		211753	2.4			6	33	246	4306		0.2	1.6	0.2	8.6			7.9	---	VH	0.20	42
27		211754	4.3			9	188	283	7463		1.5	2.7	0.3	9.5			7.8	---	VH	0.40	43
28		211755	3.1			6	118	238	7103		0.3	2.1	0.3	9.4			8.0	---	VH	0.29	31
29		211756	3.0		15		40	89	1136		0.5	1.9	0.1	153.8			6.4	6.9	---		22
30		211757	1.6		12		36	85	855		0.6	1.2	0.1	74.9			6.5	---	VL	0.07	27
31		211758	3.4			13	127	323	5933		0.2	1.9	0.2	5.8			7.9	---	VH	0.26	20
32		211759	2.4			7	51	224	6152		0.2	1.9	0.2	5.4			8.0	---	VH	0.22	32
Weighted Average			3.2		14	9	188	245	5652		0.5	2.2	0.2	20.6			7.7	6.9	---	0.27	133
			Organic Matter	Nitrate N	Bray-1 Phosphorus	Olsen Phosphorus	Potassium	Magnesium	Calcium	Sulfur	Zinc	Manganese	Copper	Iron	Boron		Soil pH	Buffer pH	Excess Carbonate	Soluble Salts	Sodium

Harris Laboratories, Inc.

TRIPLE OPTION SOIL ANALYSIS

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

Submitted By
CHEMONICS INTERNATIONAL
2000 M. NW #200

WASHINGTON DC 20036

Submitted For
SELF

Date Received

Date Reported
05-NOV-86

Samples Will Be Stored Until

LABORATORY SAMPLE NUMBERS
211760 THROUGH 211763

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

SUMMARY OF FERTILIZER RECOMMENDATIONS

Your Sample Number	Acres Per Sample	Lime Tons/Acre	PLANT FOOD NEED (lbs/acre) FOR: N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build	MgO	Ca	Mn	Cu	Fe	B	*
33														
34														
35														
36														
Weighted Average Recommendations														
Total Acres			N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build	MgO						

TO BE ECONOMICAL BUILD MAY BE SPREAD OVER SEVERAL YEARS

** L = LIME (100% ECC) G = GYPSUM S = SULFUR IN LBS

IF ★ APPEARS IN THIS COLUMN REFER TO THE SPECIAL COMMENTS AREA OF THE DETAILED REPORT

CATION EXCHANGE CAPACITY

ACTUAL % OF TOTAL CEC %K	%Mg	%Ca	%Na	%H	Cation Exchange Capacity (CEC)
1.1	5.0	93.5	0.3	0.0	41.3
0.8	4.6	94.4	0.2	0.0	42.3
0.6	7.4	91.2	0.9	0.0	16.0
0.5	6.9	91.3	1.2	0.0	13.3
0.8	5.4	93.3	0.5	0.0	28.2
%K	%Mg	%Ca	%Na	%H	CEC
Weighted Average for Total Acres					
3.7	15-20	65-75	0-5	0-5	
SUGGESTED % OF TOTAL CEC					

GRAPHIC SUMMARY OF WEIGHTED-AVERAGE TEST RESULTS

EXCESSIVE

EXTRAVAGANT

ADEQUATE

LOW

DEFICIENT

RATING: Organic Matter, Nitrate, Phosphorus, Potassium, Magnesium, Calcium, Sulfur, Zinc, Manganese, Copper, Iron, Boron

SEVERE PROBLEM

DEVELOPING

PROBLEM

SATISFACTORY

RATING: Soil pH, Buffer pH, Excess Carbonate, Soluble Salts, Sodium

SUMMARY REPORT OF ANALYTICAL RESULTS

Your Sample Number	Acres Per Sample	Laboratory Sample Number	% Organic Matter	Nitrate N ppm	Phosphorus ppm IF pH ≤ 7.1	Phosphorus ppm IF pH > 7.1	Potassium ppm	Magnesium ppm	Calcium ppm	Sulfur ppm	Zinc ppm	Manganese ppm	Copper ppm	Iron ppm	Boron ppm		Soil pH	Buffer pH	Excess Carbonate	Soluble Salts	Sodium ppm
33		211760	3.5			15	179	249	7724		1.8	3.7	0.6	11.2			7.9	---	VH	0.23	31
34		211761	3.9			6	128	231	7981		0.5	3.5	0.4	12.8			8.0	---	VH	0.24	23
35		211762	2.5			8	36	142	2924		0.2	3.8	0.1	27.9			7.4	---	M	0.26	33
36		211763	1.8			6	28	111	2431		0.1	3.2	0.1	20.2			7.6	---	M	0.16	38

Harris Laboratories Inc.
624 Peach Street, Box [illegible]

TRIPLE OPTION

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

Submitted By
CHEMONICS INTERNATIONAL
2000 M. NW #200

WASHINGTON DC 20036

Submitted For
SELF

Date Received

Date Reported
05-NOV-86

Samples Will Be Stored Until

LABORATORY SAMPLE NUMBERS
211765
THROUGH
211776

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

SUMMARY OF FERTILIZER RECOMMENDATIONS

Your Sample Number	Acres Per Sample	** L-G-S In Tons/Acre	N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build	Mg	Zn	Mn	Cu	Fe	B	★
37														
38														
39														
40														
41														
42														
43														
44														
45														
46														
47														
48														
Weighted Average Recommendations for Total Acres			N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build							

PLANT FOOD NEED (in lbs/acre)

TO BE ECONOMICAL, BUILD MAY BE SPREAD OVER SEVERAL YEARS

** L = LIME (100% ECC) G = GYPSUM S = SULFUR IN LBS

IF ★ APPEARS IN THIS COLUMN REFER TO THE SPECIAL COMMENTS AREA OF THE DETAILED REPORT

CATION EXCHANGE CAPACITY

%K	%Mg	%Ca	%Na	%H	Cation Exchange Capacity (CEC)
ACTUAL % OF TOTAL CEC					
5.2	6.2	88.3	0.3	0.0	45.1
4.5	6.2	89.1	0.2	0.0	44.7
3.2	4.7	91.9	0.2	0.0	52.8
3.2	4.5	92.0	0.3	0.0	53.4
4.9	9.1	85.6	0.4	0.0	43.6
4.4	8.9	86.1	0.5	0.0	43.4
2.8	6.6	90.4	0.2	0.0	37.1
2.3	4.7	92.6	0.4	0.0	32.4
3.6	5.7	90.4	0.3	0.0	47.1
3.1	5.4	91.2	0.4	0.0	44.7
3.2	7.5	89.1	0.3	0.0	46.5
1.1	7.3	91.3	0.3	0.0	45.5
3.5	6.4	89.9	0.3	0.0	44.7
%K	%Mg	%Ca	%Na	%H	CEC
Weighted Average for Total Acres					
2.0-7	15-20	65-75	0-5	0-5	

SUGGESTED % OF TOTAL CEC

GRAPHIC SUMMARY OF WEIGHTED AVERAGE TEST RESULTS

EXCESSIVE
EXTRAVAGANT
ADEQUATE
LOW
DEFICIENT

RATING: Organic Matter, Nitrate, Phosphorus, Potassium, Magnesium, Calcium, Sulfur, Zinc, Manganese, Copper, Iron, Boron

SEVERE PROBLEM
DEVELOPING PROBLEM
POSSIBLE PROBLEM
SATISFACTORY

RATING: Soil pH, Buffer pH, Excess Carbonate, Soluble Salts, Sodium

SUMMARY REPORT OF ANALYTICAL RESULTS

Your Sample Number	Acres Per Sample	Laboratory Sample Number	% Organic Matter	Nitrate-N ppm	Phosphorus ppm IF pH ≤ 7.1	Phosphorus ppm IF pH > 7.1	Potassium ppm	Magnesium ppm	Calcium ppm	Sulfur ppm	Zinc ppm	Manganese ppm	Copper ppm	Iron ppm	Boron ppm		Soil pH	Buffer pH	Excess Carbonate	Soluble Salts	Sodium ppm
37		211765	4.6			5	910	335	7970		0.3	5.4	0.6	7.8			7.9	---	VH	0.33	30
38		211766	4.2			4	780	330	7967		0.3	5.7	0.6	7.9			7.9	---	VH	0.39	23
39		211767	4.4			5	665	298	9710		0.2	3.4	0.5	10.4			7.9	---	VH	0.36	22
40		211768	5.3			4	671	289	9820		0.2	3.3	0.5	11.2			7.9	---	VH	0.61	32
41		211769	5.7			5	830	476	7476		0.3	20.9	0.8	20.9			7.4	---	VL	0.46	39
42		211770	3.5			6	746	466	7484		0.3	9.3	0.9	22.0			7.5	---	VL	0.36	52
43		211771	2.4			13	409	293	6708		0.3	2.9	0.3	6.5			8.1	---	VH	0.25	13
44		211772	4.9			6	295	182	6001		0.2	2.9	0.4	6.8			8.2	---	VH	0.22	27
45		211773	4.1			22	665	324	8520		0.4	6.6	0.5	7.8			7.9	---	VH	0.50	30
46		211774	3.7			10	533	291	8150		0.4	4.1	0.5	8.9			8.0	---	VH	0.39	37
47		211775	5.2			8	572	416	8290		0.5	11.9	0.7	19.4			7.2	---	VL	0.51	34
48		211776	4.6			11	189	398	8310		0.2	6.6	0.5	12.8			7.3	---	VL	0.39	34
Weighted Average			[illegible]			8	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	---	---	[illegible]	[illegible]
			Organic Matter	Nitrate N	Bray I Phosphorus	NaHCO3 Phosphorus	Potassium	Magnesium	Calcium	Sulfur	Zinc	Manganese	Copper	Iron	Boron		Soil	Buffer	Excess	Soluble	

[illegible] Laboratories

[illegible]

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

Submitted By
CHEMONICS INTERNATIONAL
2000 M. NW #200

WASHINGTON DC 20036

Submitted For
SELF

Date Received

Date Reported
05-NOV-86

Samples Will Be Stored Until

LABORATORY SAMPLE NUMBERS
211777 THROUGH 211788

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

SUMMARY OF FERTILIZER RECOMMENDATIONS

Your Sample Number	Acres Per Sample	** L-S in Tons/Acre	PLANT FOOD NEED (in lbs./acre) FOR: N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build	MgO	Zn	Mn	Cu	Fe	B	★
49														
50														
51														
52														
53														
54														
55														
56														
57														
58														
59														
60														
Weighted Average Requirements for Total Acres														

TO BE ECONOMICAL, BUILD MAY BE SPREAD OVER SEVERAL YEARS

** L = LIME (100% ECC) G = GYPSUM S = SULFUR IN LBS

IF ★ APPEARS IN THIS COLUMN REFER TO THE SPECIAL COMMENTS AREA OF THE DETAILED REPORT

CATION EXCHANGE CAPACITY

ACTUAL % OF TOTAL CEC %K	%Mg	%Ca	%Na	%H	Cation Exchange Capacity (CEC)
3.2	6.4	90.2	0.2	0.0	55.8
5.0	3.6	91.2	0.2	0.0	40.5
2.5	4.1	93.1	0.3	0.0	42.1
2.3	4.0	93.5	0.2	0.0	42.8
4.5	7.7	87.5	0.3	0.0	43.8
4.2	7.1	88.3	0.4	0.0	38.7
0.7	7.8	91.2	0.3	0.0	20.5
0.4	8.7	90.4	0.4	0.0	20.1
0.4	7.8	91.3	0.5	0.0	16.0
0.4	7.6	91.0	1.0	0.0	15.4
3.5	4.4	91.9	0.3	0.0	39.4
2.8	3.5	93.4	0.3	0.0	36.3
3.0	5.7	91.1	0.3	0.0	34.3
%K	%Mg	%Ca	%Na	%H	CEC
Weighted Average for Total Acres					
2.1-7	15-20	65-75	0-5	0-5	

SUGGESTED % OF TOTAL CEC

GRAPHIC SUMMARY OF WEIGHTED AVERAGE TEST RESULTS

EXCESSIVE

EXTRAVAGANT

ADEQUATE

LOW

DEFICIENT

RATING: Organic Matter, Nitrate, Phosphorus, Potassium, Magnesium, Calcium, Sulfur, Zinc, Manganese, Copper, Iron, Boron

SEVERE PROBLEM

DEVELOPING PROBLEM

PROBLEM

SATISFACTORY

RATING: Soil pH, Buffer pH, Excess Carbonate, Soluble Salts, Sodium

SUMMARY REPORT OF ANALYTICAL RESULTS

Your Sample Number	Acres Per Sample	Laboratory Sample Number	% Organic Matter	Nitrate N ppm	Phosphorus ppm IP pH ≤ 7.1	IF pH > 7.1	Potassium ppm	Magnesium ppm	Calcium ppm	Sulfur ppm	Zinc ppm	Manganese ppm	Copper ppm	Iron ppm	Boron ppm		Soil pH	Buffer pH	Excess Carbonate	Soluble Salts	Sodium %
49		211777	3.7			8	692	428	10080		0.7	2.1	0.7	9.4			7.8	---	VH	0.54	25
50		211778	4.6			7	785	176	7395		0.3	6.0	0.7	10.3			8.0	---	VH	0.35	19
51		211779	4.1			9	415	205	7846		0.2	3.5	0.7	8.2			8.1	---	VH	0.28	32
52		211780	4.1			12	378	206	7993		0.2	4.2	0.8	12.0			8.0	---	VH	0.28	23
53		211781	5.2			5	769	403	7666		0.2	9.1	0.4	12.9			7.5	---	M	0.43	34
54		211782	2.9			9	637	331	6827		0.2	13.4	0.5	17.0			7.6	---	M	0.32	32
55		211783	2.3			6	56	193	3741		0.2	1.7	0.3	12.5			7.9	---	L	0.14	13
56		211784	1.8			9	34	211	3636		0.1	1.5	0.2	15.9			7.8	---	L	0.16	20
57		211785	2.2			5	24	150	2921		0.2	2.2	0.3	20.2			7.4	---	M	0.20	18
58		211786	0.9			5	25	141	2808		0.2	0.7	0.2	20.2			7.5	---	M	0.19	34
59		211787	4.4			6	530	206	7239		0.4	5.4	0.5	10.4			8.0	---	VH	0.33	23
60		211788	3.7			5	399	151	6775		0.4	4.7	0.5	11.1			8.1	---	VH	0.29	22
			[illegible]			7	395	[illegible]	[illegible]		0.3	[illegible]	[illegible]	[illegible]			[illegible]	---	---	[illegible]	[illegible]
				Nitrate N	Phosphorus		Potassium	Magnesium	Calcium	Sulfur	Zinc	Manganese	Copper	Iron	Boron		Soil pH	Buffer pH	Excess Carbonate	Soluble Salts	Sodium

Harris Laboratories, Inc.

[illegible] Pugh Street, Box [illegible]

For Additional Details Call: [illegible]

TRIPLE OPTION SOIL ANALYSIS SUMMARY

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

Submitted By
CHEMONICS INTERNATIONAL
2000 M. NW #200

WASHINGTON DC 20036

Submitted For
SELF

Date Received

Date Reported
05-NOV-86

Samples Will Be Stored Until

LABORATORY SAMPLE NUMBERS
211789
THROUGH
211790

******** THIS IS A RERUN OF A TEST YOU RECEIVED EARLIER ********

SUMMARY OF FERTILIZER RECOMMENDATIONS

Your Sample Number	Acres Per Sample	** L-G-S In Tons/Acre	PLANT FOOD NEED (in lbs./acre) FOR N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build	MgO	Ca	Zn	Mn	Cu	Fe	B	*
61															
62															
Weighted Average Recommendations for Total Acres			N	P_2O_5	P_2O_5 Build	K_2O	K_2O Build	MgO	Ca	Zn	Mn	Cu	Fe	B	

TO BE ECONOMICAL, BUILD MAY BE SPREAD OVER SEVERAL YEARS

** L : LIME (100% ECC) G : GYPSUM S : SULFUR IN LBS

IF * APPEARS IN THIS COLUMN REFER TO THE SPECIAL COMMENTS AREA OF THE DETAILED REPORT

CATION EXCHANGE CAPACITY

ACTUAL % OF TOTAL CEC %K	%Mg	%Ca	%Na	%H	Cation Exchange Capacity (CEC)
1.5	6.7	91.7	0.2	0.0	52.0
0.8	6.7	92.4	0.2	0.0	50.1
1.1	6.7	92.0	0.2	0.0	51.1

Weighted Average for Total Acres

%K	%Mg	%Ca	%Na	%H	CEC
2.0-7	15-20	65-75	0-5	0-8	

SUGGESTED % OF TOTAL CEC

GRAPHIC SUMMARY OF WEIGHTED AVERAGE TEST RESULTS

EXTRAVAGANT

ADEQUATE

LOW

DEFICIENT

RATING: Organic Matter, Nitrate, Phosphorus, Potassium, Magnesium, Calcium, Sulfur, Zinc, Manganese, Copper, Iron, Boron

SEVERE PROBLEM

DEVELOPING PROBLEM

PROBLEM

SATISFACTORY

RATING: Soil pH, Buffer pH, Excess Carbonate, Soluble Salts, Sodium

SUMMARY REPORT OF ANALYTICAL RESULTS

Your Sample Number	Acres Per Sample	Laboratory Sample Number	% Organic Matter	Nitrate N ppm	Phosphorus ppm IF pH ≤ 7.1	IF pH > 7.1	Potassium ppm	Magnesium ppm	Calcium ppm	Sulfur ppm	Zinc ppm	Manganese ppm	Copper ppm	Iron ppm	Boron ppm		Soil pH	Buffer pH	Excess Carbonate	Soluble Salts	Sodium ppm
61		211789	4.9			14	300	417	9540		0.4	3.4	0.4	9.2			7.9	---	VH	0.32	18
62		211790	4.3			5	151	400	9260		0.3	3.6	0.5	11.3			8.0	---	VH	0.33	19

SECTION IX

CROP TIPS® - EXAMPLES

1. Introduction

Crop TIPS® are included here only as examples of information which is needed for the CAC project. My computer printouts will give much more detailed and up to date information on varieties, Weed control, Insect and disease Management, Marketing conditions, etc. The latest research data is used to keep the information TIPS current and useful.

What a grower or gardener receives is a condensation of published information but up dated with current research information. He is able to ask for specific information according to his current needs.

I emphasise again that these are by no means complete and should not be viewed as management advice in the form they are in.

CROP TIPS®

(EXAMPLE)

Crop: Tomato, Cherry

I. Seeding/Planting

A. Variety selection: Adapted varieties

B. Distance/Spacing: 60 inch between rows. 18-24 inches in row

C. Time of Planting: Predated from optimum expected harvest date

D. Quantity of Seed/Seeding Rate: 1 to 1¼ lb direct. 3-4oz transplant.

II. Fertility Management

A. Crop Removal: 20000 lb yield 60 N; 20 P_2O_5; 85 K_2O

B. Fertilizer Requirements: 100N; 100P_2O_5; 8 K_2O

C. Application Methods: Band half under the seed line at seeding or transplanting. Remainder before rows cover.

III. Weed Control

A. Chemical: Check up to date recommendation. Read and follow labels

B. Mechanical: Cultivation or hand weeding

IV. Water Management

A. Seasonal Water Use: 100 - 120 inches

B. Irrigation: 1 inch at planting. 1 inch per week through harvest

C. Drainage: Provide well drained site or plant on raised beds

V. Pest Management

A. Insects: Control:

Check up dated pest control guides. Read and follow labels

B. Diseases: Control:

VI. Harvesting

A. Quality Standards: Set by US Fresh Fruit and Vegetables Association
Recommended by Broker/Marketer
Depends on Market conditions

B. Harvesting Procedures: Vine ripe for local (immediate) sale
"Pinks" and "Greens" hand picked
Field graded

C. Post-Harvesting Handling:

1. Packing Pint or quart boxes, film wrapped

2. Shipping Air or Refrigeratored trucks

3. Storage 55-60°F 85-90% R.H. 10-15 days
Under proper storage conditions

CROP TIPS

(EXAMPLE)

Crop: Sweet Corn

I. Seeding/Planting

A. Variety selection: Adapted varieties. Try Super-sweet strains

B. Distance/Spacing: 30-36" between rows; 8-10" in rows

C. Time of Planting: Select harvest date. Plant 80-90 days prior depending on variety maturity range

D. Quantity of Seed/Seeding Rate: 12-15 lbs/Acre

II. Fertility Management

A. Crop Removal: 6000 lb yield Ears 20N; 5P2O5 10K2O
Stalks and leave 30N; $10P_2O_5$, $18K_2O$

B. Fertilizer Requirements: 200N $150P_2O_5$ $75K_2O$ or by soil test

C. Application Methods: Band half at seeding. Half when crop is 18-24"

III. Weed Control

A. Chemical: Pro emergence herbicide - check label for rate
Post emergence if necessary

B. Mechanical: Cultivation or hand weeding

IV. Water Management

A. Seasonal Water Use: 20 inches

B. Irrigation: 1½ inches per week

C. Drainage: Provide adequate drainage; natural or artificial

V. Pest Management

A. Insects: Control:

Check update Pest Control Guides. Read and follow labels

B. Diseases: Control:

VI. Harvesting

A. Quality Standards: Set by US Fresh Fruits and Vegetable Association

B. Harvesting Procedures: Hand pick or machine harvest at soft milk stage

C. Post-Harvesting Handling:

1. Packing Cool as soon after harvest as possible quality deteriorates rapidly after harvest

2. Shipping Crates. (Reefer or Air from Belize)

3. Storage $32^{o}F$ 90-95% RH 5-8 days loses quality rapidly

SECTION X

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