AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION

A. PRIMARY: Agriculture — AF25-0000-G352

B. SECONDARY: Soil fertility,fertilizers,and plant nutrition--Central America

2. TITLE AND SUBTITLE
International soil fertility project: northern Central America regional progress report

3. AUTHOR(S)
Walker,J.L.

4. DOCUMENT DATE: 1969

5. NUMBER OF PAGES: 44p.

6. ARC NUMBER: ARC LAT631.42.W181

7. REFERENCE ORGANIZATION NAME AND ADDRESS
N.C.State

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

10. CONTROL NUMBER
PN-RAA-435

11. PRICE OF DOCUMENT

12. DESCRIPTORS
Central America
Data
Research

13. PROJECT NUMBER

14. CONTRACT NUMBER
CSD-287 Res.

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

LAT
631.42
W181

Cod #287

INTERNATIONAL SOIL FERTILITY PROJECT

NORTHERN CENTRAL AMERICA REGIONAL PROGRESS REPORT

By

J. L. Walker

March, 1969

A.I.D.
Reference Center
Room 1656 NS

INTERNATIONAL SOIL FERTILITY PROJECT

NORTHERN CENTRAL AMERICA REGIONAL PROGRESS REPORT

Prepared by: J. L. Walker March, 1969

I. Research

Northern Central American Region:

The agricultural land of Northern Central America is over four times as large as that of North Carolina (Table 1.). However, North Carolina farmers use more than twice as much Nitrogen, 4.5 times more phosphorous and over six times more potash than is consumed in Northern Central America (Table 2.)

TABLE 1. Comparative Fertilizer Use on Agricultural Lands in Northern Central America and North Carolina.

Year	Country-State	Million Acres of Harvested Land	Average Amount of Fertilizer Used per Acre		
			N	P_2O_5	K_2O
1966	North Carolina	4.2	66 lbs.	65 lbs.	75 lbs.
1968	Guatemala	6.2	3.2	2.3	1.1
1968	El Salvador	3.6	14.4	5.8	5.8
1968	Honduras	5.2	4.0	0.6	2.5
1968	Nicaragua	3.7	7.4	5.6	2.4
	NCA Region	18.7	6.4	3.2	2.6

TABLE 2. Total Amounts of Fertilizer Used in North Carolina (4.2 million acres) Compared with Northern Central America (18.7 million acres).

Year	Country-State	Total Amounts of Fertilizer Used (million pounds)		
		N	P_2O_5	K_2O
1966	North Carolina	278.8	272.8	313.4
1968	Guatemala	19.8	14.3	6.6
1968	El Salvador	51.7	20.9	20.9
1968	Honduras	20.9	3.3	13.2
1968	Nicaragua	27.5	20.9	8.8
	NCA Region	119.9	59.4	49.5

On a per acre basis, the fertilizer use comparison is even more striking: Northern Central American farmers on the average use 10 times less nitrogen; 20 times less phosphorous and nearly 30 times less potash than North Carolina farmers.

North Carolinas' agriculture produces more than one-and-a-quarter billion dollars yearly. How much money does Northern Central American agriculture produce? What are the balance-of-payment problems in the Central American Common Market area? Poor fertilizer use is certainly a very important part of the problem.

A First Approximation of Fertilizer Needs in Northern Central America. What are some of the first steps toward improving economic returns through rational fertilizer use in the CACM area? Firstly, the fertilizer needed must be available. Is it? How much, what kinds and where are questions that can be answered through soil fertility evaluation programs sponsored in the Northern Central American Region by the International Soil Fertility Project of North Carolina State University and the Agency for International Development in cooperation with CACM member countries.

In one of the four papers I presented during the recent Latin American Soil Science Society meetings in San Jose, Costa Rica, regional fertilizer needs were projected based upon $N-P_2O_5-K_2C$ ratios we suggest for each PK soil test analytical combination and upon a weighted average treatment of soil test summary information. The data and comments that follow represent an expansion of this study in response to requests from USAID's and industry.

My operational assumptions are:
1. that the soil test summaries since July 1, 1966 are representative for the area of actual fertilizer use;
2. that the soil fertility evaluation methods used in obtaining the soil test data and the interpretation of that data predict with accuracy the probabilities of response to different plant nutrient applications;
3. and, that a weighted average analysis of the soil test results will very closely reflect the proportions of $N : P_2C_5 : K_2O$ that should be made available for the areas presently using fertilizer. An estimate of potential required fertilizer consumption on a country and regional basis will be presented in the following pages. It assumes that nitrogen consumption will be maintained at 1968 levels but that tonnages of both P_2O_5 and K_2O will be adjusted according to soil test summary data. Other projections can be made: that nitrogen consumption can be raised to its maximum use level during the 1964-1968 period, etc. The advantages of this method are that it is based upon commercial realities and needs rather than being an idealized need prediction including areas not presently using fertilizers, a projection from past consumption figures, or an estimate based upon fertilizer industry production capacities. It shows what should be used now on the areas presently using fertilizer. To the fertilizer industry it shows that if you can sell the nitrogen you sold last year, these are the amounts of P_2O_5 and K_2O that should be imported so that present consumers can buy according to their needs to begin to maximize their economic yields.

The consumption of plant nutrients in the Central American area during the period from 1964 through 1968 is presented in Table 3. With nitrogen consumption the constant, the actual fertilizer use ratios by country for each year since 1964 are as shown in Table 4. Study of the ratios reveals that for each ton of nitrogen less than half-a-ton each of P_2C_5 and K_2C were consumed in Central America. The region shows a slight increase in use of both P_2O_5 and K_2C relative to nitrogen during the past five years. Within the region, however, individual countries vary greatly in this regard. Honduras and Costa Rica have remained static while Nicaragua and Panama show increases in P_2O_5 and K_2C relative to nitrogen. Phosphorous consumption relative to nitrogen has increased in both Guatemala and El Salvador where potash use at the same time has remained fairly constant. How does this actual consumption compare with real commercial needs shown by soil test summary evaluation?

The regional $N-P_2O_5-K_2C$ import ratio for 1967 and 1968 was 1 - 0.45 - 0.41. This is roughly adequate to supply the needs of those farmers requiring only starter and maintainence applications of phosphorous and potash. These would be farmers whose soils tested adequate in both P and K. Yet, the soil test summaries (Table 5) show that only one out of five Guatemalan farmers; less than half of the Salvadoran farmers; five out of nine Honduran farmers and only one of every five Nicaraguan farmers who are now using fertilizers need to use solely a maintainence application

TABLE 3. Plant Nutrients Consumed in Central America, 1964-1968 (metric tons)

NUTRIENT AND YEAR.	GUATEMALA	EL SALVADOR	HONDURAS	NICARAGUA	COSTA RICA	PANAMA	TOTALS
NITROGEN							
1964	9,000	28,000	6,500	11,500	11,500	9,000	75,500
1965	8,000	20,500	10,000	13,000	15,500	11,500	78,500
1966	8,000	21,000	7,500	12,000	16,500	7,000	72,000
1967 est.	9,000	22,500	8,500	12,500	17,500	7,500	77,500
1968 est.	9,000	23,500	9,500	12,500	18,000	8,000	80,500
P_2C_5							
1964	6,000	9,000	1,000	7,000	7,500	1,500	32,000
1965	5,500	8,500	500	11,500	5,000	2,000	33,000
1966	5,500	8,500	1,000	8,000	6,000	2,500	31,500
1967 est.	6,500	9,000	1,500	9,000	6,000	3,000	35,000
1968 est.	6,500	9,500	1,500	9,500	6,000	3,000	36,000
K_2C							
1964	1,500	9,000	4,500	2,500	5,500	1,000	24,000
1965	2,000	8,000	4,000	3,000	7,000	1,500	25,500
1966	2,000	8,500	5,000	2,500	7,500	2,000	27,500
1967 est.	3,000	9,000	6,000	4,000	8,500	1,500	25,500
1968 est.	3,000	9,500	6,000	4,000	8,500	2,000	33,000

of P and K. The great majority of Northern Central American farmers who use fertilizers at present are not using then correctly. They need supplementary applications of either phosphorous or potash or of both P and K to correct plant nutrient deficiencies that are limiting crop production. But the fertilizer these farmers need is not presently available in the region.

TABLE 4. N - P_2O_5 - K_2O Fertilizer Use Ratios for the Central American Area

COUNTRY	1964	1965	1966	1967	1968
Guatemala	1-0.67-0.17	1-0.69-0.25	1-0.69-0.25	1-0.72-0.22	1-0.72-0.22
El Salvador	1-0.32-0.32	1-0.42-0.39	1-0.40-0.40	1-0.40-0.40	1-0.40-0.40
Honduras	1-0.15-0.69	1-0.05-0.40	1-0.13-0.67	1-0.18-0.70	1-0.16-0.63
Nicaragua	1-0.61-0.22	1-0.88-0.23	1-0.67-0.21	1-0.72-0.32	1-0.76-0.32
Costa Rica	1-0.65-0.48	1-0.32-0.45	1-0.36-0.45	1-0.34-0.49	1-0.33-0.47
Panama	1-0.17-0.11	1-0.17-0.13	1-0.36-0.29	1-0.40-0.20	1-0.38-0.25
REGION	1-0.42-0.32	1-0.42-0.32	1-0.44-0.38	1-0.45-0.41	1-0.45-0.41
North Carolina			1-0.98-1.12		

The fertilizer need ratio (Table 6) for each country of the region for the areas presently using fertilizers shows that there is an obvious marked difference between actual fertilizer use ratios (Table 4.) and real commercial crop production needs. If Nitrogen consumption were maintained at 1968 levels, the amounts of Phosphorous (P_2O_5) and Potash (K_2O) which should be made available for the farmers presently using fertilizers would be as shown in Table 7.

TABLE 6. Fertilizer Need Ratio According to Weighted Average Treatment of Northern Central America Soil Fertility Analyses Summaries.

CCUNTRY	FERTILIZER NEED RATIO N - P_2O_5 - K_2C
Guatemala	1 - 1.65 - 0.82
El Salvador	1 - 1.28 - 0.58
Honduras	1 - 1.30 - 1.00
Nicaragua	1 - 1.55 - 1.30

TABLE 5. Northern Central America Soil Fertility Summary Showing the N - P_2O_5 - K_2C Ratios Suggested for Each Soil Analysis Condition.

SOIL FERTILITY ANALYSIS RESULT		N - P_2O_5 - K_2O Ratio Suggested	Guatemala July, 1966-July, 1968 13,244 farmers samples		El Salvador 1967 + 1968 7,617 farmers samples		Honduras 1967 + 1968 3,604 farmers samples		Nicaragua 1967 + 1968 9,773 farmers samples		REGION 34,238 farmers samples	
P_2O_5	K_2O											
Deficient	Deficient	2 - 4 - 4	2,556	19.3%	290	3.8%	998	27.7%	4,154	42.5%	7,998	23.4%
Deficient	Adequate	2 - 4 - 1	7,615	57.6%	3,679	48.3%	905	25.1%	2,678	27.4%	14,877	43.4%
Adequate	Deficient	2 - 1 - 4	265	2.0%	91	1.2%	205	5.7%	1,094	11.2%	1,655	4.8%
Adequate	Adequate	2 - 1 - 1*	2,808	21.2%	3,557	46.7%	1,496	41.5%	1,847	18.9%	9,708	28.4%

* The number 1 in the ratio indicates the maintainence and starter application where soil fertility analyses results show adequate levels of P, K or PK. The Nitrogen portion of the suggested ratio includes all at planting and side dressing N applications.

TABLE 7. Phosphorous (P_2O_5) and Potash (K_2O) Needs at 1968 Nitrogen Consumption Levels for the Area Presently Using Fertilizers in the Northern Central America Region.

COUNTRY	Needed N-P_2O_5-K_2O Import Ratio Based on Soil Fertility Analyses	1968 Nitrogen Consumption (metric tons)	Immediate Consumption Needs (metric tons)	
			P_2O_5	K_2O
Guatemala	1 - 1.65 - 0.82	9,000	14,850	7,380
El Salvador	1 - 1.28 - 0.58	23,500	30,080	13,630
Honduras	1 - 1.30 - 1.00	9,500	12,350	9,500
Nicaragua	1 - 1.55 - 1.30	12,500	19,375	16,250
TOTALS		54,500	76,655	46,760

Assuming that Nitrogen consumption is maintained at 1968 levels, the increase in Phosphorous and Potash necessary to correct plant nutrient deficiencies that are limiting economic crop production where fertilizers are presently used in the region is shown in Table 8.

TABLE 8. Additional Phosphorous and Potash Imports Necessary to Correct Plant Nutrient Deficiencies in the Present Northern Central American Fertilizer Use Area. Nitrogen Consumption Remains at the 1968 Levels.

COUNTRY	1968 Nitrogen Consumption (metric tons)	Import Adjustment Necessary for Present Fertilizer Use Area			
		P_2O_5		K_2O	
		Metric Tons	% Change Over '68	Metric Tons	% Change Over '68
Guatemala	9,000	8,350	+ 128%	4,380	+ 146%
El Salvador	23,500	20,580	+ 217	4,130	+ 43
Honduras	9,500	10,850	+ 723	3,500	+ 58
Nicaragua	12,500	9,875	+ 104	12,250	+ 306
REGION	54,500	49,655	+ 184	24,260	+ 108

Fertilizer prices to the consumer are approximately $ 250 per metric ton of Nitrogen, $200 per metric ton of P_2O_5 and $100 per metric ton of K_2O. A dollar spent on fertilizer for correcting plant nutrient deficiencies should produce three to four dollars of profit (Cate and Vittori, ISTP Preliminary Report No. 1) whereas a two-for-one return on the fertilizer dollar can be expected if only maintainence and starter applications are necessary. The consumer value of the adjusted fertilizer imports needed to correct plant nutrient deficiencies is shown in Table 9.

TABLE 9. Approximate Consumer Cost (million dollars) of N - P_2O_5 - K_2C for the Northern Central American Region.

COUNTRY	Actual Consumption (1968) N	P_2O_5	K_2O	$ Million Total	Additional Investment in P_2O_5 + K_2O Needed for 1968 Nitrogen Levels N	P_2O_5	K_2O	$ Million Total
Guatemala	$ 2.250	1.30	0.30	3.850	$2.250	2.97	0.74	5.96
El Salvador	$ 5.875	1.90	0.95	8.725	$ 5.875	6.02	1.35	13.255
Honduras	$ 2.375	0.30	0.60	3.275	$2.375	2.47	0.95	5.795
Nicaragua	$ 3.125	1.90	0.40	5.425	$3.125	3.875	1.625	8.625
REGION	$ 13.625	5.40	2.25	21.275	$13.625	15.335	4.675	33.635

If Nitrogen consumption is maintained at 1968 levels, the consumer cost of additional imports of P_2O_5 and K_2O for adjusting consumption to needs within the present fertilizer use areas would be:

COUNTRY	Additional investment needed ($Million) P_2O_5	K_2O	Total ($ million)
Guatemala	1.67	0.44	2.11
El Salvador	4.12	0.41	4.53
Honduras	2.17	0.35	2.52
Nicaragua	1.975	1.225	3.20
REGION	9.935	2.425	$12.36 million.

An approximation can be made of the dollar returns that could be expected from such increased investment in fertilizers if they were applied according to recommendations based upon soil fertility analyses. For example, in Nicaragua about 80 percent (Table 5) of the needed fertilizer imports are for correction of deficiencies of either phosphorous or potash or both in areas where fertilizers are presently used. Thus, if the phosphorous and potash needed according to soil test results were provided in balance with the Nitrogen consumed in 1968, 7.7 million dollars could be invested at a probable net return of $ 3 for every $ 1 invested in fertilizer. The dollar yield on this investment would be about $ 23 million. The remainder of fertilizer imported for Nicaragua could be invested on the 20 % of the cases that need only maintainence plus starter fertilization where probable net returns are $ 1 for $ 1.

Another way of looking at this concept is that about 20 % of the Nitrogen used would be on fields needing only P and K maintainence. Thus, about 2,400 of the 12,500 metric tons of Nitrogen used would be for cases requiring a 2 - 1 - 1 N - P_2C_5 - K_2C use ratio. About 1,200 metric tons of P_2C_5 and of K_2C would be needed for these cases. The consumer cost would be about $ 960,000. The remainder of the Nitrogen would be used on fields needing additional Phosphorous or Potash or both to correct plant nutrient deficiencies. The remaining 10,100 metric tons of Nitrogen would be applied on such fields along with 18,175 metric tons of P_2C_5 and 15,050 metric tons of K_2O. The consumer cost in this case would be about $ 7,665,000. The probable net returns on the consumer value of fertilizer needed in the region are shown in Table 10.

TABLE 10. Probable Net Returns on Consumer Value of Fertilizer Needed in the Northern Central American Region Assuming no Expansion in Nitrogen Use Over 1968.

1. COUNTRY:	Guatemala	El Salvador	Honduras	Nicaragua	REGION
2. Percent of soil samples needing P or K or both to correct deficiencies:	78.8	53.3	58.5	81.1	
3. Total fertilizer investment ($N+P_2O_5+K_2O$) needed to correct deficiencies if nitrogen consumption is kept at 1968 levels ($ million):	$ 5.197	$ 8.865	$ 4.218	$ 7.665	$ 25.945
4. Probable net return on investment to correct deficiencies ($ million):	$15.591	$ 26.595	$ 12.654	$23.0	$ 77.84
5. Fertilizer investment in $N+P_2O_5+K_2O$ needed for soil fertility maintainence and starter cases ($ million):	$ 0.763	$ 4.390	$ 1.577	$ 0.96	$ 7.69
6. Probable net return on investment for maintainence and starter cases ($ million) :	$ 0.763	$ 4.390	$ 1.577	$ 0.96	$ 7.69
7. Total fertilizer investment needed if nitrogen consumption remains at 1968 levels and P_2O_5 and K_2O are adjusted for the amount of nitrogen consumed, according to soil fertility analyses results ($ million):	$ 5.96	$ 13.255	$ 5.795	$ 8.625	$ 33.635
8. Total probable net profit on fertilizer investment if P_2O_5 and K_2O imports are adjusted, for the amount of N consumed in 1968, according to soil fertility analyses and applied according to recommendations ($ million) :	$ 16.354	$ 30.985	$ 14.23	$ 23.96	$ 85.529

$ 21 million is presently being spent by farmers for fertilizer in Northern Central America. Soil fertility analyses for more than 34,000 farmers samples have been studied. These results show that the 21 million dollars is not being wisely invested to produce profits. Country crop yield averages show why farming is at best a marginally profitable activity for the great majority of Northern Central American farmers. Correct use of the present $ 21 million spent on fertilizers plus a total additional fertilizer input of 12.3 million dollars to correct phosphorous and potash deficiencies in areas presently using fertilizers but using them improperly can be expected to net some $ 85.5 million for the Northern Central American region. But to achieve this, the fertilizer must be applied according to recommendations based on soil fertility analyses.

This presentation shows my best estimate of how much and what plant nutrients should be available, assuming a static nitrogen consumption, in each country of Northern Central America. Each farmer must send in samples of his own soils for fertility analysis to determine where he should invest his fertilizer dollar to give him the greatest profit probabilities. I am now organizing the fertilizer need data according to agricultural regions, crops and soil series within the regions. There is great variability within areas even on a soil series basis. Such soil fertility variability shows why the use of general fertilizer recommendations results in very low net profit probabilities.

Industry is being asked to cooperate in supplying data on fertilizer consumption according to crop and area within each country. This and knowledge of the amounts of plant nutrients recommended by crop according to our revised fertilizer guide sheets plus soil fertility analyses summaries by area, crop and soil series can then be used in planning how much of what kinds of fertilizers should be made available at in-country fertilizer distribution centers. Such a study is now being completed for the Northern Altiplane area of Guatemala (880,000 acres) and the coastal plain area of El Salvador (185,000 acres).

Please give me your comments and criticisms on the validity and usefulness of this approach.

Soil Samples Analyzed per Metric Ton and $ of Fertilizer Consumed in Northern Central America (1967 plus 1968)

COUNTRY	Soil Samples Analyzed	Metric Tons of $N+P_2O_5+K_2O$ Consumed	Consumer Cost $ Million	METRIC TONS SAMPLE	DOLLARS SAMPLE
Guatemala	15,034	37,000	7.70	1:2.5 tons	1:$500
El Salvador	7,617	83,000	17.05	1:11 tons	1:$2200
Honduras	3,604	33,000	6.30	1:9 tons	1:$1750
Nicaragua	9,773	51,500	10.75	1:5.3 tons	1:$1100
REGION	36,028	204,500	41.80	1:5.7 tons	1:$1150

The number of soil samples analyzed is exceedingly low in relation to the amount of money invested in fertilizers in El Salvador and in Nicaragua. This is all the more surprising considering that El Salvador and Nicaragua are the only countries in the region whose soil testing laboratories do not charge for soil fertility analyses.

THE NUMBER OF SOIL SAMPLES ANALYZED since initiation of International Soil Testing Project activities in Northern Central America is given in Table 11. Comparing 1968 with 1967, every country except Honduras showed an increase in the number of farmers soil samples analyzed. Comments on the situation are made in the section on Honduras.

TABLE 11. Number of Soil Samples Tested Since Initiation of International Soil Testing Project Activities in Northern Central America.

YEAR	GUATEMALA			EL SALVADOR			HONDURAS			NICARAGUA			REGION		
	Number of Samples	% Change from last yr.	% Change from 1964	Number of Samples	% Change from last yr.	% Change from 1964	Number of Samples	% Change from last yr.	% Change from 1964	Number of Samples	% Change from last yr.	% Change from 1964	Number of Samples	% Change from last yr.	% Change from 1964
1968	8231	21%	426%	4529	27%	166%	3116	- 1%	785%	5122	10%	435%	20998	16%	359%
1967	6803	188	334	3559	8	109	3159	89	797	4651	295	386	18172	114	297
1966	2361	35	51	3300	76	94	1668	6	374	1177	- 12	23	8506	30	86
1965	1753	12	12	1878	10	10	1572	347	347	1330	39	39	6533	43	43
1964	1566			1703			352			957			4578		

Note: On July 1, 1966, most Central American Soil Fertility Analyses laboratories initiated new control methods using North Carolina soil extracting solutions and modern multiple analyses equipment designed and built under International Soil Testing Project guidance. For this reason, reliable soil test summaries are now available for more than 40,000 farmers soil samples analyzed in the Northern Central American laboratories since that date.

AT THE RECENT MEETINGS OF THE LATIN AMERICAN SOIL SCIENCE SOCIETY in San Jose, Costa Rica, nineteen of the 38 papers presented were given by agronomists cooperating directly in the International Soil Fertility Project. Dr. J. W. Fitts was keynote speaker. As Vice-President of the Society, I presided at several meetings including those on Soil Fertility and Analyses and on Education and Extension in Soils. In addition, I presented four papers and was co-author on four more: "Fertilizers: First Approximation of Needs in Northern Central America"; "Examples of the Multiple Uses of Soil Fertility and Analyses Programs: Plow Pan in Soils of Northern Central America"; "Economic Impact of a National Soil Testing Program"; "Soil Sampling in the Guatemalan Highlands: An Economic Impact Program for the Production of Basic Crops"; "Summary of Two Years of Soil Fertility Analyses in Guatemala"; "Soils of Guatemala: Plant Nutrient Status, 1967"; "Nutrient Status (1967) of Physiographic Areas of Guatemala"; and, "Impact Soil Testing Program on the Coastal Plain of El Salvador". Tabular data from some of these papers is still available (in spanish).

More than 75 agronomists from the United States, Mexico, Central America and Peru attended the meetings. Six of the eleven officers elected by the Society for 1969 have participated in the International Soil Fertility Project summer seminars given at North Carolina State University in Raleigh under Agency for International development contract csd-287. This is direct evidence that the Society members recognize the practical and scientific value of the contributions that these members of the International Soil Fertility Project are making to increase crop production through soil fertility evaluation and proper fertilizer use.

GUATEMALA

RESEARCH

I. Fertilizer Need Correlation studies:

Ing. Jorge Gonzalez, Head of the Guatemalan Program, reports on soil test - greenhouse correlation studies that:
A. 15 soil series (4 reps each) are being studied for phosphorous soil test correlation; these should be harvested within the next month. Sunflower is the plant being used in these studies.
B. 15 soil series (4 reps each) are being studied for potash soil test correlation; the plant tissue from this study has just been harvested.
C. Small greenhouse trials on soils from the Pacific Coastal Plain (tropical wet-dry climate), Altiplane (temperate wet-dry climate) and Peten (tropical wet climate) have all shown positive responses to sulphur when high N-P-K rates were used. Whether this is an artifact produced during the trials is being studied in a field trial in the Pacific Coastal Plain area.

II. Phosphorous Fixation:

Sixteen soil series have been studied. Of these, all but three fixed phosphorous. Native P levels renged from 2 to 16 ppm P. Two of the soils did not pass the critical level (19 ppm P) even when 700 ppm P (equal to 3200 pounds of P_2O_5 per acre) had been added.

I believe that in Guatemala as well as in El Salvador, we may be on the threshold of some very significant discoveries regarding phosphorous use and response: P fixation studies in both countries show that when a soil analyzes less than 9 ppm P, there is a better than 90% probability that it fixes phosphorous. Ing. Gonzalez and I have discussed the desirability or a routine soil testing procedure for P fixation: at the end of each day, add a standard 150 ppm P solution to all farmers samples analyzing less than 10 ppm P. Incubate 48 hours, determine whether 150 ppm P added has resulted in the soil passing the critical level of 19 ppm P (150 ppm P x 20% efficiency = 30 ppm effective P; so, 150 ppm P is more than enough to push non-fixing soils past the critical level). Unfortunately, three vacancies now exist in the Soils Department. Until these vacant positions have been filled, additional necessary field correlation trials and follow-up studies can not be undertaken. Work will be concentrated on lab and greenhouse studies.

Soil test summaries show that the farmers samples fall mainly in two groups: those that contain less that 20 ppm P and those that analyze +100 ppm P.

III. Potash Analyses and Critical Levels:

It appears that the critical levels for K for those soils derived from volcanic materials lie somewhere between 78 and 125 ppm K (1 : 5 soil to N.C. extract ratio). Results of last years wheat trials (48 to 60 bushel production) showed significant responses to K_2C. The soils in these studies, with the exception of one that analyzed slightly less than 100 ppm K, all had K levels between 100 and 125 ppm. The greenhouse correlation study previously mentioned shows similar results though analyses of the data is still not completely finished. Low plant tissue K contents have been frequently found in fields where soils tested 78 to 100 ppm K. Soil test summary results show that farmers soils fall into three general groups: those analyzing less than 50 ppm K; a larger group in the range from 100 to 125 ppm K and a third group that has +200 ppm K.

IV. Impact Soil Testing Programs for Fertilizer Need Evaluation:

Soil sample analyses for N, P, K, Ca+Mg, Al and pH have been completed for the more than 1,000 farmers soil samples collected over a 400,000 hectare area of the Guatemalan uplands during the Impact Soil Sampling drive to gather fertilizer-need information to increase food crop production. One composite sample was collected for every 100 hectares in the state of Quezaltenango and one composite sample was callected for every 1000 hectares in the states of San Marcos, Huehuetenango, Solola, Totonicapan, El Quiche and Chimaltenango. The total area sampled contains 33.5% of the arable land of Guatemala. It is also the most densely

Wheat Yields - Kg/HA

	0	NP	NPK_1	NPK_2
Sumpango	2613	3030	3304	3417
Parramos Chm.	375	1702	1845	1756
Paquixic Chm.	851	1863	1958	1970
Patzicia	298	1238	1107	1083
Patzun	1292	1530	1571	1750
San Martín Jilt.	321	1066	1244	1363
Zaragoza	381	1750	2274	2232
Chimaltenango	1060	1429	1756	1673
Joyabaj	333	1357	1375	1375
Totonicapán	327	1625	1684	1565
Chipita Chm.	1554	2143	2530	2339
$\bar{X}$ en Kg/Ha	855	1703	1877	1866

SOIL TEST DATA

#	N	P	K	pH
1	16	9.0	100+	6.5
2	32	31.5	100+	6.7
3	32	1.8	100+	6.2
4	32	10.0	100+	6.6
5	16	5.0	100+	6.5
6	32	6.5	100+	6.2
7	16	3.0	100+	6.3
8	16	38.0	100+	6.5
9	32	31.5	95	5.9
10	16	9.0	100+	6.8
11	16	8.0	100+	6.5

populated. The population, mostly pure Mayan indian, varies in density from 80 to 100 people per square kilometer. Over $500,000 dollars is invested in fertilizer there but yields on the average are very low. Basic food crops adapted to a low mountain wet-dry to moist climate, such as corn, wheat, beans, potatoes and vegetables, are grown throughout the area on farms averaging less than 2 acres each. Our objective is to substitute fertilizer for land in this area. Preliminary data showing that this can be done is presented in the following sections.

Participants in this Impact Program included: The Minister of Agriculture, Sr. Francisco Montenegro Girón; The National Soil Fertility Program, Soils Department and Laboratory; The Agricultural Extension Service; The Indian Development Service; and, the Division of Investigations of the DGIEA, Ministry of Agriculture. The Salvadoran Soil Fertility and Analyses Program, Research and Extension Division (DGIEA), National Agronomic Center (CNA), Ministry of Agriculture, El Salvador also actively participated in the sampling drive as did the International Soil Testing Project, Northern Central America Office, N.C. State University-Agency for International Development; The American Potash Institute, Northern Latin America Office; and, the Agronomy and Extension sections of the National Wheat Growers Cooperative.

The soil fertility data is being organized by soil series, and N-P_2O_5-K_2O needs according to weighted average treatment of the soil test results for the cultivated areas are being calculated, so that private companies and farmers Co-ops can have the fertilizers needed available in local distribution centers throughout the region. An example of the form being used is presented for one of the most important soils of the region in Table 12.

TABLE 12. Example of Calculation Form Used in Preparing the Report on Fertilizer Needs in the Guatemalan Altiplano - 1969.

Prepared by the National Soil Fertility Program, DGIEA, MAg., La Aurora in Cooperation with the International Soil Fertility Project, N.C. State Univ.-AID.

QUETZALTENANGO (Qe) soil series.
Area covered by soil series: 21,987 manzanas (1.6 acres).
We estimate that approximately 21,987 manzanas or 100 % of the Soil Series area is cultivated. 377 soil samples from the cultivated area have been analyzed by the National Soil Fertility Program Laboratory during the years 1966 through 1968. The summary of these results and our estimate of the total amounts of N, P_2O_5 and K_2O needed to obtain yield goals of 100 cwt of corn and 60 cwt of wheat per manzana in the area is presented below.

PLANT NUTRIENTS Phosphorous (P)	Potash (K)	N-P_2O_5-K_2O Ratio Needed	% Samples in each Category	Weighted Ratio P_2O_5	K_2O
Deficient	Deficient	2-4-4	1.9	0.08	0.08
Deficient	Adequate	2-4-1	71.3	2.85	0.71
Adequate	Deficient	2-1-4	0.3	-	0.01
Adequate	Adequate	2-1-1	26.5	0.26	0.26

WEIGHTED NEED RATIO N- P_2O_5 - K_2O: 1 - 1.60 - 0.53

Quintales (cwt) per manzana (1.6 acres) N suggested for yield goal of 100 cwt corn per manzana = 180 lbs ; for yield goal of 60 cwt wheat per manzana = 105 lbs N. Total amount of plant nutrients needed to adequately fertilize the entire cultivated area if in :

	Nitrogen (N)	Phosphorous (P_2O_5)	Potash (K_2O)
CORN	39,580cwt(1980tons)	63,330cwt(3166tons)	20,980cwt (1049tons)
WHEAT	23,090cwt(1155tons)	36,940cwt(1847tons)	12,240cwt (612tons)

The report on fertilizer needs in each soil series is accompanied by the following explanatory material (Table 13).

TABLE 13. Explanatory Material to Accompany Soil Series Reports on Fertilizer Needs in the Guatemalan Altiplano.

The tables summarize soil sample analyses from the first of July, 1966 through 1968 and present our suggestions for fertilizers for wheat and corn in accord with each analytical condition. The yield goals of 60 cwt of wheat and 100 cwt of corn per manzana (equivalent: 60 bu wheat and 100 bu corn per acre) imply other good management practices in addition to the correction of plant nutrient deficiencies. Among these are adequate plant population (28,000 plants per manzana for corn) and pest control. The total quantities of Nitrogen (N), Phosphorous (P_2O_5) and Potash (K_2C) recommended includes all broadcast, at planting and side dressing applications. In deciding which formulas and what quantities of fertilizers to use in accord with each soil analysis condition the following factors should be kept in mind:

1. Each farmer must have his own soils analyzed to determine which fertilizers he needs.

2. The data summarized show that there is no such thing as a general soil fertility level in any of the soil series studied. There are no general recommendations for fertilizers that will fit all farmers needs. The use of general fertilizer recommendations must be discontinued.

3. About half of the Nitrogen must be applied to the crop at planting time. The other half should be applied following planting time but before flowering.

4. In the case of severe Phosphorous deficiencies, we recommend applying phosphorous in bands. It may also be economical to broadcast about half of the P_2O_5 and plow or hoe it in before planting time.

5. In the case of Potash deficiencies, we recommend broadcast application. In order to avoid salt damages, the quantity of N + K_2C applied in bands at planting time should not exceed 180 lbs. per manzana. Because of this factor and due to the lack of adequate fertilizer formulas, we recommend making a broadcast application before planting time of KCl, K_2SO_4, or $(K, Mg)_2(SO_4)_3$ to correct severe potash deficiencies. In these cases, the Potash and Phosphorous should be mixed together, broadcast and then plowed or hoed in before planting time.

6. Crops need potassium before flowering time. Potassium does not move easily in the soil. This element, like phosphorous, should be applied at or before planting time.

Other factors should also be considered. Among these are:

1. Management ability of the farmer. This can decide the total quantities of fertilizer which he should use but should not affect the ratio of plant nutrients employed.

2. Storage or marketing of some 5 times more corn and 4 times more wheat than is now being produced in the area. This implys consideration of the effects of such production increases on unit values of wheat and corn.

Table 14 shows the principal crops of Guatemala, average yields and prices and major production areas and acerages planted. On an average, the picture is pretty dismal. In many areas, more than half of the farmers are using fertilizers -- but most of them are obvicusly using them incorrectly.

TABLE 14. Principal Crops of Guatemala, 1967 and 1968. Average Yields and Values, Extension Planted and Percent Fertilized.

CROP	YIELDS (cwt per acre) and VALUE ($ per cwt)		AREA PLANTED (acres) and % CF AREA FERTILIZED	
CEREALS			1,939,500 acres	45% fertilized
Rice	16 cwt	$4.00 cwt	33,500	20
Corn	9	3.00	1,720,000	45
Altiplain	9		1,310,000	55
Pacific Coast				
1st Planting	11		230,000	25
2nd Planting	7		(60,000)	0
North	4		180,000	0
Wheat	7	5.85	111,000	80
LEGUMES			286,500	10
Beans, dry	6	10.00	263,000	10
HORTICULTURAL			52,000	85
Potato	35.5	5.00	9,500	85
TEXTILE			226,000	65
Cotton				
lint	7.5	20.00	221,000	75
cottonseed	11.5	2.00		
OIL CROPS			50,000	5
Sesame	13	8.00	6,000	40
OTHER CROPS			722,500	65
Banana	55	2.50	47,500	85
Cacao	3.5	18.00	6,000	50
Coffee, dry green	5.5	26.00	442,000	85
Sugar Cane	25 tons	6.50 ton	75,500	60
Rubber	9.5 cwt	15.50 cwt	5,000	5
Tobacco, native	9.5	15.00	8,500	80

What kind of yields and profits can be obtained in some of these areas? Practical commercial results (Table 16 A & B) obtained by farmers participating in the National Soil Fertility Evaluation Program show what can be done to increase farm profits and production in Guatemala. Many of the farmers producing these yields are illiterate campesinos. The breakdown of this data for temperate region corn and wheat and tropical region corn and cotton is presented in Tables 16, 17, 18 and 19.

TABLE 15A. Effects of Following Different Systems for Fertilizer Use in Guatemala

CROP, AVERAGE PRODUCTION (Bu per Acre) and AREA PLANTED	YIELDS (Bu per Acre) and NET PROFIT ($ per Acre), COMMERCIAL PRODUCTION		
	Unfertilized	General Fertilizer Practice (No Soil Analysis)	Fertilized According to Soil Testing Project Recommendations
Corn, highlands (15 Bu per Ac.) 1,310,000 acres	9 to 12 Bu per Ac. $16 to $21	15 to 20 Bu per Ac. $16 to $25	80 to 100 Bu per Ac. $112 to $161
Corn, tropical Pacific coast (18 Bu per Ac.) 231,000 acres	8 to 20 Bu per Ac. $11 to $36	25 to 40 Bu per Ac. - $14 to +$55	75 to 100 Bu per Ac. $72 to $164
Rice (26 Bu per Ac.) 33,600 acres	20 Bu per Ac. $46	26 to 40 Bu per Ac. $49 to $81	60 to 80 Bu per Ac. $103 to $168
Wheat (12 Bu per Ac.) 111,000 acres	4 to 8 Bu per Ac. $14 to $29	12 to 16 Bu per Ac. $23 to $38	48 to 61 Bu per Ac. $133 to $185
Potato, irish (59 Bu per Ac.) 9,500 acres	40 Bu per Ac.	59 Bu per Ac.	450 to 600 Bu per Ac.

TABLE 15B. Summary of Effects of Following Different Systems for Fertilizer Use in Corn, Rice, Wheat and Potatoes in Guatemala.

EFFECT UPON	PRACTICE FOLLOWED		
	Use of General Fertilizer Practice Compared with Using No Fertilizer	USE OF FERTILIZER ACCORDING TO PROJECT RECOMMENDATIONS	
		Compared with Using No Fertilizer	Compared with Using General Practice
Yields	0.25 to 5 - fold increase	3 to 15 - fold increase	1.5 to 10 - fold increase
Net $ Returns per Acre	$50 loss to $ 46 gain	$35 to $157 greater	$ 15 to $178 greater

TABLE 16. Evaluation of the Economic Value of Different Systems of Fertilization Used in the Production of Corn in the Guatemalan Altiplain (1,310,000 acres planted, 55% fertilized).

	UNFERTILIZED	GENERAL PRACTICE	FERTILIZED ACCORDING TO SOIL TEST
Yields (cwt per acre)	5.5 to 7	9 to 12	48 to 60
Gross Value at $3.00 cwt	$16.50 to $21.00	$27.00 to $36.00	$144 to $180
Fertilizer Use and Cost			
N - P_2O_5 - K_2O			
0 - 0 - 0	0		
54 - 54 - 0	-	$10.80	
NPK test			
91 - 127 - 36 DDA			$28.90
110 - 110 - 54 DMA			$29.45
97 - 42 - 42 DAA			$17.15
Cost of Soil Test			$ 0.25
Seed			$ 2.00
NET PROFIT PER ACRE	$16.50 to $21.00	$16.20 to $25.20	$112.30 to $160.60
Range in Farmers Net Return per Fertilizer Dollar for Profits (Losses) He Produces Above Those of Farmers Not Using Fertilizers		($0.44) to $0.81	$3.10 to $8.40
FARMERS LOSS PER ACRE			
A. If He Uses No Fertilizer	$91.30 to $144.10		
B. If He Uses Fertilizer But NOT on the Basis of Soil Test Recommendations		$87.10 to $144.40	

TABLE 17. Evaluation of the Economic Value of Different Systems of Fertilization Used in the Production of Wheat in the Guatemalan Altiplain (111,000 acres planted, 80% fertilized).

	UNFERTILIZED	GENERAL PRACTICE	FERTILIZED ACCORDING TO SOIL TEST
Yields (cwt per acre)	2.5 to 5.0	7 to 9.5	29 to 36.5
Gross Value at $5.85cwt	$14.60 to $29.25	$41.00 to $55.60	$169.60 to $213.50
Fertilizer Use and Cost			
N - P_2O_5 - K_2O			
0 - 0 - 0	0		
73 - 48 - 0		$17.75	
NPK test			
110 - 163 - 54 DDA			$36.40
110 - 108 - 54 DMA			$29.45
110 - 51 - 51 DAA			$28.10
Cost of Soil Test			$ 0.25
NET PROFIT PER ACRE	$14.60 to $29.25	$23.25 to $37.85	$132.95 to $185.15
Range in Farmers Net Return per Fertilizer Dollar for Profits (Losses) He Produces Above Those of Farmers Not Using Fertilizers ----------		($0.34) to $1.31	$2.85 to $6.[illegible]7
FARMERS LOSS PER ACRE			
A. If He Uses No Fertilizer	$103.70 to $170.55		
B. If He Uses Fertilizer But NOT on the Basis of Soil Test Recommendations		$95.10 to $161.90	

TABLE 18. Evaluation of the Economic Value of Different Systems of Fertilization Used in the Production of Corn in the Guatemalan Pacific Coastal Plain (231,000 acres planted, 25% fertilized).

	UNFERTILIZED	GENERAL PRACTICE	FERTILIZED ACCORDING TO SOIL TEST
Yields (cwt per acre)	5 to 12	15 to 24	45 to 60
Gross Value at $3.00cwt	$15.00 to $36.00	$45.00 to $72.00	$135.00 to $180.00
Fertilizer Use and Cost			
N - P_2O_5 - K_2O			
0 - 0 - 0	0		
36 - 36 - 36 or		$10.90	
54 - 54 - 0		$10.80	
NPK test			
75 - 58 - 0 DDA			$15.10
75 - 58 - 0 DMA			$15.10
79 - 24 - 0 DAA			$11.75
Mechanization and Others	$ 0 to $4.20	$4.20 to $48.00	$4.20 to $48.25
NET PROFIT PER ACRE	$10.80 to $36.00	($13.90) to $57.00	$71.90 to $164.00
Range in Farmers Net Return per Fertilizer Dollar for Profits (Losses) He Produces Above Those of Farmers Not Using Fertilizers ----------		($4.58) to $4.28	$2.38 to $13.03
FARMERS LOSS PER ACRE			
A. If He Uses No Fertilizer	$35.90 to $153.20		
B. If He Uses Fertilizer But NOT on the Basis of Soil Test Recommendations		$14.90 to $177.90	

TABLE 19. Evaluation of the Economic Value of Different Systems of Fertilization Used in the Production of Cotton on the Guatemalan Pacific Coastal Plain (221,000 acres planted, 75% fertilized).

	UNFERTILIZED	GENERAL PRACTICE	FERTILIZED ACCORDING TO SOIL TEST
Yields (cwt per acre)			
Seed Cotton (100%)	3 to 9	18 to 24	30
Lint (35%)	1 to 3	6 to 8.5	10.5
Cottonseed (56%)	2 to 5	10 to 13	17
Base Used			
Seed Cotton at $7.00cwt	6	21	30
Lint at $20.00cwt	2	7.5	10.5
Cottonseed at $2.00 cwt	3.5	12	17
Gross Value	$42.00 to $ 47.00	$147 to $174	$210 to $244
Fertilizer Use and Cost			
N - P_2O_5 - K_2O			
0 - 0 - 0	0		
30 - 44 - 17		$11.45	
67 - 103 - 12		$22.10	
NPK test			
91 - 155 - 108 DDD			$32.65
91 - 144 - 36 DDM			$31.45
91 - 100 - 50 DMA			$27.95
91 - 36 - 14 DAA			$18.50
Mechanization and Others	$99.00	$129.00	$129.00
NET PROFIT PER ACRE	($52.00 to $57.00)	($4.10) to $33.55	$48.35 to $96.50
Range in Farmers Net Return per Fertilizer Dollar for Profits (Losses) He Produces Above Those of Farmers Not Using Fertilizer ----------		$2.17 to $7.91	$3.07 to $8.30
FARMERS LOSS PER ACRE			
A. If He Uses No Fertilizer	$100.35 to $153.50		
B. If He Uses Fertilizer But NOT on the Basis of Soil Test Recommendations		$14.80 to $100.60	

Field work has ended and soil sample analyses have been completed for an impact soil testing program ordered by the Minister of Agriculture for the Zacapa-Teculutan horticultural area, over 400 composite farmers samples were collected. The Minister of Agriculture, in a televised program, has announced that such soil testing programs will continue. Plans are to sample the Pacific Coastal Plain and Pacific Slope this year.

V. Fertilizer Guide Sheets;

New fertilizer guide sheets have been prepared for corn and sorghum and for wheat and dryland rice (Tables 20 and 21). We are as yet unable to justify on the basis of experimental data a separate guide sheet for each of these crops.

I have prepared a study of average crop production and wholesale price data for Guatemala to use in making economic fertilizer recommendations (attached). Included in the study are common names in spanish and english, botanical classification, average yields and wholesale value per manzana and per hectare plus wholesale price for more than 140 crops grown in Guatemala. USAID Guatemala has requested 300 copies (distributed) of this report. It has also been sent to ROCAP-AID.

VI. Soil Fertility Evaluation:

At present growth rates, Guatemalas population will increase from 4.5 to over 12 million within the next thirty years. Unexploited areas of potentially productive land are practically exhausted in Guatemala. And those that do remain are located in the humid tropical lowlands of northern Guatemala. In cooperation with USAID-Guatemala, FAO-FYDEP, INTA and the Ministry of Agriculture, we have studied the physical capabilities of agricultural production and are now studying the fertilizer needs of these areas. To date, 1144 samples have been collected by various agencies from these areas and analyzed: all were deficient in nitrogen and only 3.4% had adequate levels of both phosphorous and potash. Over 90 percent were severely deficient in phosphorous and nearly 50 percent were severely deficient in potassium. A field correlation study in savanna soils of the Peten raised yields from 3 to 61 bushels of corn per acre: liming, N, P, K, and minor elements were all needed to produce the 61 bushel yield; poor variety and severe sulphur deficiency were responsible for the less than 100 bushel yield. In these areas, scientific guidelines must be followed. More than 200 samples have been received from the AID-MAg Impact Rice Program area in Northern Guatemala, none of these samples were adequate in both phosphorous and potash; 97.5% were severely deficient in phosphorous and 70% needed corrective applications of potash. Commercially produced yields of rice from this area, using the recommended fertilizer practices plus good seed and pest control have averaged 60 bushels per acre with some instances of 80 bushel yields.

The following soil test summaries have been completed:
1. Summary by Physiographic Area, Soil Series and Physical Capacity for 13,244 samples analyzed from 1 July 1966 to 1 July 1968 (prepared by J.L. Walker & J.A. Gonzalez);
2. Summary for entire country (1 July 1966 to 1 July 1968) by physical capacity (soil depth, slope, drainage, limits to root penetration) (prepared by Walker, Gonzalez and K. J. Daley, Peace Corps volunteer working with the program);
3. Summary of soil test results by physiographic area and soil agricultural capacity for 13,244 farmers samples analyzed from 1 July 1966 to 1 July 1968 (prepared by Walker, Gonzalez and Daley).

Work is nearing completion on the summary by crop for the entire country; by crop within each physiographic area and by crop within each soil series area. A summary has been rough drafted by Dr. Al Plant of plant nutrient deficiency distribution by Municipio and by rainfall area. When completed, these summaries will contain all of the soil test data to the end of 1968.

TABLE 20. Fertilizer Guide Sheet for CORN and SORGHUM. National Soil Fertility Program DGIEA-MAG, Guatemala

Prepared by: Gonzalez, Walker, Plant
Date : 29 I 69 Review Before: 29 I 70.

Element		P O T A S S I U M (K)		
		N - P_2C_5 - K_2C to apply when Soil Test Value is:		
		DEFICIENT	MEDIUM	ADECUATE
PHOSPHORUS	DEFICIENT	total: 110-110-110 BC 0 - 38 - 38 AP 36 - 72 - 72 SD1* 50-0-0 SD2** 24-0-0	110 - 110 - 72 BC 0 - 38 - 0 AP 36 - 72 - 72 SD1* 50-0-0 SD2** 24-0-0	110 - 110 - 36 BC 0 - 38 - 0 AP 36 - 72 - 36 SD1* 50-0-0 SD2** 24-0-0
	MEDIUM	total: 110-72-110 BC 0 - 0 - 38 AP 36 - 72 - 72 SD1* 50 - 0 - 0 SD2** 24 - 0 - 0	110 - 72 - 72 - AP 36 - 72 - 72 SD1* 50 - 0 - 0 SD2** 24 - 0 - 0	110 - 72 - 36 AP 36 - 72 - 36 SD1* 50 - 0 - 0 SD2** 24 - 0 - 0
(X)	ADECUATE	total: 110-36-110 BC 0 - 0 - 50 AP 39 - 39 - 60 SD1* 46 - 0 - 0 SD2** 25 - 0 - 0	110 - 36 - 72 BC 0 - 0 - 36 AP 36 - 36 - 36 SD1* 50 - 0 - 0 SD2** 24 - 0 - 0	110 - 36 - 36 AP 36 - 36 - 36 SD1* 50 - 0 - 0 SD2** 24 - 0 - 0

NOTES

Suggestions are in lbs of N-P_2C_5-K_2C per acre.

Suggested rates are for yield goal of 100 bu per acre.

BC = Broadcast and plow in before planting.

AP = Apply at planting, 5 cm. below and 5 cm. to side of seed.

SD = Side dressing.
SD1* 30 days following planting (for corn, when plant has 8 leaves).
SD2** shortly before flowering.

J. L. Walker

TABLE 21. Fertilizer Guide Sheet for WHEAT and DRYLAND RICE. National Soil Fertility Program DGIEA-MAg, Guatemala

Prepared by: Gonzalez, Walker, Plant
Date: 29 I 69 Review Before: 29 I 70.

Element		P C T A S S I U M (K)		
		N - P_2O_5 - K_2O to apply when Soil Test Value is:		
		DEFICIENT	MEDIUM	ADEQUATE
		total: 66-118-125	66 - 132 - 75	66 - 132 - 38
PHOSPHOROUS (P)	DEFICIENT	BC 0 - 86 - 75 AP 32 - 32 - 50 SD* 34 - 0 - 0 66 - 75 - 125	BC 0 - 57 - 0 AP 38 - 75 - 75 SD* 34 - 0 - 0 66 - 75 - 75	BC 0 - 57 - 0 AP 38 - 75 - 38 SD* 34 - 0 - 0 66 - 75 - 38
	MEDIUM	BC 0 - 35 - 63 AP 40 - 40 - 62 SD* 26 - 0 - 0 66 - 40 - 125	AP 38 - 75 - 75 SD* 28 - 0 - 0 66 - 48 - 75	AP 38 - 75 - 38 SD* 28 - 0 - 0 66 - 38 - 38
	ADEQUATE	BC 0 - 0 - 63 AP 40 - 40 - 62 SD* 26 - 0 - 0	AP 48 - 48 - 75 SD* 18 - 0 - 0	AP 38 - 38 - 38 SD* 28 - 0 - 0

NOTES

Suggestions are in pounds of N - P_2O_5 - K_2O per acre.

Suggested rates are for a yield goal of 60 bu per acre

BC = Broadcast and plow in before planting

AP = Apply at planting

SD* = Side dressing or top dressing 30 to 45 days after planting.

J. L. Walker

II. Technical Assistance

Installed soil crusher. 400 soil samples have been crushed in one day.

Lab analyzed 3800 farmers samples in first three months of 1969 and for the last month has been analyzing 120 samples per day. As predicted, secretarial help is now the big bottleneck.

Repaired and calibrated the flamephotometer and three colorimeters.

Ing. Gonzalez and his staff, Dr. Al Plant of the American Potash Institute and I gave a crash training course to the two new Honduran technicians who are now in charge of the Soil Fertility Evaluation Program in Honduras. Ing. Gonzalez and his staff and Dr. Plant did an excellent job of training on the mechanics of Soil Fertility Evaluation during the two weeks in March when the Hondurans were with us. We held numerous night-time and weekend sessions on running a soil testing laboratory, repair and trouble-shooting on electronic equipment; rapid analyses of soils; interpretation of results; fertilizer recommendations; and, greenhouse correlation studies.

Prepared USAID Airgram on Coffee: Production Problems and Fertilizer Use.

III. General Comments

I had a very enjoyable visit with Jack P. Hanking, General Manager of radio station WELS, Kinston, North Carolina, during mid-March. We taped a radio broadcast featuring Ing. Jorge Gonzalez, Bob Linder (who is our Peace Corps Liaison man) and myself for North Carolina listeners from the Guatemalan Soil Testing Laboratory.

As a result of a days conference given by Ing. Gonzalez and myself to the agronomists of ANACAFE concerning the danger of using general fertilizer recommendations and the possible economic impacts of cooperating in the National Soil Fertility Evaluation Program, ANACAFE has agreed to furnish 20,000 soil sample cartons plus $300 per month (half to be used for salary support and half for the emergency materials fund) to the National Program.

The last of the fertilizer company private labs has been closed with MAEGLI now sending all of its farmers samples to the National Lab. This brings to nine the number of private labs closed since the inauguration of the Modernized multiple analyses soil testing laboratory on July 1, 1966.

TABLE 22.

SALVADORAN SOIL FERTILITY AND ANALYSES PROGRAM
MINISTERIO DE AGRICULTURA Y GANADERIA
DIRECCION GENERAL DE INVESTIGACION Y EXTENSION AGRICOLA

Sección de Suelos - Santa Tecla, El Salvador, C.A.

RESULTS OF ANALYSES FOR PHOSPHOROUS (P) AND POTASH (K) FOR 1968

Soils of:	Number and (%) of Samples	FK DD	DM	DA	MD	MM	MA	AD	AM	AA
Entire Republic	4200	17 (0.4)	96 (2.3)	1477 (35.2)	1	13 (0.3)	278 (6.7)	1	51 (1.2)	2266 (53.9)
Coastal Plain	1905 (45.4)	3 (0.2)	27 (1.4)	469 (24.6)	0	4 (0.2)	129 (6.8)	0	15 (0.8)	1258 (66.0)
Coastal Mountain Range	1117 (26.6)	2 (0.2)	25 (2.2)	485 (43.4)	1 (0.1)	6 (0.5)	77 (6.9)	1 (0.1)	27 (2.4)	493 (44.2)
Interior Valleys	759 (18.1)	4 (0.5)	19 (2.5)	340 (44.8)	0	3 (0.4)	48 (6.3)	0	7 (0.9)	338 (44.6)
Central Mountain Range	279 (6.6)	1 (0.4)	11 (3.9)	108 (38.7)	0	0	17 (6.1)	0	1 (0.4)	141 (50.5)
Northern Mountain Range	113 (2.7)	7 (6.2)	12 (10.6)	64 (56.6)	0	0	7 (6.2)	0	1 (0.9)	22 (19.5)
Unclassified	27 (0.6)	0	2 (7.4)	11 (40.7)	0	0	0	0	0	14 (51.9)

DA - (P) Phosphorous deficient - (K) Potash adecuate

AM - (P) Phosphorous adequate - (K) Potash medium

EL SALVADOR

I. Research.

Ing. Salvador Molina, Head of the Soil Fertility Evaluation Program for El Salvador, reports that:

1. Soil Test - greenhouse correlation studies for the latest group of soils studied gave excellent statistical correlations for phosphorous response at a critical level calculated to be 18 ppm P. Cate-Nelson graphs are now being prepared for this data.

2. Liming resulted in more P-fixation in three of the soil series for which fixation studies were made. These soils, like similar soils in Guatemala, have pH's between 5.5 and 7.0, fix as much as 800 Kg. P per Hectare and have very high extractable Ca contents. Only three samples analyzed during 1968 had exchangeable Al contents greater than 0.5 me. per 100 g. soil.

3. Soil sample analyses have been completed for the Impact Program on the Coastal Plain of El Salvador. A publication of the data is being assembled by Ing. Miguel Menéndez of the University of San Salvador, Ing. Salvador Molina and myself. This publication will contain recommendations for fertilizer use and observations on the occurrence of plow pan in this large area (73,000 hectares) containing over 10% of the total arable land of El Salvador. In spite of widespread public opinion that Nitrogen is the only element that gives a response in this area, of the 1421 samples analyzed 69% were adequate in both P and K but 31% needed the application of P to correct deficiencies of this nutrient. One percent needed corrective applications of both P and K. Soil test results gave excellent correlations with soil series in this area.

None of the plow pan samples had a bulk density in excess of 1.45. Nonetheless, plow pan does exist over much of this area. It is a matter of the amount of non-active porosity caused by the large amount of pumice in these soils. In spite of the low bulk density of these zones, they are quite compact enough to block root penetration below the upper 6 to 10 inches of the soil. Probably, a simple density probe would prove the most useful means of determining compaction that could impede root penetration in these areas. Bulk density figures by themselves do not tell you anything except that the guideline of + 1.7 Db that we use in the U.S. can't be applied here.

4. Ing. Molina and his staff have prepared the 1968 soil test summary by physiographic regions of El Salvador (Table 22). A large number of samples resulting adequate in both P and K is the result of nearly two and a half more farmers samples being received from the Pacific Coastal Plain during 1968 than during 1967. To date slightly less than 55% of the samples received from that area are resulting adequate in both P and K.

5. Ing. Salvador Molina and his staff have prepared a good illustrated bulletin on the Soil Testing Laboratory. The publication contains pictures of the multiple analyses equipment plus graphs and tables showing the origin of the farmers samples analyzed during 1967 according to organization sending in the sample and crop for which fertilizer recommendations were desired.

II. Technical Assistance.

The new soil crusher was installed and in operation three hours after my arrival. When I returned from Honduras I heard that 600 soil samples had been prepared in one day using the new equipment.

The Salvadoran Program has provided educational materials in the form of farm models showing how to take soil samples for the Programs of Guatemala, Honduras and Nicaragua. These models have proven very useful in the training sessions that I have given in each of these countries.

Work is underway on a great soil group map for the Republic. Soil fertility evaluation results will be keyed to this map.

The Soil Fertility Evaluation Laboratory has analyzed more than 4300 farmers soil samples during the first three months of 1969. This is more than the entire number of samples analyzed during 1968. The routine analytical system, in which each member of the laboratory staff is assigned specific duties according to the procedure I worked out last year, has proven very useful according to Ing. Molina. The lab was easily able to use this system to switch from analyzing 110 to analyzing 220 samples per day. The 220 sample per day analytical rate (which includes interpretation and recommendations) was maintained throughout the month of March.

I have repaired the laboratories colorimeter.

III. General Comments:

In spite of the very highly complimentary remarks concerning the Salvadoran Program by Ing. Fernando Robles, FERTICA fertilizer company agronomist, I am concerned over the possible problems that can easily arise in the Salvadoran Program if more secretarila help to work directly with the program is not provided. Two hundred samples analyzed each day represent half that many letters. As has been amply proven in Guatemala, one secretary cannot possibly prepare this many letters a day and at the same time distribute soil sample carton and information sheets, receive the general public, answer phone calls and take care of requisitions and report forms.

HONDURAS

I. Research.

Ing. Vladimiro Castellanos, Dr. Al Plant and myself have summarized all of the Honduras soil test data for the years 1967 and 1968. These data, on a Municipio, crop, and physiographic basis are being put into final form for publication. On the Caribbean Coast, including the Departments of Olancho, Gracias a Dios, Cortez, Santa Bárbara, Yoro, Atlántida and Colón an average of 8 out of every 10 farmers who have sent soil samples to the laboratory had soils deficient in either P or K or both. In the Western Central Region, comprising the Departments of Santa Bárbara, Copán, Lempira and Ocotepeque, an average of four out of every five farmers sending in soil samples required the use of corrective applications of P or K or both. In the Pacific area, in the Departament of El Paraíso 8 out of every 10 samples were deficient in either P or K or both; one of every two samples needed corrective applications of P or K or both in the Department of Valle; and, in the Department of Choluteca, 3 out of every seven samples analyzed low in either P or K or both. Nearly half of the soil samples analyzed come from the Choluteca region. This seriously affects the soil test summary for the entire country though it does reflect the picture of the farmers presently using fertilizer fairly enough. Conclusions regarding the potential plant nutrient needs of areas that are now using very little fertilizer must await more samples. Probably, an Impact Soil Sampling Program similar to those mounted in Guatemala or El Salvador would be the most effective means for quickly ascertaining the plant nutrient status of these areas. To appreciate the impact of the Choluteca area on the soil test summary data, consider the following: for Choluteca, during the years of 1967 and 1968, 1293 samples came from fields that were planted to cotton. Of these samples, 65.2% had adequate P and K levels, requiring the use of N-P_2C_5-K_2O in a 2-1-1 ratio; 16.5% were deficient in phosphorous but adequate in potash and required the use of a 2-4-1 ratio; 12.7% were deficient in both P and K and needed the use of a 2-4-4 ratio and 5.6% had adequate P but low K, indicating the need of a 2-1-4 ratio. Soil Samples falling in this last group generally indicate improper fertilizer use. Also, within the Choluteca area, 352 samples came from a special study area in an INA zone. 92% of these samples had adequate P and K levels.

II. Technical Assistance.

Two weeks were spent with Ing. Vladimiro Castellanos, Head of the Honduras Soil Fertility Evaluation Program, and members of his staff presenting a series of six training sessions whose theme was "Soil Fertility and Analysis for Greater Economic Returns". Technicians from DESARRURAL, the National Development Bank, Peace Corps, General Directorate for Agriculture of the Ministry of Natural Resources, National Agrarian Institute, and agronomists with fertilizer companies participated. During this visit, the areas of Choluteca, Juticalpa, Tegucigalpa, San Pedro Sula, La Ceiba and Santa Rosa de Copán were covered.

Emergency measures have been taken to keep the Honduran Soil Fertility Program functioning following the sudden departure of the two key project lab leaders for other positions. The two new technicians for the Soil Testing Lab and Fertilizer Recommendation sections of the Honduran Program traveled with me to Guatemala on my return trip from Nicaragua. In Guatemala, they received the intense training previously detailed. While they were in Guatemala, we repaired the Honduran Labs electronic equipment. Following this, the Honduran equipment was calibrated against the Guatemalan equipment and the backlog of Honduran soil samples, which we also brought with us, was analyzed by both the Guatemalan and Honduran technicians. Control samples for Honduras were also analyzed to be used in putting the Honduras lab back into operation. We then returned to Honduras: multiple analyses equipment was repaired and put into operation as was the new soil crusher. New attachments were made for the Colorimeter and Flame Photometer which should greatly speed the analytical work involving this equipment. Arrangements were made through Mr. Carrol Deyoe, Development Officer for Agriculture, USAID, Honduras so that in case of future emergency situations arising in the Honduran Program, Ing. Castellanos can communicate directly with my office using STRATCOM facilities. Most problems will probably be solvable in this manner though I anticipate that much more attention will be necessary until such time as sufficient trained personnel are available in Honduras to keep the Honduran program from bogging down. This trouble could have been avoided had the Ministry of Natural Resources allowed its personnel to participate in the summer seminars offered by our project instead of allowing three years to pass since last sending technicians to these training sessions.

III. General Comments.

Comparing 1968 with 1967 (Table II), every country except Honduras in the Northern Central America region showed an increase in number of farmers soil samples analyzed. Unstable budgets for both years made it difficult or impossible to obtain when needed expendible items such as soil analytical reagents, sample cartons and repair parts and maintainence of laboratory equipment and vehicles. Lack of funds for training the technicians responsible for the success of the program plus poor coordination of program efforts, particularly with the extension service (DESARRURAL), all contributed to the poor 1968 showing of the Honduran Soil Fertility Program.

This proves once again, if more proof was needed, that farmers demand prompt and reliable service in soil fertility evaluation analyses. If they don't get it from their Ministry of Natural Resources Laboratory, they will go somewhere else. You can have a well-equipped and well-staffed laboratory but a laboratory is not a program. The Honduran program must be able to count on quick and sympathetic action on the part of the top-level Ministry of Natural Resources officials. Without this support it will surely fail. The economic impact of good Soil Fertility Evaluation Programs is well established. Enough evidence is available from Honduras to clearly show that serious plant nutrient deficiencies occur in every important agricultural area of the country. Low yields from other parts of the country from which no soil samples have been received suggest that in these areas, also, nutrient deficiencies are severely limiting crop production. The economic implications of decisive positive action on the part of the MRN in support of the Honduran program when multiplied by the number of farmers and applied on a national scale are immense compared with the present sorry state of agriculture in the republic. From another point of view, for most farmers the soil samples he sends into the laboratory and the fer-

tilizer recommendations he receives based upon the soil fertility status of those samples represent the only contact he has with the Ministry of Natural Resources during the entire year. What support will he give to the MRN when the fertilizer recommendation from "his" laboratory results in more money in his pockets? But what does he think when weeks or months go by and no reply is received to his request for Soil Fertility Evaluation and Recommendations? Can he be expected to understand that the only two technicians trained to run the program have left for other positions and that there are no experienced persons to replace them? Can he understand why, instead of insuring that the program would not lack well-trained and experienced technicians to keep it running smoothly, the MRN has sent no one for three years to the training seminars on Soil Fertility Evaluation given each summer by the International Soil Fertility Project?

NICARAGUA

I. Research.

Ing. Ramiro Montes, Head of the Nicaraguan Soil Testing Program, has done an excellent job of summarizing the soil analyses results for 1967 and 1968. We have broken these results down by zone, major crop areas from which the samples came within each zone and Department. The summary of analytical results, which is attached, was prepared for use during a series of 8 conferences I gave in Nicaragua during February and March.

During the course of the conferences we had the opportunity to see how many subsamples were really needed to make a representative composite sample of a farmers field. Four different fields were sampled. Samples comprising one, two, four, eight, sixteen and twenty-five cores were collected from each field. In every case, 25 cores were needed to make a representative composite of the field. A lesser number of cores gave results that ranged from 6.2 to 6.8 in pH, 13 to 51 ppm P, and from 220 to 320 ppm K within a single field.

Serious potato production problems exist in the Department of Jinotega. A conference was given to potato growers from this area. Prior to this, the Extension Agent from the Ministry of Agriculture collected samples from several potato fields in the area. The results of this sampling were interesting. Most of the potato growers had never sent samples in to be analyzed. Rather, they had been using 1-2-1 fertilizers for a number of years. 41.7% of the samples were deficient in both phosphorous and potash; 41.7% were high in phosphorous and deficient in potash and 16.6% were adequate in both elements. No samples were found that were low in P and high in K. The summary for the department (334 samples) showed 63.1% deficient in both P and K, 10.5% high in P and low in K, 11.1% deficient in phosphorous and adequate in potash and 15.3% adequate in both elements. With more than 80% of the potato growers fields running deficient in P or K or both, it is not surprising that the growers are finding that their yields are uneconomical.

II. Technical Assistance.

Three weeks were spent during February and March with the Program in Nicaragua. Eight conferences were given in different areas of the country. Emphasis was on the poor economy of using general fertilizer recommendations and on the economic impacts possible through a national soil fertility evaluation program. Ing. Luis Osorio, the Director of the Agricultural Consultation and Training Service of the Ministry of Agriculture, and his very able assistant, Ing. Claudio Perez, did a fine job of coordinating these meetings. One of the important achievements during this period in Nicaragua was the training of the more than 100 agricultural credit agents of the National Bank of Nicaragua and the members of the Extension Service on the importance of taking representative soil samples and the economic returns possible through applying the amounts and types of fertilizers recommended based upon soil analyses. Conferences were also given to the Peace Corps where John Smith and Dave Leonard made excellent contributions to the discussions on how to increase farm income through proper fertilizer use and other good agricultural

practices. The Minister of Agriculture, Dr. Alfonso Lovo C., attended one of the night conferences given for the extension service personnel. We had a highly enlightening exchange of ideas and impressions on fertilizer use in Nicaragua during the several hours that the conference lasted. A special meeting was held for representatives of the fertilizer industry. Attendance was good. As a result, we hope that industry now feels more a part of the National Program and will participate more actively in sending in soil samples, participating in fertilizer guide sheet preparation, and helping to point out and solve any bottlenecks that might develop in maintaining rapid and accurate soil fertility evaluation analyses services.

Ing. Claudio Pérez seems to have the logistical problem of getting the soil samples into the lab well under control. He has worked out with Ing. Roberto Rodríguez, Ing. Silvio Baez, and Ing. Ronald Zelaya of the National Bank of Nicaragua a system whereby soil samples are concentrated in regional centers (either National Bank of Nicaragua or Extension Service centers). A vehicle from Ing. Pérez' organization passes by once a week collecting the farmers samples from each regional center at the same time dropping off the soil test results for the samples brought in during the previous week

Several thousand soil samples have already been collected and analyzed during the cooperative Impact Program organized by Ing. Osorio's division of the Ministry of Agriculture in cooperation with the National Bank of Nicaragua.

Ing. Mayo Vega, the new head of the Agronomy Department of the La Calera experiment Station of the Ministry of Agriculture, is coordinating the correlation studies which are the indespensible research foundation necessary for the success of the National Soil Fertility Evaluation Program. In addition, he will be coordinating the meetings necessary to improve the fertilizer guide sheets for important crops grown in Nicaragua.

During my visit in Nicaragua, I also had an opportunity to work in the lab with Ing. Montes. The colorimeter was repaired, as was the Multiple Analyses pH meter. The phosphorous procedure was speeded up through a method making better use of the multiple analyses equipment.

NICARAGUA - FEB. 69

RESULTADOS DE ANALISIS DE SUELOS 1967/68 - (9,773 MUESTRAS)

POR ING. RAMIRO MONTES V., JEFE, DEPARTAMENTO DE QUIMICA, CENTRO EXPERIMENTAL AGROPECUARIO Y

DR. JAMES L. WALKER, DIRECTOR REGIONAL, PROYECTO INTERNACIONAL DE FERTILIDAD DE SUELOS

"LA CALERA". MINISTERIO DE AGRICULTURA Y GANADERIA. NICARAGUA, C. A.

ZONA	CULTIVOS SEMBRADOS SEGUN MUESTRAS	DEPARTAMENTO	NUMERO DE MUESTRAS	NECESITAN CORRECCION DE DEFICIENCIAS DE P o K: DE P SI, DE K SI	DE P SI, DE K NO	DE P NO, DE K SI	DE P NO, DE K NO	NUMERO DE AGRICULTORES QUE TIENEN QUE CORREGIR DEFICIENCIAS DE P o K o de P y K
PACIFICO (SUR)	MAIZ, ARROZ, PASTOS, CAÑA	RIVAS	450	21.8%	7.6%	14.6%	56.0%	4 DE CADA 9
	MAIZ, ARROZ, FRUTALES	CARAZO	310	35.5%	53.2%	1.9%	9.4%	9 DE CADA 10
	ALGODON, ARROZ, MAIZ	GRANADA	435	40.0%	38.2%	6.4%	15.2%	6 DE CADA 7
	MAIZ, ALGODON, HORTALIZAS	MASAYA	521	22.4%	52.8%	1.9%	22.9%	3 DE CADA 4
PACIFICO (NORTE)	ALGODON, MAIZ, HORTALIZAS	MANAGUA	1277	23.7%	53.7%	2.6%	20.0%	4 DE CADA 5
	ALGODON, PASTOS	LEON	461	28.6%	27.1%	19.1%	25.2%	3 DE CADA 4
	ALGODON, MAIZ, AJONJOLI	CHINANDEGA	1123	24.0%	56.9%	5.7%	13.4%	8 DE CADA 9
TOTALES			4577	26.3%	45.6%	6.5%	21.6%	
CENTRAL (SUR AL NORTE)	MAIZ, PASTOS	CHONTALES	559	74.8%	7.3%	7.3%	10.6%	9 DE CADA 10
	MAIZ, SORGO, HORTALIZAS	BOACO	236	53.8%	14.8%	21.2%	10.2%	9 DE CADA 10
	MAIZ, FRIJOL, CAFE	MATAGALPA	1302	53.5%	13.4%	16.1%	17.0%	5 DE CADA 6
	MAIZ, FRIJOL, SORGO	ESTELI	876	36.4%	11.9%	26.7%	25.0%	3 DE CADA 4
	MAIZ	JINOTEGA	334	63.1%	11.1%	10.5%	15.2%	6 DE CADA 7
	MAIZ, FRIJOL	MADRIZ	663	37.0%	17.1%	16.6%	29.3%	7 DE CADA 10
	MAIZ, FRIJOL, ARROZ	NUEVA SEGOVIA	846	67.0%	9.0%	13.6%	10.4%	9 DE CADA 10
TOTALES								
ATLANTICO (SUR AL NORTE)	PASTOS, ARROZ, MAIZ	RIO SAN JUAN	65	90.8%	6.1%	4.6%	1.5%	T O D O S
	FRUTALES, ARROZ, MAIZ	ZELAYA	315	98.7%	1.0%	0.0%	0.3%	T O D O S
	? ?	COMARCA DE EL CABO	0	?	?	?	?	?
TOTALES								

PROMEDIO BRUTO DEL RENDIMIENTO AGRICOLA

(Average Crop Production and Average

Y

ECIO POR UNIDAD POR MAYOR EN GUATEMALA, CENTROAMERICA

Wholesale Price Data for Guatemala, Central America)

1968

Por (By)

Dr. James L. Walker, Regional Director
International Soil Testing Project
North Carolina State University, Raleigh
Agency for International Development
Contract csd-287

INTRODUCTION

This table is a first approximation in gathering data on general crop production and values in Guatemala. It was prepared for use experimentally in a system for making fertilizer recommendations according to three factors:

1. Correction of plant nutrient deficiencies shown by soil test results;
2. Value of the crop to be produced, and;
3. How well the farmer manages; that is, does his past performance suggest he will be below, at, or well above average production levels for the crop he plans growing.

As Cate* has demonstrated, adequate consideration of the last two factors plus costs of fertilizers can guide us on how much a farmer can economically safely invest to correct plant nutrient deficiencies. The soil test results and the crop needs can then guide our recommendations on how to distribute the fertilizer investment.

An attempt has been made to list the common names for each crop in both english and spanish and a short description has been attempted for crops that are uncommon or unknown in the mainland United States. Were my foresight as clear as my hindsight, I would have placed the word "average" in the colum titled "wholesale price" because for many crops (tomatoes are a good example) the price range may fluctuate greatly around the average. My spanish and english speaking friends will realize, I hope, that I am neither language expert, botanist, nor agricultural economist. I am, however, responsible for any errors or omission of facts in the data attached. Your criticisms and suggestions for modifications are welcome.

---

*Cate, R. B., ISTP/NCSU/AID csd-287, personal communication.

PROMEDIO BRUTO DEL RENDIMIENTO AGRICOLA Y PRECIO POR UNIDAD POR MAYOR EN GUATEMALA, C.A. 1968 1/

(Average Crop Production and Price Data for Guatemala, Central América, 1968)

Dr. James L. Walker, International Soil Testing Project, N.C. State Univ./AID-csd 287

Revisado: 1/14/69

Cultivo (Crop) Nombres Comunes	Nombre Botánico (Botanical Name)	Rendimiento Bruto Promedio (Average Production) Mz(1.6 acres)	Ha(2.2 acres)	Precio por Mayor (Wholesale Price)	Unidad (Unit)	Valor Bruto Por (Crop Wholesale Value per) Manzana(Mz)	Hectare(Ha)
I. Fuentes para Nutrición Humana (Food Crops):					qq (cwt)		
A. Granos y Vegetales (Grains and Vegetables):							
Acelga (swiss chard)	Beta vulgaris	85 qq	123 qq	Q. 3.00		Q. 255.00	Q. 369.00
Ajo (garlic)	Allium sativum	68	98	15.00		1020.00	1470.00
Alcachofa (artichoke)	Cynara Scolymus	20	29	20.00		400.00	580.00
Apio (celery)	Apium graveolens v. dulce	71	103	9.00		639.00	927.00
Arroz (rice, dryland)	Oryza sativa	26	37	4.00		104.00	148.00
Arveja, Guisante (green pea)	Pisum sativum	10	14.5	6.00		60.00	87.00
Avena (oats)	Avena sativa	15.5	22	18.00		279.00	396.00
Ayote (crook-neck squash; cuhaw)	Cucurbita moschata	47	68	2.50		117.50	170.00
Berenjena (egg plant)	Solanum melongena	65	68	3.00		195.00	282.00
Berro (watercress)	Nasturtium officinale v. aquaticum; Roripa Nasturtium-aquaticum	38	55	12.00		456.00	660.00
Bledo (amaranthus; pigweed)	Amaranthus sp.	80	116	20.00		1600.00	2320.00
Brócoli (broccoli)	Brassica oleracea v. italica	52	75	8.00		416.00	600.00
Camote; batata (sweet potato)	Ipomoea batatas	23	33	6.00		138.00	198.00
Cebada (barley)	Hordeum vulgare	4	6	15.00		60.00	90.00

1/ Para usarse con la tabla "Guía para hacer recomendaciones para Fertilizantes según Ganancia Esperada y Resultado de Análisis de Muestras de Suelo", J.L. Walker, 1968.

Guatemala-Promedio Bruto del Rendimiento Agrícola (Contd.)
J.L. Walker - ISTP/HCSU/AID

Cultivo (Crop) Nombres Comunes	Nombre Botánico (Botanical Name)	Rendimiento Bruto Promedio (Average Production) Mz(1.6 acres)	Ha(2.2 acres)	Precio por Mayor (Wholesale Price)	Unidad (Unit)	Valor Bruto Por (Crop Wholesale Value per) Manzana(Mz)	Hectare (Ha)
Cebolla (onion)	Allium Cepa	125	181	Q. 4.00	qq (cwt)	Q. 500.00	Q. 724.00
Centeno (rye)	Secale cereale	6	8.5	——		——	——
Chilacayote (melabargourd. Squash family, appears like watermelon with white stripes)	Cucurbita ficifolia	43	62	1.00		43.00	62.00
Chile chamborote (redpepper, tabasco)	Capsicum frutescens	4.5	6.5	160.00		720.00	1040.00
Chile chiltepe (round hot pepper, pea-size)	C. frutescens v. baccatum	23	33	30.00		690.00	990.00
Chile chocolate (dark brown, dry and hot)	C. annuum accuminatum	8.5	12.3	55.00		467.50	676.50
Chile güaque (dry, red and hot)	C. annuum var. longum	40	58	75.00		3000.00	4350.00
Chile jaiba	C. sp.	40	58	75.00		3000.00	4350.00
Chile Jalapeño (green, hot; for Jalapeñas)	C. pubescens	30	43.5	30.00		900.00	1305.00
Chile pasa (for tamales)	C. annuum v. grossum	15	21.7	120.00		1800.00	2604.00
Chile pimiento (verde)(bell or sweet pepper)	C. annuum	80	115	7.00		560.00	805.00
Col de Bruselas (brussels sprouts)	Brassica oleracea v. gemmifera	40	57.5	10.00		400.00	575.00
Coliflor (cauliflower)	Brassica oleracea v. botrytis	250	362.5	2.00		500.00	725.00
Colinabo (kohlrabi)	B. rapa; B. caulorapa	8	11.6	8.00		64.00	92.00
Ejote (beans, green or string)	Phaseolus vulgaris	5	7.6	4.00		20.00	30.50
Elote (sweet cob corn)	Zea mays	40	57.5	8.00		320.00	460.00
Espinaca (spinich)	Spinacia oleracea	95	138	2.00		190.00	276.00
Frijol (dry, pinto, black, kidney beans)	Phaseolus vulgaris	10	14.5	10.00		100.00	145.00

Guatemala-Promedio Bruto del Rendiniento Agrícola (Contd.)
J.L. Walker - ISTP/NCSU/AID

Cultivo (Crop) Nombres Comunes	Nombre Botánico (Botanical Name)	Rendimiento Bruto Promedio (Average Production) Mz(1.6 acres)	Ha(2.2 acres)	Precio por Mayor (Wholesale Price)	Unidad (Unit)	Valor Bruto por (Crop Wholesale Value per) Manzana(Mz)	Hectare (Ha)
Garbanzo (gram, garbanzo, chickpea)	Cicer arietinum	5 qq.	7 qq.	Q. 18.00	qq (cwt)	Q. 90.00	Q. 126.00
Güicoy (acorn squash(segmented skin); pumpkin, bush squash)	Cucurbita pepo	38	55	3.00		104.00	165.00
Güisquil (chayote; vegetable pear; chuchu; christophine; mirliton)	Sechium edule	80	116	1.50		120.00	174.00
Haba (european broad bean)	Vicia faba	5	7	12.00		60.00	84.00
Ichintal (güisquil root)	Sechium edule	6	9	13.00		78.00	117.00
Izote, Flor de (yuca flower)	Yucca elephantipes	30	43.5	6.00		180.00	261.00
Lechuga (lettuce)	Lactuca sativa	150	217.5	2.50		375.00	544.00
Lenteja (lentils)	Lens esculenta	7.3	10.5	18.00		131.50	189.00
Maicillo o Sorgo (Sorghum)	Sorghum vulgare	8.5	12	2.75		23.00	33.00
Maíz (field corn)	Zea mays	15	21	3.00		45.00	63.00
Malanga (taro, dasheen; yautia; tanier)	Colocasia antiquorum; C. esculenta; xanthosoma sagitfifolium	150	210	3.00		450.00	630.00
Maní, cacahuate (peanuts)	Arachis hypogaea	19	27	10.00		190.00	270.00
Miltomate (husk tomato, ground-cherry)	Physalis pubescens	60	87	3.00		180.00	261.00
Nabo (turnip)	Brassica campestris	85	123	2.50		212.50	307.50
Ocre u okra (okra)	Hibiscus esculentus	25	35	10.00		250.00	360.00
Pacaya (flower of pacaya palm, ear-corn shape)	Chamaedorea sp.	17	24.6	22.00		374.00	541.00
Papa o patata (white potato)	Solanum tuberosum	59	85.5	5.00		295.00	427.50
Pepino (cucumber)	Cucumis sativus	84	122	2.50		210.00	305.00
Perejil (parsley)	Petroselinum crispum; P. hortense	50	70	10.00		500.00	700.00

Guatemala-Promedio Bruto del Rendimiento Agrícola (Contd)
J.L. Walker - ISTP/NCSU/AID

Cultivo (Crop) Nombres Comunes	Nombre Botánico (Botanical Name)	Rendimiento Bruto Promedio (Average Production) Mz(1.6 acres)	Ha(2.2 acres)	Precio por Mayor (Wholesale price)	Unidad (Unit)	Valor Bruto Por (Crop Wholesale Value per) Manzana(Mz)	(Hectare(Ha)
Perulero (güisquil variety, small, white, smooth)	Sechium edule var.	95 qq	138 qq	Q. c6.25	qq (cwt)	Q. 594.00	Q. 862.50
Puerro (leek)	Allium porrum	84	122	23.00		1932.00	2806.00
Rábano (radish)	Raphanus sativus	52.5	76	6.00		315.00	456.00
Remolacha (beet)	Beta vulgaris	80	116	2.00		160.00	232.00
Repollo o col (cabbage)	Brassica oleracea v. capitata	250	362.5	1.50		375.00	544.00
Tomate (tomato)	Lycopersicon esculentum; Solanum lycopersicum	108	156.6	3.50		378.00	548.00
Trigo (wheat)	Triticum vulgare; T. aestivum.	12	17	5.85		72.00	102.00
Yuca (manioc, cassava)	Manihot utilissima	156	226	3.00		468.00	678.00
Zanahoria (carrot)	Daucus carota	184	267	3.00		552.00	801.00
IB. Frutas (Fruits)							
Acerola (acerola, Barbados cherry; vitamin C production)	Malpighia glabra	5	7	55.00		275.00	385.00
Aguacate, palta (avocado)	Persea americana, P. gratissima	353	512	8.00		2824.00	4096.00
Anona (blanca); chirimoya (bullocks heart; custardapple; cherimoya; sweet sop)	Annona cherimola; A. squamosa; A. reticulata	105	152	46.00		4830.00	6992.00
Banano (banana)	Musa sapientum; M. cavendishii	92.4	134	2.50		231.00	335.00
Cainito (star-apple; both green and purple; cainito)	Chrysophyllum Cainito	30	43.5	46.00		1380.00	2001.00
Cereza, capulín (cherry)	Prunus Capuli, P. salicifolia	8.5	12	15.00		127.50	180.00
Chico o Chicc Zapote (sapodilla; fruit of chewing-gum tree)	Achras Zapota	15.5	22	41.70		646.50	917.50

Guatemala-Promedio Bruto del Rendimiento Agrícola (Contd.)
J.L. Walker - ISTP/NCSU/AID

Cultivo (Crop) Nombres Comunes	Nombre Botánico (Botanical Name)	Rendimiento Bruto Promedio (Average Production) Mz(1.6 acres)	Ha(2.2 acres)	Precio por Mayor (Wholesale Price)	(Unidad) (Unit)	Valor Bruto por (Crop Wholesale Value per) Manzana(Mz)	Hectare (Ha)
Ciruela (spanich plum, red, small, smooth skin)	Prunus domestica, P. salicina	50 qq	72.5 qq	Q. 8.00	qq (cwt)	Q. 400.00	Q. 580.00
Coco (coconut)	Cocos nucifera	3760 nuezas	5452 nuezas	4.00/100 nuts		150.50	218.00
Durazno; Pavías, Melocotón (clingstone peach, native)	Prunus Persica	78 qq	113 qq	10.00		780.00	1130.00
Fresa (strawberry)	Fragaria spp.	20	29	20.00		400.00	580.00
Granada (pomegranate)	Punica granatum	17	24.6	16.00		272.00	393.50
Granadilla (passion fruit)	Passiflora ligularis; P. quadrangularis	43	62	18.00		774.00	1116.00
Guanaba; Guanábana (soursop)	Annona muricata	5.5	8	45.00		247.50	360.00
Higo, higueras (fig)	Ficus Carica	10	14.5	10.00		100.00	145.00
Injerto, ingerto, zapote verde o Raxtul (ingerto zapuyul; green sapote; smooth green skin, red-orange flesh)	Calocarpum viride	138	200	10.00		1380.00	2000.00
Jocote, Jobo (Spanish plum, yellow hombin	Spondias mombin, S. Lutea	160	232	25.00		4000.00	5800.00
Jocote corona (Spanish plum, red hombin; rough red skin)	Spondias purpurea	10	14.5	22.00		220.00	300.00
Lima (lime, sweet)	Citrus medica linetta	42	61	5.00		210.00	305.00
Lima limón	C. spp.	87	126	3.00		261.00	378.00
Limón (lime, sour)	C. medica acida; C. aurantiifolia	90	130.5	4.15		373.50	541.50
Limón Real (Juice lime)	C. medica; C. limon	81	117	5.00		405.00	585.00
Mamey (zapote mamey, mammee apple)	Mammea americana	55	80	30.00		1650.00	2400.00
Mandarina (tangerine; mandarine)	Citrus reticulata	50	72.5	6.00		300.00	435.00
Mango (mango)	Mangifera indica	150	217.5	3.00		450.00	652.50

Guatemala-Promedio Bruto del Rendimiento Agrícola (Contd.)
J.L. Walker - ISTP/NCSU/AID

Cultivo (Crop) Nombres Comunes	Nombre Botánico (Botanical Name)	Rendimiento Bruto Promedio (Average Production) Mz.(1.6 acres)	Ha(2.5 acres)	Precio por Mayor (Wholesale Price)	Unidad (Unit)	Valor Bruto por (Crop Wholesale Value per) Manzana(Mz)	Hectare(Ha)
Manzana (apple)	Pyrus malus, Malus sylvestris	150 qq	217.5 qq	Q. 10.00	qq (cwt)	Q. 1500.00	Q. 2175.00
Manzanilla (crab-apple)	Crataegus pubescens	100	145	30.00		3000.00	4350.00
Marañón, jocote (marañon, cashew fruit)	Anacardium occidentale	42.5	61.6	3.00		127.50	185.00
Melón (musk melon)	Cucumis Melo	80	116	5.00		400.00	580.00
Membrillo (quince)	Cydonia vulgaris; C. oblonga	16	23	7.00		112.00	161.00
Mora, zarzamora (blackberry)	Rubus spp.	6	8.7	8.00		48.00	69.50
Nance (nanche; golden spoon; small, bright yellow "cherry")	Brysonima crassifolia	50.5	73	20.00		1010.00	1460.00
Naranja (sweet orange)	Citrus sinensis	650	942.5	8.00		5200.00	7540.00
Naranja agria (sour orange)	C. Aurantium birgaradia	14.5	21	6.40		92.00	134.50
Níspero (de Japón o ciruelo japonés (Sapodilla Loquat)	Eriobotrya japonica	69.5	101	—		—	—
Papaya (papayá)	Carica papaya	45	65	2.00		90.00	130.00
Paterna (aril, food inga)	Inga spectabilis	10	14.5	9.00		90.00	130.50
Pera (pear)	Pyrus communis	68	98.6	13.20		897.50	1301.50
Perote, manzana común (native apple)	Malus sylvestris	10	14.5	16.00		160.00	232.00
Piña (pineapple)	Ananas sativus; A. comosus	210	304.5	2.00		420.00	609.00
Pitahaya, pitaya (night-blooming cereus fruit)	Hylocereus undatus	9	13	20.00		180.00	260.00
Plátano (plantain)	Musa paradisiaca; M. sinensis	380 bunches*	213 qq	3.00		639.00	927.00
Sandía (watermelon)	Citrullus vulgaris	250 qq	362.5	2.50		625.00	906.00
Tamarindo (tamarind)	Tamarindus indica	163	236	7.00		1141.00	1652.00

* Bunches = 25 kilos (56 libras) = 213 quintales.

Cultivo (Crop) Nombres Comunes	Nombre botánico (Botanical Name)	Rendimiento Bruto Promedio (Average Production) Mz(1.6 acres)	Ha(2.5 acres)	Precio por Mayor (Wholesale price)	Unidad (Unit)	Valor Bruto por (Crop Wholesale Value per) Manzana(Mz)	Hectáre(Ha)
Toronja (grapefruit)	Citrus maxima; C. paradisi	416qq	603 qq	Q. 3.00 qq	qq (cwt)	Q. 1248.00	Q. 1809.00
Tuna (prickly pear fruit)	Nopalea sp.	8	11.6	8.00		64.00	98.00
Uva (grape)	Vitis sp.	5	7	—		—	—
Zapote, nanney. colorado (red fruit, brown rough skin, large black seed)	Calocarpum mammosum, Lucuma mammosa	75.5	109	16.00		1208.00	1744.00

II. Otros Cultivos, Exportables y Tradicionales, Incluendo Especias, Oleaginosas y Textiles.
(Other Crops, both Export and Traditional including spices, oils and textiles.)

Aceite de Citronela (citronella grass oil)	Cymbopogon nardus	164 lbs.(4 cortes)	237.8 lbs.	0.50 lb.		82.00	119.00
Aceite de té de limón (lemon grass oil)	C. citratus	196 " "	284 "	1.20 "		235.00	341.00
Achiote o Annato (dark red food coloring, annetto dye)	Bixa orellana	16 qq	23 qq	25.00 qq		400.00	575.00
Ajonjolí (sesame)	Sesamum indicum	22	32	10.00		220.00	320.00
Algodón rama (cotton, unginned)	Gossypium sp.	35	50	—		—	—
Algodón oro (ginned)	———	12.5	18	28.00		350.00	504.00
Algodón semilla (cottonseed)	———	19	27	3.00		57.00	81.00
Alpiste (canary-grass, birdseed)	Phalaris canariensis	18	26	—		—	—
Anís (anise)	Pimpinella anisum	22	31	80.00		1760.00	2480.00
Arboles de navidad (Christmas trees)	Coniferae	—	—	3.00 por metro		—	—
Cacao (cocoa; beans for chocolate)	Theobroma cacao	5.5	8	18.00		99.00	144.00
Café (pergamino) (coffee, dried unhusked)	Coffea arabica	9	13	26.00		234.00	338.00
Caña (para azúcar)(sugar cane)	Saccharum officinarum	42ton.caña	60.9 ton.caña	6.50 ton.caña		273.00	396.00
		74qq. azúcar	107 qq. azúcar	8.00 qq. azúcar		592.00	856.00

Cultivo (Crop) Nombres Comunes	Nombre Botánicos (Botanical Names)	Rendimiento Bruto Promedio (Average Production) Mz(1.6 aceres)	Ha(2.5 acres)	Precio por Mayor (Wholesale Price)	Unidad (Unit)	Valor Bruto por (Crop Wholesale Value per) Manzana(Mz)	Hectare(Ha)
Caña (para panela) (brown raw sugar, native producers)	Saccharum officinarum	17 cargas de 400 lbs. 68 qq	24 cargas 98.6 qq	8.50 qq.	qq (cwt)	Q. 578.00	Q. 838.00
Caña de Castilla o de Casa (uva-grass, native huts)	Gynerium sagittatum	8	11.6	——		——	——
Caña fístula (golden-shower tree; used for laxative production)	Cassia fistula	80 qq. caña	116	20.00		1600.00	2328.00
Cardamomo (cardamon, spice)	Elettaria cardamomum	6 qq	8.5 qq.	3.16 lb		1896.00	2686.00
Chicle (latex for chewing gum)	Achras Zapota	1.5 lb/árbol/año 120,000 qq.	174,000 qq.	73.00 qq. látex seco		8,760,000.00*	12,702,000.00*
Cilantro, culantro (coriander)	Coriandrum sativum	7.5 qq	10.8 qq	40.00		300.00	432.00
Corozo (oil palm, cohune)	Crbignya cohune	68 lbs	98.6	0.05 lb		3.50	5.00
Flores (flowers, commercial)	——						
Girasol (sunflower, Texas com)	Helianthus annuus	10 qq semilla	14.5	6.00 qq semillas		60.00	87.00
Hierba buena (mint, peppermint)	Mentha piperita	15 qq	22	40.00		600.00	880.00
Higuerillo, ricino (castor bean)	Ricinus communis	6 qq	8.7	12.00		72.00	104.50
Hule, caucho (rubber, latex crude cure)	Hevea brasiliensis	16	23	20.50		328.00	471.50
Jengibre (ginger root)	Zingiber officinale	12	17	12.00		144.00	204.00
Kenaf (kenaf fibre, sacks)	Hibiscus cannabinus	25	36	13.00		325.00	468.00
Laurel (bay leaf, spice)	Litsea guatemalensis	8	11.5	40.00		320.00	460.00
Linaza, lino (linseed)	Linum usitatissimum	3	4.4	60.00		180.00	250.00
Maguey, Henequen o sisal (henniquen, sisal)	Agave sp.	11.5	16.5	——		——	——

* Producción de unos 8 millones de árboles de el Petén, los cuales pueden ser cortados una sola vez cada seis años.

Guatemala-Promedio Bruto del Rendimiento Agrícola (Contd)
J.L. Walker - ISTP/NCUS/AID

Cultivo (Crop) Nombres Comunes	Nombre Botánico (Botanical name)	Rendimiento Bruto Promedio (Average Production) Mz(1.6 acres)	Ha(2.5 acres)	Precio por Mayor (Wholesale price)	Unidad (Unit)	Valor Bruto por (Crop Wholesale Value per) Manzana(Mz)	Hectare(Ha)
Maxan, hojas de, o platanillo o bijao (leaf used for wrapping)	Calathea macrosepala	45 cargas	65 cargas	Q. 10.00	qq (cwt)	Q. ———	Q. ———
Mimbrera o mimbre (willow, used for baskets)	Salix fragilis	16 qq	23 qq	———		———	———
Orégano (marjoram or spanish thyme, oregano spice)	Coleus amboinicus	42	60	40.00		1680.00	2400.00
Pimienta gorda (allspice)	Pimenta officinalis	———	———	70.00 qq		———	———
Pimienta negra (black pepper)	Piper nigrum	20	29	70.00		1400.00	2030.00
Quina o cinchona (bark for quinine production)	Cinchona officinalis	22	32	———		———	———
Romero (rosemary, spice)	Rosmarinus officinalis	8	11.6	———		———	———
Rosa de Jamaica (sorrel, spice)	Hibiscus sabadariffa	8	11.6	———		———	———
Soya (soybean)	Glycine Max	14	20	8.00		112.00	162.00
Tabaco (tobacco)	Nicotiana tabacum	16	23	15.00		240.00	348.00
Té seco (tea)	Thea sinensis	—	—	———		———	———
Tzibac o Civac (pith of rushes for weaving baskets)	Typha sp.	12.5	18	40.00		500.00	725.00
Vainilla (vanilla)	Vanilla panifolia	6 qq dry pods	8.7	500.00		3000.00	4350.00

EZG

REFERENCES:

A. Average yields and prices calculated from data furnished by:

1. Ministry of Agriculture, Department of Agricultural Statistics; Direction General of Agricultural Marketing; Direction General of Agricultural Research & Extensión.

2. USAID/Agricultural Division, U.S. Embassy, Guatemala.

4. ISTP/North Carolina State Univ./AID, Regional Office for Central América.

B. 1. Bailey, L.H. and E.Z., 1930, Hortus, 652 pp., Ill., MacMillan Co., N.Y.

2. McBryde, F.W., 1947, Cultural and Historical Geography of Southwest Guatemala, 184 pp. Ill., Smithsonian Institution, Institute of Social Anthropology, No. 4.

3. Rojas, V., 1936, Elementos de Botánica General, Tomo III. 984 pp., Ill., Tipografía Nacional, Guatemala, C.A.

4. Valle D., A., 1965, Aspectos Sobre Fertilización de los Principales Cultivos Económicos, 393 pgs. typed, Bank of Guatemala, C.A.

5. Personal communications:

Atlee, C.B., Horticulturalist, USAID, Am. Emb., Guatemala

González S., J., Agronomist, Dep. Soils, DGIEA, Min. Agr., Guatemala

Juárez, J.L., Agronomist, FERTICA, S.A., Guatemala

Troutner, W.R., Ag. Economist, USAID-Cal. Poly. Contr., Am. Emb., Guatemala

Valle D., A., Agronomist, Agro-Químicas de Guatemala, S.A.

Wyld, J., Chemist, Dept. Soils, DGIEA, Min. Agr., Guatemala

RBG

NORTHERN CENTRAL AMERICA PROGRESS REPORT - March, 1969 J. L. Walker

- ADDENDUM and CORRECTIONS -

Page 6, Paragraph 2, Line 2:

Instead of: "A dollar spent on fertilizer for correcting ---------- applications are necessary."

Read: "A dollar spent on fertilizer ($N+P_2O_5+K_2O$) for correcting plant nutrient deficiencies should produce two to three dollars of profit."

Page 6, Table 9:

Instead of: "Additional Investment in $P_2O_5+K_2O$ ---------- levels."

Read: "Total Investment in $P_2O_5+K_2O$ ---------- levels."

Page 9:

Insert second paragraph as follows: "This approach to estimating potential fertilizer needs in the Northern Central American area is both realistic and conservative: Firstly, Nitrogen is held static at 1968 consumption levels and the P_2O_5 and K_2O necessary to maximize return on the $N+P_2O_5+K_2O$ dollar are to be made available. Secondly, more dollar yield will result from the use of the additional P_2O_5 and K_2O applied according to soil fertility analyses. This will increase cash available and demand for complete fertilizers will grow accordingly. Thirdly, each farmer using fertilizers for producing profits has at least two neighbors who will be influenced by his success to invest their plant nutrient dollars logically through soil fertility analyses. This will also increase $N-P_2O_5-K_2O$ demand. Soil fertility analyses results show that Northern Central American farmers are far from maximizing their profits on the money invested in fertilizers. At best, only three-out-of-every-ten farmers can hope to be anywhere close to maximum profit on the dollar invested in plant nutrients under present conditions. These are the 28% who need only maintenance and starter applications of phosphorous and potash in addition to the Nitrogen needed to produce the crop. At the present low levels of P_2O_5 and K_2O consumption in the region, enormous sums of money are being lost. Data for some of the important crops in Guatemala are presented in Tables 15 through 19 (pages 15 through 19) of this report. This conservative evaluation shows that just on the Altiplain of Guatemala, on the area presently fertilized, incorrect fertilizer use on corn and wheat alone is now costing the country at least $7.25 million in potential revenue lost each time these crops are harvested. Can we expect that the picture in any of the other countries of the region is any better?"

Page 9, Paragraph 4:

Instead of: "The number of soil samples analyzed is exceedingly low ---------- for soil fertility analyses."

Read: "The number of soil samples analyzed is exceedingly low in relation to the amount of money invested in fertilizers in every country except Guatemala."