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FERTILIZER USE IN HAITI

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I T I N E R A R Y

October 18, 1973	Travel from Muscle Shoals to Port-au-Prince.
October 19	Briefing with USAID officials.
October 20	Trip to Kenscoff area.
October 21	Reviewed reports.
October 22	Aerial trip over northern coast, Artibonite Valley, Port-de-Paix and Central Plateau
	Trip to the Israel Mission in Cul-de-Sac area.
October 23	Briefing with DANRDR at Damien. Worked on report.
October 24	Visited Taiwan Mission in Artibonite Valley.
October 25	Interview with fertilizer importers in Port-au-Prince.
October 26	Visited IHPCADE and HASCO officials. Worked on report.
October 27	Worked on report.
October 28	Worked on report.
October 29	Visited Venezuelan Ambassador. Worked on report.
October 30	Discussion with extension and research personnel of DANRDR. Worked on report.
October 31	Debriefing with USAID.
November 1, 1973	Return to Muscle Shoals, Alabama.

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SUMMARY OF RECOMMENDATIONS

1. Haitian officials are forewarned of tight fertilizer supplies in the next 2-3 years and that prices are likely to increase.
2. Fertilizer must continue to be imported in bags for the present.
3. Some 25-kg bags of fertilizer should be imported rather than the current practice of importing only 50-kg or 100-pound bags.
4. IHPCADE should help coffee producers shift from a 10-5-20 with 1 percent MgO fertilizer to a higher analysis such as 14-7-28 with 1.4 percent MgO.
5. A privately-owned fertilizer bulk blending plant should be considered when fertilizer use reaches 20,000 to 25,000 tons annually.
6. Present technical expertise in the fertilizer import business should be used in training and promotion programs to help increase fertilizer use.
7. Demonstration kits that contain seed, fertilizers, tools, and instructions on how to use the kits should be used.
8. Agricultural institutions should use radio messages in Creole language to publicize demonstrations and create awareness of availability of technological inputs.
9. The Artibonite Valley offers the best immediate opportunity for increased fertilizer use. Three needs must be met: (1) functional irrigation system, (2) agricultural credit, (3) input delivery system.
10. Fertilizer should "pay its own way," i.e., direct subsidies should not be relied on to affect use.

11. Some taxes on export crops and a pier improvement tax should be evaluated to determine if they restrict agricultural production and fertilizer use.
12. Statistics on fertilizer use and sales should be maintained for use in planning needed future changes in fertilizer marketing.
13. Fertilizer recommendations for major crops should be published as soon as possible.
14. Community councils should be considered as a possible nucleus for organizing farmer associations and/or cooperatives.
15. If deposits of bat guano are as large as reported and if analysis is high enough to make it profitable, efforts should be made to use the material on crops in locations near the deposits.

I. Objectives

This report was prepared at the request of USAID as a part of an overall assessment of the agricultural sector in Haiti. The team was asked to study and identify the current fertilizer situation in Haiti and make recommendations for increasing fertilizer use.

Specifically, the report was to include information on the current status and potential future use of fertilizers, fertilizer manufacture and/or blending, port handling capabilities, institutional infrastructure for storage, handling, marketing, and distribution of fertilizers by type, quantity and time, supply-demand projections, personnel training requirements, and other related information regarding fertilizer use in Haiti. The report was to also include recommendations on policy implications regarding fertilizer use or other recommendations that have both immediate and long-term implications for economically increasing production of the major crops through fertilizer use.

II. Background

A. Land

The Republic of Haiti occupies the western one-third of the island of Hispaniola in the Caribbean Sea between Puerto Rico and Cuba. The Dominican Republic occupies the eastern two-thirds of the island. Haiti is comprised of 10,714 square miles which is about the same size as Maryland in the United States.

Most of the country is rough, mountainous terrain which is unsuitable for cultivation. Almost 1 million hectares of land is arable, however.

Although located in the tropics, Haiti is generally semi-arid because the mountains which separate it from the Dominican Republic prevent the moisture-laden trade winds from reaching Haiti. Temperature in the centers of population is warm--ranging from 70 to 90 degrees Farenheit year-round. High mountain areas--ranging up to 9,000 feet above sea level--are much cooler. Humidity is high in many coastal areas including the capital city of Port-au-Prince.

B. People

Haiti is one of the most densely populated countries in the world--about 467 people per square mile. Its density is surpassed in the western hemisphere only by some of the smaller islands in the Caribbean.

The last population census was taken in 1950, but more recent estimates of population have been made by the Haitian Statistical Institute and the Haitian Service for the Eradication of Malaria. Their surveys show current population to be about 5 million with an average annual growth of about 2.0 percent.

Haiti has the highest proportion of rural population among Latin American countries--almost 90 percent. There are only three cities with more than 20,000 inhabitants: Port-au-Prince, 280,000; Cap Haitien, 50,000; and Gonaives, 29,000.

French is the official language--the only Republic in the Western Hemisphere where this is found. However, French is spoken by only about 10 percent of the people; the remainder speak Creole which is a mixture of French and African dialects. Literacy is estimated between 10 and 18 percent.

The nation's mortality rate was estimated in 1969 to be 16.9 deaths per 1,000 inhabitants and the infant mortality rate was 146.5 deaths per 1,000 live births. There was considerable improvement from 1960 when the rates were 21.6 per 1,000 and 190 per 1,000 respectively, but they still are the highest in the Americas. Life expectancy at birth for the general population was estimated at 40 years in 1960 and 47.5 years in 1970.

The average food intake per capita in Haiti is estimated at 1700 to 1800 calories per day with 45 grams of protein. These are among the lowest levels in the world and suggest serious nutritional deficiencies. Some principal causes of death are tuberculosis, malnutrition, and gastrointestinal illnesses.

C. Economy

Agriculture--characterized by a large number of very small individual family subsistence plots--is the mainstay of the Haitian economy. The only exceptions to this pattern are a very few large sugar plantations and a few large government and individual holdings. Subsistence-type agriculture employs about 80 percent--about 1.8 million--of the Haitian work force.

Agriculture generates about 50 percent of the GDP (Gross Domestic Product) in Haiti and accounts for 60 percent of the value of exports. The expansion of agricultural production was estimated at about 6.4 percent in 1971, which represents an improvement over 1968-1970. Important crops include coffee, sugar cane, corn, beans, sorghum, rice, cotton, bananas, manioc, and sisal.

Coffee is the principal export, although its percentage of the total value of Haitian exports has declined in recent years. Other important exports have included sugar, bauxite, essential oils, and light manufactured products. The United States purchased U.S. $39.6 million in exports from Haiti in 1971--more than 60 percent of the nation's total exports.

Haiti's gross national product (GNP) in 1970 was $352 million; per capita GNP is about $78, the lowest in the Western Hemisphere.

D. Agricultural Problems

The problems of agriculture are complex, particularly in terms of deficiencies in soil fertility, irrigation, organization of labor, care of crops and cattle, and crop storage and transportation. Rainfall is distributed irregularly through the year. The rough Haitian topography aggravates the land shortage problems--about 61 percent of the cultivable land is mountainous--and poor land use rapidly lowers soil productivity. The very small size of family farms (they average about 1 hectare), the increase in population, and the system of inheritance contribute to the fragmentation of the land and hamper efficiency. Population pressures on the land are intense; this has forced production of food crops on steep land with serious erosion problems being the inevitable result.

Crop yields are low as compared to averages for Latin America or the United States. FAO Production Yearbook data include the following for 1971:

	Yields in 100 Kg per hectare harvested			
	Corn	Rice	Cotton (fiber)	Sugar cane
Haiti	8.1	10.8	2.2	444
Latin America	14.8	16.9	3.5	514
United States	54.5	52.0	4.9	921

Coffee yields are also quite low. An estimated 300,000 farming units of an average size of less than one hectare have produced approximately 550,000 bags (60 kilograms each) annually for the past several years. Much of the crop receives little or no cultivation. Agricultural production is generally considered to be lower today than in 1789 when 8,500 plantations controlled about 500,000 hectares.

The state of Haitian agriculture is dramatically illustrated by viewing the primitive tools used by peasant farmers. The machete and the hoe remain as the most important tools even on the few plantations which exist. Some peasants who own no tools are reported to rent machetes from more prosperous neighbors, one-third of the crop being the rental payment. Church World Service is reported to have introduced a wide-lipped shovel for use by shoeless peasants.

III. Fertilizer Situation in Haiti

A. History of Use

Fertilizers and other purchased inputs have never been used widely in Haiti. Haiti's subsistence type of agricultural production is based on exploitation of native soil fertility. Soil erosion has

further depleted the fertility status of mountainous areas. However, Haiti's arid climate has reduced the severity of leaching of bases which characterizes most tropical soils.

About 15 years ago there was a fertilizer mixing plant in Port-au-Prince. A Mr. Clement Barbot had a share in operation of the plant. Construction and/or planning of the plant apparently was begun in 1955. It became operational in 1957 and closed in 1958. The plant was premature and probably had a political, rather than economic basis for existence. All importers were supposed to pay a tax on import of fertilizers. These funds were reportedly used to support the plant. Only one grade (10-10-10) was produced. Lateritic soil was used as a filler which contributed to the poor physical condition which was reported for the fertilizer. Since this fertilizer plant closed, all fertilizers have been imported.

B. Present Levels of Use

Prior to arriving in Haiti, FAO estimate of fertilizer use was obtained (See Appendix Table I). Fertilizer consumption for 1962-66 is shown along with estimated annual increases in use beginning in 1967. As can be seen, FAO has no record of any potash use.

We were unable to discover any "hard data" on fertilizer use in Haiti. On the basis of interviews with importers and public officials and on correspondence with the major United States producer who sells in the Caribbean area, however, we estimate the total tonnage of fertilizer used in 1972 to have been 1,800 metric tons.

Almost twice that amount (3,000 metric tons) will be used this year. Our estimate of current fertilizer use by crop and import, distribution and credit channels is contained in Table 1.

C. Procurement--Importers and Sources of Supply

Major fertilizer importers in Haiti appear to be as follows:

Societe Anonyme Darbouco (DARBOUCO)

Au Jardin Tropical (subsidiary of DARBOUCO)

Societe d'Etudes et de Realisations Agricoles (ERA)

Haitian American Sugar Company (HASCO)

Minor importers include:

Compagnie des Tabacs Comme Il Faut

Roger Carrier

A. Wien

A. Derenoncourt

Agr. Dossous

These minor importers apparently serve as "order takers and fillers" and make no attempt to maintain a fertilizer inventory.

In the past three or four years U.S. firms (largely W. R. Grace's plants in Jamaica, Puerto Rico, and the mainland, have been major suppliers of a variety of grades of mixed fertilizers. Substantial tonnages (100 to 150 tons in 1972) of 12-12-17 (2 percent MgO and potassium sulfate as the source of potash) have been imported from Ruhr-Stickstoff in Germany. This product is dyed blue and has been used largely on vegetables.

TABLE 1.--ESTIMATED FERTILIZER USE BY CROPS AND IMPORT DISTRIBUTION AND CREDIT CHANNELS IN 1972 AND 1973

Crop	Primary Importer of Fert.	Imported from	Credit Supplied by	Estimated Sales (m.t.) 1972	1973
Coffee	ERA	Dominican Republic	IHPCADE	300	600
Sugar cane	HASCO	U.S. Dominican Republic	--	150	300
Cotton	ERA		IDAI	200	200
Rice	Darbouco	U.S. Dominican Republic	Darbouco Merchants BCA	1000	1700
Vegetables	Darbouco	Germany U.S.	Darbouco Merchants BCA	150	200
Other crops----------NO SIGNIFICANT USE ----------					
Total				1800	3000

Urea is the major nitrogen material used in Haiti and is likely to continue in this position. In the past 3 to 4 years, urea has been imported from W. R. Grace's plants in Puerto Rico and Jamaica and Feresan and Fertilizantes Quimicos Dominicanos in the Dominican Republic. Small quantities have also been imported from Italy and Curacao Trading Company, headquarters in Amsterdam, Holland.

Small quantities of ammonium sulfate and concentrated superphosphate have also been imported.

Importers are now obtaining most of their fertilizer requirement from Fertilizantes Quimicos Dominicanos and Feresan, both in Dominican Republic, because of lower prices.

Many in Haiti report that fertilizer use is limited because "fertilizer prices are too high." Indeed, prices are much higher than in most parts of the world. We attempted to determine costs of fertilizers to importers, distribution costs, and importer and retailer margins on some representative shipments. These costs are shown in tables 2, 3, and 4.

TABLE 2--COSTS OF UREA FROM FERTILIZANTES QUIMICOS DOMINICANOS 30 M. T. TRUCKLOAD LOTS IN SEPTEMBER 1973 (50-KG BAGS)

	Per Ton	Per Bag
Value of merchandise	$ 101.00	$ 5.05
Inland freight	14.00	0.70
Port handling charge (paid even though port facilities were not used)	3.60	0.18
Supplement to Haiti Customs House employees for handling (at $15/load)	0.50	0.03
Total costs of product to importer 1/	119.10	5.96
Importer markup at 20% (covers storage, handling, other business costs, and profit) 2/	23.82	1.19
Average transportation cost	6.00	0.30
Total costs to small merchant or large farmer	148.92	7.62
Merchant markup 3/		0.50
		8.12

1/ Payment terms: 25% cash; 25% in 30 days; 25% after 60 days; remaining 25% after 90 days.

2/ Importers reported their markups were 15 to 20%. We used 20% in our calculations.

3/ Importers reported that merchants who resell fertilizer to farmers have markup of 50¢/bag or more. Some 50-kg bags of urea are broken down into smaller lots--as small as 1-kilo--for use on rice nurseries. A price of 10¢/lb. was quoted on these small lot sales.

Note: Additional transportation costs are sometimes incurred by importers and/or merchants. Incoming trucks from Dominican Republic are sometimes delayed by roads, customs, etc., and importers must pay extra money to drivers. Also, extra costs are sometimes incurred for transportation to merchants and farmers during the rainy season.

TABLE 3--COSTS OF 12-12-17, 2% MgO FROM RHUR-STICKSTOFF (POTASSIUM SULFATE AS K SOURCE)--THIS 600-BAG LOT (50-KG EACH) IMPORTED JANUARY 1972

	Total	Per Ton	Per Bag
Value of merchandise	$1678.67	$ 55.96	$ 2.80
Packing	280.00	-	-
Freight charges in Hamburg	161.47	-	-
Ocean freight, B/L expenses including embarking and disembarking	1344.98	-	-
Insurance	53.58		
Consular fees	46.80	-	-
Delivered to Port-au-Prince US	$3565.50	$118.85	$ 5.94
Port handling charges	108.00	3.60	0.18
Total costs of product to importers 1/	3673.50	122.45	6.12
Importer markup at 20% (covers storage, handling, other business costs and profit) 2/		24.49	1.22
Average transportation cost (most apparently sold in vegetable producing area near Port-au-Prince)		4.00	0.20
Total costs to small merchant or larger farmer		150.94	7.54
Merchant markup 3/			0.50
Total costs to small farmer			8.04

1/ Payment terms: 180 days to pay at 6% interest rate

2/ Importers reported their markups as 15-20%. We used 20% for our calculations.

3/ Importers reported that merchants who resell fertilizer to farmers have markup of 50¢/bag or more.

TABLE 4--COSTS OF FERTILIZERS BEING PAID AND/OR QUOTED TO A LARGE SUGAR CANE PLANTATION, C.I.F. PORT-AU-PRINCE

Material or Grade	Price/S.T. Feb. 1973	Price/M.T. Oct. 1972
16-4-12	$ 87.00	$ 99.25
18-8-24 1/	110.00	115.50
16-6-16	-	105.10
Urea (46-0-0)	108.00	109.00
Ammonium Sulfate (21-0-0)	-	89.80
Potassium Sulfate	108.00	-

1/ The plantation also purchased one or more 30 metric ton truckloads from a Dominican Republic supplier who delivered to the farm at a price of $112.00 per ton.

Note: Personnel reported importers also collected the following fees; importers made payment to appropriate GOH organizations:

Import License	2.50 per lot
Declaration and stamp	2.23 per lot
Brokerage and Fee	5.00 per lot
Customs handling	3.60 per metric ton
Customs verification	0.40 per metric ton

The preceding tables were constructed from importer invoices and discussions with these importers and a sugar cane plantation manager. Another importer reported these figures from memory:

Ocean freight from Santo Domingo in 50 m.t. lots (5 weeks ago)	$ 19.00/mt
Ocean freight from Santo Domingo in 50 m.t. lots (present)	22.23/mt
Ocean freight from Jamaica or Puerto Rico by container (he thought this price may now be increased by 5%)	32.80/mt
Handling costs by Customs (approx.)	4.00/mt
Fee to Minister of Commerce and Industry	2.00/lot
Transport costs from Port to storage (approx.)	0.25/mt
Assessment to improve Port-au-Prince pier 1/	7.80/mt
Truck freight from Santo Domingo	14.00/mt

Private sector contacts were very open in their discussions in these sensitive areas and the price information was quite similar from all contacts. There were evidences of genuine competition among importers. The private sector would apparently expand fertilizer distribution and marketing activities if demand is increased. One importer established a fertilizer warehouse several years ago in the Artibonite Valley. It was unprofitable and closed because of low fertilizer demand at that time. All importers contacted maintain fertilizer inventory in Port-au-Prince and also sell seed, tools, pesticides, and other farm inputs.

1/ The other importers did not mention this figure--apparently because they are currently receiving fertilizers by truck and this is a new assessment.

D. Transportation, warehousing, distribution, and marketing systems

Practically all internal transport of fertilizer is by truck in 50-kg or 100-pound bags to points where truck travel is possible. At this point, it is either carried by burro or people to even more remote locations. There are some instances, particularly in the Artibonite Valley, where 50-kg bags are rebagged into smaller lots--as small as 1 kg--for use on rice nurseries.

There are no public rail systems in the country for fertilizer transport. Water transport is not possible to interior points and water transport of cargo along the coast is not being used at this time.

There are no bulk handling facilities for fertilizers at the ports or at the limited importer storage areas in Port-au-Prince. Importers we visited reported having some storage in Port-au-Prince, but store fertilizer for only 2 to 3 months. Each maintains a limited inventory of fertilizers. One importer is building storage to handle an additional 2,000 bags. This is a 2-story concrete structure that will handle 1,000 bags on each floor. Reported cost of the structure is $5,000. The total storage capacity used for fertilizer in Port-au-Prince appears to be 500 tons. However, this could be rapidly increased by importers using other storage.

The procedure for buying fertilizers is varied. Small farmers may buy from a retailer who has purchased small lots of fertilizer from an importer. In the case of the coffee producer, however, fertilizer purchases are made through the IHPCADE; and cotton, along with some corn, producers may buy fertilizer through IDAI's supervised credit program. Larger farmers, corporations, and dealers may buy directly from Port-au-Prince importers, or, as in the case of a large sugar cane plantation and at least one vegetable producer, they may import fertilizers directly.

Personnel of the largest sugar cane plantation were asked if they have any plans for purchase of fertilizer for resale to the small farmers who supply 80 percent of the cane delivered to the mill. The organization apparently feels it could not afford to do this. The corporation is already large enough to arouse suspicion of its motive and would be further suspect if it began selling agricultural inputs or services to farmers.

There was no evidence of widespread fertilizer education and promotion. There are some efforts which are worthy of mention. IHPCADE is reported to have 109 agents located throughout the country to work with coffee producers. IHPCADE also reports that it has invested $30,000 in a 5-year period to demonstrate fertilizer use practices. IDAI also has agricultural agents who supervise the use of credited inputs. Some promising work has been started in fertilizer research and education by the

Taiwan Mission in the Artibonite Valley. Some of their calculations on economics of fertilizer use on rice is contained in Appendix Table 2. And one importer promotes fertilizers along with the other merchandise he sells at community markets. He has a truck wired for sound which he uses to transport the goods into an area and promotes sales by advertising his merchandise through the loud speaker.

IV. Factors Limiting Fertilizer Use

Major restrictions to increased fertilizer use are ranked in two groups in order of seriousness as viewed by the authors:

1. Institutional weaknesses
2. Transportation and physical facilities deficiencies
3. Peasant illiteracy and isolation
4. Lack of credit
5. Market uncertainties
6. High fertilizer prices

These limitations are all interrelated and are briefly discussed on the following pages.

1. Institutional weaknesses

No attempt was made to assess the effectiveness of institutions except as they relate to use of fertilizers. Other TDY reports, along with previously known information in USAID, are the proper sources of such an assessment. In brief visits with DANRDR personnel along with study of previous TDY reports, the team concluded that this institution is not now performing a viable research and extension program. Normally, such an

organization would be a catalyst for increasing the use of modern farming techniques including fertilizer and other inputs. DANRDR, however, is not performing such a service. There are three examples which illustrate the seriousness of this situation.

a. The total budget for the organization has been almost constant at $1.2 million. Of this, $1.08 million is budgeted to salaries. Of the remaining $120,000, about $50,000 is for BCA (for small farmer credit); $18,000 for subsistence payment to students; $6,000 to FAO; and $34,000 for gas, oil, parts, supplies, per diem, office furnishings, etc. This is two and one-half percent of GOH budget. It is impossible to perform a countrywide extension program on such a small operating budget.

b. A top extension official stated that Esso Standard Oil Company is currently conducting field tests and extension work in the Artibonite Valley. Esso ceased its Caribbean fertilizer operations five years ago. This indicates a serious information gap between the extension headquarters and field programs.

c. Dr. Adrien, Head of Agricultural Chemistry at the Faculty of Agronomy and Veterinary Medicine (affiliated with DANRDR) has some good research at Damien. However, his fertilizer trials are being conducted on only a few crops and results are not too applicable in other areas. There

is no GOH research to determine fertilizer requirements for rice or recommendations for extension workers to convey to rice growers. This crop is projected for a 79,000-metric ton increased production in GOH's 5-year plan.

Contact with IDAI, IHPCADE, and other institutions was not extensive enough to assess their capabilities. However, given the overall situation, similar weakness could probably be found in their capabilities.

2. Transportation and Physical Facilities Deficiencies

Road conditions are terrible. Primary roads which link major cities are impassable during parts of the rainy season. An almost total lack of secondary roads prohibits any significant use of fertilizer in many sections of the country. The preceding discussions in this report, the attached pictures, and the thousands of words which have been written by others about Haiti's roads describe the seriousness of the situation. There is practically no fertilizer storage capacity away from Port-au-Prince.

3. Peasant Illiteracy and Isolation

Almost 90 percent of the population is reported to be illiterate, and as mentioned earlier, the farmer is not accustomed to purchasing inputs for agricultural production. Because of poor roads, and thus an inadequate transportation system, many farmers are also isolated, complicating the task of injecting agricultural technology into the traditional farming pattern.

Peasant farmers have long memories and many of them have some allegiance to suppliers of fertilizers which perform well. A

12-12-17, 2% MgO grade of fertilizer which has been dyed blue has been imported for several years from Germany. Primary use has been on vegetables. Many farmers now associate blue fertilizer as being the only kind to use for vegetables. Although the imported product is good, the farmer needs to know why it is useful on his crops, rather than think the fertilizer is best because it is blue.

4. Lack of Credit

Credit is a very serious limiting factor due to its general unavailability to Haitian farmers. However, a few farmers are able to obtain credit. Coffee growers purchased approximately 300 tons of 10-5-20 with 1% MgO through IHPCADE last year. IHPCADE's cost for the fertilizer was $100.00 per ton. Farmers received a $50.00 per ton subsidy, paid $25.00 per ton at the time they obtained the fertilizer and repaid the remaining $25.00 at the time of coffee harvest and sale.

IDAI supplies some supervised credit, primarily for cotton and corn. Importers sometimes supply credit to large dealers (30 to 60 days) and to a few selected farmers. Most direct credit by importers is to farmers in the Artibonite Valley or vegetable growers near the Port-au-Prince market. BCA pays importers at time of fertilizer purchase for a selected list of farmers, then collects from farmers at harvest.

Rice farmers in the Artibonite Valley generally do not have credit available except through importers or merchants. This is a serious deficiency to increasing fertilizer use in that area.

There is considerable risk to merchants or importers who extend credit. We were told of instances of three Deputies who had made credit purchases from importers and/or merchants and who refused to pay for the fertilizers. The importers and merchants had no recourse and had to absorb the loss.

5. Market Uncertainties

This limitation is serious in many parts of the country and for many crops--such as corn, for example--because there is no ready market for increased production. The corn is usually consumed by the family and its livestock, and/or bartered for other products. Bartering occurs with nearby farmers or at community markets.

One notable exception to this system of marketing food crops is for vegetables produced in the Port-au-Prince area. Individual producers may bring their produce into the city where market activity occurs daily. Or, they may sell vegetables to a middleman who buys at the farm and sells through retailers--usually women who sell vegetables on the city streets. Some farmers sell their vegetables on contract with middlemen, receiving partial payment at the time of the contract and the rest when transfer of ownership occurs.

Although export crops--such as coffee and sugar cane--enjoy ready international markets, many small producers do not consider the enterprise as extremely profitable. Some of the literature about Haitian agriculture asserts that high taxes limit the farmer's interest in producing export crops. Many abandon production of these crops in favor of the more traditional subsistence type farming.

Rice is one crop that is marketable at a profitable price. Given adequate credit and reliable supply of inputs and technical assistance, rice farmers appear ready to intensify production.

6. Fertilizer Prices

Fertilizer prices are higher in Haiti than in most of Latin America. Urea, for example, costs farmers approximately $150.00 per metric ton (Table 2) in 50-kg bags in September 1973. This compares to the following September-October 1973, prices in other Latin American countries: El Salvador, $137.00; Guatamala, $152.00; Venezuela, $125.00 (from domestic production); Brazil, $147.00; Nicaragua, $138.00. Price increases of $30.00 to $40.00 per ton over the past 12 months were noted for most countries.1/

Importation in small lots, double bagging of many products against the rigors of transport and handling, high transportation costs, and purchase by subsistence farmers in very small lots all contribute to this cost. All trends point toward higher fertilizer prices during the next 2 to 3 years.

The price of fertilizer per unit of plant nutrient is less important than its price relationship with the value of increased agricultural production. For example, price relationships between fertilizer and rice appear highly favorable in Haiti, whereas fertilizer use on sugar cane appears less favorable.

1/ These prices were obtained by telephone from fertilizer trade officials on November 16, 1973, and are believed to be reasonably accurate.

Calculations from data supplied by the Taiwan Mission show a fertilizer investment of $62.60 to produce an extra 975 kg of rice with a local value of $292.50 (benefit-cost ratic of 4.67 to 1). The variety Bluebonnet 50 was used in this example. Some IR varieties were more fertilizer responsive but are less acceptable to Haitian consumers.

Discussions with a sugar cane plantation indicate that ratoon sugar cane production averages 17 to 20 tons per acre (the metric system was not used by plantation personnel in this instance) without fertilizer and 26 to 27 tons per acre with application of 300 pounds of fertilizer. Cane was valued at $5.00 per ton and the applied cost of fertilizer was approximately $8.50 per 100 pounds. These experiences indicate a value of increased cane production of $30.00 to $50.00 for a fertilizer investment of $25.50. Fertilizer use is not very profitable under these conditions; working toward a higher value for cane would seem to be the best route to profitably use fertilizer in this instance. The plantation (probably using the most advanced technology in Haiti) had no experience with fertilizing plant cane.

7. Other Factors

There are some taxes that may restrict fertilizer use on coffee and refined sugar for internal use. A $16.40 actual tax per quintal of coffee has been reported. The $7.80 per ton pier assessment and other customs duties also limit fertilizer use to some extent.

V. Fertilizer Needs and Goals

As noted earlier in this report, the per capita intake of calories is between 1700-1800 per day. We have calculated the fertilizer requirement for domestic production of grain to increase food consumption by 700 calories per capita per day.

Studies of the role of fertilizer in the less developed countries have shown that, on the average, one ton of plant nutrients (N, P_2O_5, and K_2O) well used, will increase food grain production by 10 tons. Each ton of grain will furnish 5,000 calories per day for one year, enough to provide two people with a 2500-calorie diet for one year.

By using this formula, it is estimated that Haiti has an increased fertilizer need of 70,000 metric tons of plant nutrients (N, P_2O_5, and K_2O) to provide the 700-calorie increase to an estimated 5 million people.

We emphasize that need and demand are not the same. Need is a goal. Demand is the amount of product, in this case, fertilizer, that is sold or can be sold at a given price.

Fertilizer needs were also projected for meeting the Government of Haiti's five-year goals for increasing non-export food crops. Again using the formula of one ton of plant nutrient being able to produce 10 tons of commodity (bananas and beans were considered on the same basis as grains which may not be quite valid, particularly for beans), fertilizer requirements to meet these goals were computed:

Commodities	Production (m.t.) 1970-71	1971-76	Production increase (m.t.)	Fertilizer (PN) required for production incr. (m.t.)
Beans	42,000	48,000	6,700	670
Corn	252,000	321,000	69,000	6,900
Bananas	190,000	215,000	25,000	2,500
Rice	81,000	160,000	79,000	7,900
				17,970

Assuming an average plant nutrient content of fertilizers used in Haiti to be 45 percent, approximately 40,000 tons of fertilizers would be required to meet the above GOH goals for non-export crops.

The large sugar cane plantation projects their purchases to be 300 metric tons of fertilizers (not plant nutrients) in 1974 and 600 tons in 1975. No information was obtained on fertilizers being used or projected for use by the other mills.

IHPCADE has made projections for use of 30,000 tons of fertilizers (10-5-20 with 1% MgO) over the next five years and expects to purchase the fertilizer at $100.00 per ton. Recommendations concerning this are found in the next section of this report.

VI. Recommendations

Development of institutions, infrastructure (particularly roads) and education in rural areas are the long-range answers to agricultural development in Haiti. Fertilizer use, irrigation, drainage, and improved varieties of seed will be required for major increase in production of food and export crops.

If fertilizer use is to be increased dramatically in Haiti, however, farmers, and those who advise them, must be knowledgeable about fertilizer, have a favorable attitude toward its use, and know how to use it in conjunction with other improved practices. There must also be an adequate supply of the kind of fertilizer needed when and where it is needed and at a favorable cost. There must also be adequate credit and ready markets that channel farm production into domestic and export markets. The same, of course, is needed for other agricultural inputs.

For this to occur, the Government of Haiti, and donors working with it, must be committed financially and institutionally to improving agricultural production and infrastructure must be developed to meet the needs. We have no blueprints as to how to accomplish this task, but offer a few recommendations that we hope will be useful while infrastructures and institutions are being studied and strengthened by those who are working on the problem.

1. Fertilizer Procurement

Fertilizer manufacture and distribution is a worldwide business that is currently in a tight supply situation, and thus a seller's market. This means that fertilizer prices will be higher for 2 to 3 years and may be more difficult to buy in the small lots imported in Haiti.

South Vietnam, for example, recently received offers of only 55,000 tons in response to its request for bids on 126,000 tons of urea. Sellers offered the material at about $100.00 per ton F.O.B. Gulf Coast, about $35.00 per ton higher than U.S. domestic market prices.

The tight fertilizer supply situation is reported for two reasons: (1) to forewarn officials in Haiti that fertilizer will be harder to buy from many sources, and (2) that prices are likely to increase.

Haitian importers have already encountered price increases. That is a major reason for their relatively recent shift to the Dominican Republic as a source of fertilizers.

For the present, Haiti must continue to rely on imports for supplying its fertilizer needs. Since there are no facilities for bulk handling and bagging at the Port-au-Prince pier, or for distribution, the fertilizer must also continue to be imported in bags.

Some 25-kg bags should be imported rather than following the current practice of importing only 50-kg bags. This is particularly needed in coffee-producing areas. The Haitian coffee producer often must make the last part of fertilizer delivery on his back. A 50-kg bag of fertilizer is very hard to carry, particularly up hills and mountains. IHPCADE could make an immediate effect by including such a requirement on its next bid for fertilizers for coffee producers.

IHPCADE should also shift from use of a 10-5-20 with 1% MgO fertilizer to a high-analysis grade. A 14-7-28 grade with 1.4% MgO, for example, could be produced. Some saving would be obtained in procurement costs (per ton of plant nutrients) and thus would cut transportation and other distribution costs by more than 30 percent. Suggested formulations could be supplied for the 14-7-28 grade with 1.4% MgO, or similar grades, if needed.

When fertilizer use in Haiti increases to 20,000 to 25,000 tons annually, construction of a small bulk blending plant with bagging facilities should be considered. Someone in the private sector should own and operate the plant on a profit-oriented basis. TVA personnel could probably be made available TDY to USAID for assistance when this need is established.

The major advantages of a bulk blending plant include lower fertilizer costs due to bulk freight rates and the potential for producing prescription-type mixtures of a wide variety of grades for Haitian crops and soils. A bulk blending plant requires less investment and a lower level of technical competence than larger facilities. The formulation chart (Appendix Table 3) illustrates the simplicity of formulating and the wide variety in grades which may be produced.

This plant would have a complementary effect on establishment of a soil-testing laboratory which is under consideration. Operating problems for a bulk blending plant would be minimized if materials were imported, and mixtures prepared, bagged, and stored during the dry season.

When, and if, fertilizer consumption should reach 40,000 to 50,000 tons, construction of an ammoniation-granulation type of plant should be considered.

2. Training and Promotion

The private sector advises farmers on the use of fertilizer and other inputs. This is a practice that is followed throughout the world. Three of the importers--two from one company--have college degrees.

One has a degree from Cornell University, one from Rutgers, and one from a school in Belgium. Efforts should be made to use their expertise in training, promotion, and increasing use of agricultural inpúts.

Simple fertilizer demonstrations should be considered in promising fertilizer use areas in Haiti. Demonstration kits that would contain seed, fertilizer, tools, and visual instructions should be considered on rice in the Artibonite Valley. Such kits would be an excellent means for introducing high lysine corn should this program develop.

The demonstration kit suggestion could be further developed into an impact education program if and when the agricultural extension service is equipped with enough expertise and budget to conduct such an effort. One method would be to pattern the program after parts of the Test-Demonstration Program which is conducted in the Tennessee Valley by the land-grant university extension services, TVA, and farmers.

One part of the program would be to conduct fertilizer practice demonstrations. These demonstrations should be established to show the effects of proper use of fertilizer in combination with other recommended production practices such as irrigation and use of improved seed. The demonstration kits would be useful in this effort. Such demonstrations could also be used in the future to help investigate solutions to specific soil fertility problems--such as micronutrient deficiencies.

The program could also involve the use of whole-farm demonstrations. That is, the farmer would be encouraged--and assisted--in making

farm plans and learning more about deciding on the types of enterprises that offer the highest possible income. Extension workers could use such farms as the nucleus of their educational programs.

Both efforts--demonstrations on fertilizer use and whole-farm activities--should be used for farmer meetings, tours, field days, and farm planning schools. They would also be very useful in training extension agents.

As already mentioned, fertilizer importers are trained and should be used in educational efforts. They should also be encouraged to participate in farmer demonstration programs. They could supply fertilizers for demonstration plots, for example, and thus help increase fertilizer use in the country. Representatives of FAO--and other potential donors--should also be contacted about the prospect of helping finance and conduct the farm demonstration program.

The Taiwan Mission work in the Artibonite Valley is impressive and should be continued. USAID should assist in transfer of their technology to Haitian institutions. Working with ODVA agents, whom they want to help train, some demonstrations kits could help expand this effort to increase rice production.

Similar demonstrations should be continued with IHPCADE, IDAI, or any other supervised credit agencies. Results of demonstrations should be visually presented at strategic points, such as local markets, in areas where demonstrations are conducted. Results of demonstrations should be documented (yields, production practices, cost-benefit ratios, etc.) for use in educational programs.

Radio is the only form of mass communications in Haiti that can leap the literacy barrier. Agricultural institutions should be encouraged to use this medium to publicize demonstrations and create awareness of demonstration kits, supervised credit, and technological inputs which become available.

3. Area for Emphasis

The best immediate opportunity for increased fertilizer use--and consequently, increased food production--is in the Artibonite Valley. To achieve this potential, however, several simultaneous developments are essential. These include (1) a functional irrigation system, (2) adequate credit to purchase fertilizers, seed, and other essential agricultural inputs, and (3) an adequate delivery system to provide the fertilizer and other inputs. The public sector (GOH and donors) must develop parts (1) and (2). The private sector will develop the delivery system as irrigation and credit help widen the fertilizer market potentials.

The private sector (primarily importers) should be informed of expected irrigation and credit developments to provide lead time for development of warehouses, sources of supply, etc. Fertilizer should "pay its own way," i.e. direct fertilizer subsidies should not be relied upon to affect use. A serious danger with subsidies is that farmers are difficult to "wean" from artifically low fertilizer prices just as Haitian vegetable producers are hard to "wean" from blue fertilizers. The problem is compounded by the general outlook for increased fertilizer prices.

4. Taxes and Duties

Although the GOH tax programs on agricultural commodities were not analyzed, there are four areas that need to be evaluated to determine if they hold back agricultural production and thus fertilizer use: (1) the $16.40 per quintal tax on coffee; (2) the $7.80 per ton pier improvement tax on fertilizer imports at Port-au-Prince; (3) an alleged tax on internal sale of refined sugar; (4) a $3.60 handling charge by Customs officials on truck-delivered fertilizer from Dominican Republic along with a $15.00 per truckload fee as a supplement to Haiti Customs House employees for handling.

5. Fertilizer Statistics and Recommendations

Statistics on fertilizer use and sales should be kept on a continuing basis to help plan for needed future changes in fertilizer import, mixing, and marketing. Fertilizer recommendations, together with variety recommendations for major crops should be published as soon as possible for guidance of the large numbers of public employees and private importers and merchants who are in the position to influence farmers. DANRDR should be involved in this. The recommendations proposed by Gustave Menager, at the team's request (Appendix Table 4), should be a good starting point.

6. Community Councils

USAID officials reported that community councils are one of the few bright spots in Haiti. Where fertilizer is beginning to be used, they could be encouraged to consolidate fertilizer orders into

truckload lots. Many farmer cooperatives in the United States had their beginnings with similar ventures. Many cooperative leaders argue convincingly that this "grass roots" approach builds a more effective farmer organization than one which is built by a government on a central organization.

7. Bat Guano

An official concession has been obtained by a Mr. Leon Alexandre from GOH for exploitation and export of bat guano. Dr. Lebert Jean-Pierre--who is assisting in this matter--estimates these deposits to total 100,000 tons and is having chemical analyses made of samples from the major deposits. The major deposits are in caves near Dondan and Laconbe although scattered deposits are found in an estimated 100 caves in Haiti.

If the deposits are extensive, and if the analysis is high enough to warrant exploitation, the guano should be used in Haiti. The critical need for fertilizer and the inherently low analysis of bat guano all suggest its use near the area of the deposits in preference to export. The material might be particularly well suited for coffee producers who are located near the deposits.

The commercial value of the bat guano might be established and its use encouraged (through supervised credit) by IHPCADE.

8. Role of Fertilizer in Agricultural Development

In conclusion, increased fertilizer use may be considered as an important "lead practice" in Haiti because of the readily

observed response from its use. The differences in the growth, color, yields, and profit are easily observed. In contrast, plant response and increases in crop yields may be less evident for some other technological changes. Also, fertilizer does not present the environmental hazards which some inputs, notably insecticides, might present in situations where peasant farmers use irrigation water for drinking or bathing purposes. As peasant farmers accept fertilizer use, their readiness to accept other new technology may be enhanced, and the rate of transition from a subsistence type of agriculture toward a modern agriculture may be increased.

Thus, fertilizer is an important tool in rural resource development. Perhaps one of the most outstanding examples is the Tennessee Valley, a region in which the team has worked. In the early 1930's, this region of some 40,000 square miles was one of the gall spots of the United States. Productivity of the soil was gone, soil erosion was rampant, some farmlands had been abandoned, sedimentation and siltation of streams were extensive, and disastrous floods were commonplace. Farm incomes were among the lowest in the nation, poverty was everywhere, and human erosion had set in.

Fertilizer was the primary instrument used in the Tennessee Valley to restore soil productivity, reduce runoff and erosion, and improve the living condition of farmers. In Haiti, fertilizer, irrigation, and water control where feasible, and improved seed are the technological inputs which offer most immediate opportunity for increased agricultural production.

FERTILIZER STATISTICS-HAITI

Appendix Table 1

NITROGEN

Year	Production	Consumption	Exports	Imports
		('000 Metric Tons Plant Nutrient)		
1962-66 Ave.		.10		.10
1967		.15		.15
1968		.15		.15
1969		.15		.15
1970		.20		.20
1971		.20		.20
1972		.20		.20

PHOSPHATE

1962-66		.10		.10
1967		.10		.10
1968		.10		.10
1969		.10		.10
1970		.10		.10
1971		.10		.10
1972		.10		.10

POTASH

1962-66 Ave				
1967				
1968				
1969				
1970				
1971				
1972				

Source: Annual Fertilizer Review, FAO Rome, 1971

Appendix Table 2. The Cost of BB-50 Applying Fertilizer and Without Fertilizer

Bluebonnet 50	Seed Quantity and their cost		The labor cost from seedling to harvesting labor/ha		The amount of fertilizer and their cost N-P-K=80-40-40 kg/ha		Estimated production (Rough rice)	Milling ratio	Local price	Amount of white rice	Net income	Amount of net income between A and B
A The area of applying fertilizer	40 kg	60 G	180	900 G	Compound fertilizer N-P-K = 12-12-17 300 kg	6 bags x 375 G = 225 G	4000 kg	65%	1.5G/kg	2600 kg	2627 G	1127 G
					Urea 46% 100 kg 2	2 bags x 44 G = 88 G						
B The area without fertilizer	40 kg	60 G	175	875 G	Zero		2500 kg	65%	1.5G/kg	1625 kg	1502 G	
1	The method of applying fertilizer											

(1) Basical fertilizer: To apply the compound fertilizer (N-P-K=12-12-17) 200 kg, before transplanting 1 or 2 days.
(2) Additional fertilizer: 1st additional fertilizer 15 days after transplanting, to apply the urea, 46%, 50 kg.
2nd additional fertilizer 25 days after transplanting, to apply the urea, 46%, 50 kg.
(3) Heading fertilizer to apply the compound fertilizer (N-P-K=12-12-17) 100 kg, 40 days after transplanting.

FORMUCHART 45-18

Formulation Chart(45-0-0, 18-46-0, 0-46-0, and 0-0-60 A

P_2O_5 REQUIREMENTS →

NITROGEN REQUIREMENTS ↓

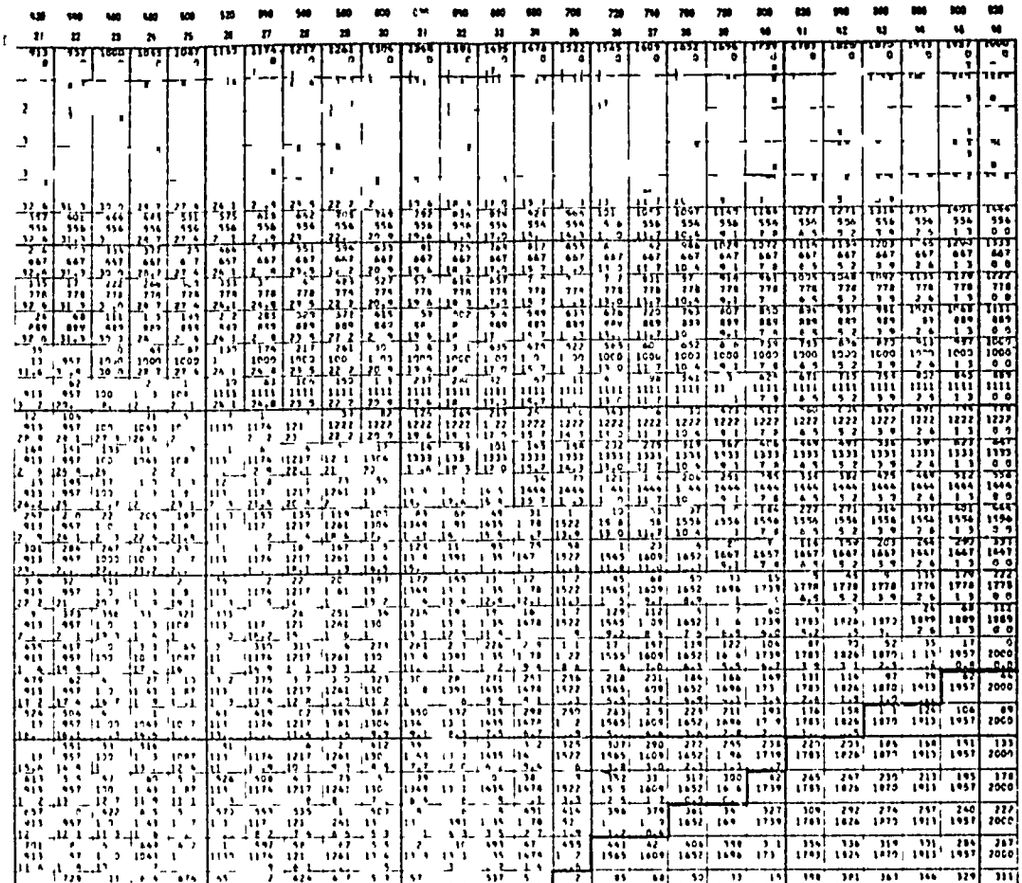
POUNDS	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600
UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0	0	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
20	1	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
40	2	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
60	3	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
80	4	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
100	5	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
120	6	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
140	7	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
160	8	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
180	9	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
200	10	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
220	11	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
240	12	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
260	13	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
280	14	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
300	15	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
320	16	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
340	17	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
360	18	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
380	19	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
400	20	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
420	21	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
440	22	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
460	23	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
480	24	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
500	25	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
520	26	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
540	27	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
560	28	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
580	29	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
600	30	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
620	31	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
640	32	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
660	33	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
680	34	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
700	35	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
720	36	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
740	37	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
760	38	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
780	39	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
800	40	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
820	41	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
840	42	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
860	43	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
880	44	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304
900	45	43	87	130	174	217	261	304	348	391	435	478	522	565	609	652	696	739	783	826	870	913	957	1000	1043	1087	1130	1174	1217	1261	1304

Formulations above line are within 2 000 pound limit; below line exceeds 2 000 pounds

POTASH →

POUNDS	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600
UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
POUNDS OF 60% POTASH REQUIRED	0	34	67	101	134	167	201	234	267	300	334	367	401	434	467	501	534	567	600	634	667	700	734	767	801	834	867	901	934	967	1001

These mixtures are not necessarily compatible for long periods of time and thus should not be used for other than straight bulk blending for immediate use



Appendix Table 3

SHADED AREA TOP NUMBER 0 46-0
SECOND NUMBER 18 46-0
THIRD NUMBER MAXIMUM UNITS OF POTASH (0-0-60)
POSSIBLE WITHIN 2 000 POUND UNIT

OTHER AREA TOP NUMBER 45-0-0
SECOND NUMBER 18-46-0
THIRD NUMBER MAXIMUM UNITS OF POTASH (0-0-60)
POSSIBLE WITHIN 2 000 POUND UNIT

MAXIMUM GRADES AT SPECIFIED RATIO				
Ratio	Grade	Pounds		
		45 0	18 46 0	
1 1 0	28 36 28 36	757	1233	0
1 1-1	19 26 19 6 19 26	921	37	647
1 1 2	14 58 14 58 29 15	394	36	672
1 1 3	11 73 11 73 35 19	317	516	1173
1 1 4	9 81 9 81 39 24	265	477	13 8
1 2 0	20 73 41 0	2	18 0	0
1 2 1	15 39 30 78 15 3	149	133	513
1 2 2	12 75 24 50 24 5	118	1 65	817
1 2 3	10 17 20 3 30 2	98		1 17
1 2 4	8 70 17 39 34 79	86	756	116
2 1 0	34 79 17 39 0 0	1244	7 6	
2 1 1	24 97 13 9 13 49	9	548	65
2 1 2	2 2 11 1 22 2	747	67	736
2 1 3	19 1 9 30 27 91	669	676	97
2 1 4	16 11 8 25 32 22	576	50	1 76
2 2 1	22 94 22 9 11 47	420	987	392
3 1	37 64 12 55 0	1455	565	
3-1 1	31 13 10 38 10 3	1203	451	346
3 2 2	23 79 15 86 15 86	782	690	579
4 5 0	25 96 32 45 0 0	5 9	1611	0
RATIO	GRADE	46 0	18 46 0	0 0 4
1 3 0	19 93 46 0 3 0	296	17 4	0
1 3 1	12 21 36 6 12 21	216	1157	407
1 3-2	10 15 30 44 20 29	196	1127	676
1 3-3	8 64 26 04 26 04	168	964	869
1 3-4	6 05 18 16 36 32	117	473	1711
1 3 9	4 65 23 94 41 82	90	516	1396
1 4-0	11 93 46 0 3 0	722	1278	0
1 4 1	9 65 38 60 9 65	696	1 72	322
1 4 2	8 31 33 25 16 63	522	924	556
1 4-3	7 32 29 21 21 90	459	911	730
1 4 4	6 51 26 04 26 04	459	723	968

APPENDIX TABLE 4

Crop	N 20% N Am. Sulph.	P_2O_5 18% Sup phos.	K20 60% M. Potash	Comments
Cane	75	45	100	Non-irrigated cane
	120	70	150	With irrigation
Coffee	30	45	30	1-5 yr
	60	40	90	5-15 yr
	50	30	75	Over 15 yr
Corn	60	70	80	60 bu/acre
Rice	80	40	40	Dry season
	70	40	40	Rainy season
	90	50	60	N/respons. var.