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TECHNICAL AND ECONOMIC FEASIBILITY OF BULK HANDLING-BLENDING IN GUATEMALA

COST, MATERIALS, EQUIPMENT AND OPERATION

BY

INTERNATIONAL FERTILIZER DEVELOPMENT STAFF
TENNESSEE VALLEY AUTHORITY

MUSCLE SHOALS, ALABAMA
FEBRUARY 1974

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TECHNICAL AND ECONOMIC FEASIBILITY OF BULK HANDLING-BLENDING IN GUATEMALA

COST, MATERIALS, EQUIPMENT AND OPERATION

Introduction

Many LDC's are now able to consider the technical and economic feasibility of producing their own finished fertilizers. Although the basic raw materials or intermediates may be imported there are potential savings with in-country manufacture of the final products. Bagging is usually less expensive in the importing country, importing in bulk is cheaper, and in-country employment is created.

Bulk blending is the simplest way to make finished mixed fertilizers. It involves only a physical mixing of a few intermediate products; no chemical reaction involved. Typical intermediates used in bulk blending include urea, ammonium sulfate, diammonium phosphate, triple superphosphate, and potassium chloride. They can be purchased and imported in bulk and mixed in the proper proportions to give the desired N-P or N-P-K ratios.

This report describes bulk blending and examines the potential for bulk blending in Guatemala. It should be useful as a guide to investors having an interest in such a facility. Sufficient information is presented to allow the interested party to discuss the process with a contractor who can furnish engineering design and details.

The Tennessee Valley Authority (TVA) developed this report with financial assistance from the Agency for International Development (AID). As an agency of the United States Government, TVA does not endorse any particular name or brand of equipment, process, or fertilizer material and does not design, fabricate, construct, or engineer fertilizer facilities such as bulk blending plants.

Summary and Recommendations

With some modifications to its ports, Guatemala could import bulk fertilizers and fertilizer raw materials for bulk blending N-P or N-P-K products. Based on present rail and truck capability, the plant should be located in the Caribbean area at Santo Tomas or Puerto Barrios, with truck and/or rail delivery of bagged product to distribution centers. Such a system would be comparable to what is being done in Brazil, where large storage capacity is required, product moves only in bags, and the truck is the primary transport vehicle. Potential investors would gain much useful information by visiting Brazilian bulk-handling and blending facilities. For a number of reasons, it is felt that the plant probably would not be built near the port of Acajutla in El Salvador. If the capability for bulk transport of bulk fertilizer in-country is developed, an alternate site for the blending plant could be Esquintla or Guatemala City.

Results of the economic estimate show that based on current world market import prices, which are high due to demand and non-availability, product to the farmer will be quite high, primarily due to the high cost for nitrogen (urea). Estimated sales prices are $8 or more per cwt (100 lbs), Esquintla, with straight urea selling for about $12 per cwt ($264/mt). Additional charges are necessary to reach the farmer (freight and distribution charges). Based on current conditions, the facility would not significantly lower fertilizer prices to the farmer as Guatemala has the ability to obtain fertilizers through means other than straight imported bagged material. The N-P or N-P-K product could be sold at Esquintla for about $6 per cwt (100 lbs) and $7.50 per cwt for urea. No attempt is made to forecast what the market will do and if and when prices will decline; not much change will be noted probably through 1975.

If, on the other hand, it can be assumed that the farmer can buy fertilizer, even at the higher prices, then a bulk handling-bulk blending facility is a potentially sound investment. Since raw material cost accounts for the major portion of total production cost in blending it is necessary to fully investigate cost and availability prior to making a decision on investment.

Specific Recommendations are as follows:

1. Special attention must be paid to procurement to assure getting good quality raw materials, with some precautions taken during handling and storing to avoid degradation and segregation. Only granular materials should be used, but micronutrients may be used in powdered form with a binder.

2. If bulk blending is carried out, the first shipment of urea should be conditioned to avoid any possible bulk storage problems. Based on results, unconditioned or lightly conditioned urea could be tested. The exact humidity levels of the port area are not known.

3. If it is necessary to build new storage facilities a wood pole-concrete type structure is recommended with a minimum of exposed steel. The building would consist of horizontal or ground-level storage.

4. Raw materials should be weighed prior to mixing to assure accuracy. A rotary mixer probably would be best although other types are capable of adequate mixing. The plant should have bagging capability of 30 mt/hour.

5. A source of filler (screened limestone) should be found to allow the production of even-numbered formulas.

6. Scheduling should be such that raw materials are on hand and blending begun prior to the peak season of February, March and April.

7. Imported raw material costs for blending account for a large portion of the total production cost; selling price is heavily influenced by this cost. Large tonnages should be procured where possible to obtain the lowest cost.

8. Until bulk transportation in-country is possible, the site for the plant should be Santo Tomas or Puerto Barrios with truck or rail shipment of bagged product. If bulk shipment by rail becomes possible, a site at Guatemala City or Esquintla would be suitable for the blending plant.

9. Potential investors should get to know in detail the port and transportation facilities. When bulk unloading at 150 mt/hr (1200 mt/day) is possible, bulk blending can be carried out.

10. The blend should be made in the highest grade possible with the available materials (e.g., a 19-19-19 instead of 15-15-15) to achieve the lowest cost per mt of nutrients to the farmer. This will require some farmer education as they are accustomed to buying on a cost per bag basis.

11. The availability of raw materials should be assured before investment is made.

12. Compared with importing bagged products from a developed country such as the United States, bulk importing and blending-bagging in Guatemala will be cheaper as labor is less expensive, and import duty is eliminated. Bagged urea will cost about $20.00 per mt (F.O.B.) more in the United States than bulk urea; it is estimated that the total operating cost per mt is $15.00 for a 14,000 mt/year plant for production of N-P or N-P-K bulk blends and $9.01 per mt for bagging of 6,000 mt straight urea in the same facility. A given plant should be operated at the highest possible capacity. This will lower the cost per mt.

The Fertilizer Situation in Guatemala

Consumption of fertilizer in Guatemala has increased from about 15,000 mt of N, P_2O_5, K_2O in 1962 to around 50,000 mt in 1972. Much of the growth is in nitrogen products.

Material and analyses	Plant Nutrient Content $N-P_2O_5-K_2O$, %	% of Total Used
Urea (46%N)	46	33
16-20-0	36	18
15-15-15	45	13.5
20-20-20	40	12.0
Ammonium Sulfate (21%N)	21	5.5
Ammonium Nitrate (33%N)	33	3.5
12-24-12	48	6.3
14-14-14	42	3.7
Other phosphates	--	3.4
Other mixed goods	--	1.0
Average	38.9	Total 100 %

In 1972, the N-P-K ratio was about a 2-1-0.5. In some previous years over 40 different analyses have been imported for farm consumption. Fewer than 20 grades are being imported now, but there is some indication of a need for more specific ratios tailored to individual crops.

Guatemala's only fertilizer granulation plant was brought on in 1972 at Tecun-Uman near the Mexican border. It has a capacity of 60,000-70,000 mt/year of mixed fertilizers in various ratios. Raw materials for the plant are imported to Guatemala by rail. This plant and plants in Costa Rica and El Salvador supply a significant portion of Guatemala's fertilizer needs.

About 85% of the fertilizer used in Guatemala is distributed through the private sector. The remainder distributed by the Government through

BANDESA and through two cooperatives, FENACOAC[a] and FECOAR.[b] It is estimated that about 85% of all fertilizers are distributed through private distributors and dealers.

Imports into Guatemala are through Caribbean ports, Puerto Barrios and Santo Tomas, and through the Pacific port of Champerico and across Mexican and El Salvador borders. If the fertilizer is imported from outside the Central American Common Market (CACM) there is a 10% import duty and from within there is only a border tax of about $0.02 per 100 lb (cwt) bag or 44¢ per mt.

Description of Bulk Blending Process

In order to adequately describe a bulk-blending process, it is necessary to look at the total system starting at the procurement of raw materials to the point of distribution to the farmer. Figure 1 shows a flow diagram of the process. In step 1 raw materials such as urea, diammonium phosphate (DAP) and potassium chloride (KCl) are purchased in bulk usually by direct contact with a company or through an exporter-importer. The bulk materials are shipped in bulk to the importing country either by ocean-going ship, coastal barge, rail or truck or possibly a combination of these. The importing country must have adequate facilities for receiving bulk cargo. In the case of Guatemala the only in-country production is in the form of N-P or N-P-K granulated compounds which is already a complete fertilizer. Therefore, it is most likely that incoming materials will arrive via ocean-going ship. Adequate storage facilities must be available for storage of the bulk materials.

Step 2 involves the reclaiming of raw materials from storage for use in preparation of the formulas. Step 3 is the metering or weighing of the raw materials in the proper proportions as specified by the formula.

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a) National Federation of Cooperatives of Savings and Credit (Federacion Nacional de Cooperativas de Ahorro y Credito)

b) Federation of Regional agriculture Cooperatives (Federacion de Cooperativas Agricolas Regionales)

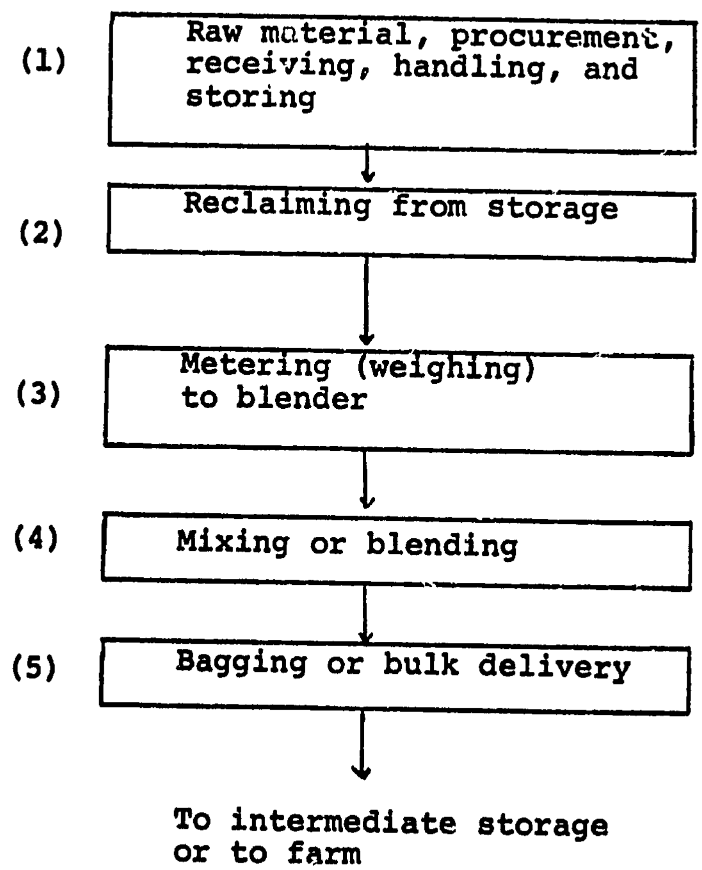

Fig. 1. STEPS IN BULK BLENDING

The materials are mixed in Step 4 to give a homogenous product. Then it is moved in bulk or bagged (Step 5) for distribution to regional warehouses or to farmers.

Procurement of Raw Materials

Much of the success of any fertilizer venture will depend upon the procurement procedures used. It is necessary to plan several months ahead to determine the types and quantities of materials needed and their cost. Advance planning also is required for receiving and unloading and to assure proper handling procedures.

Table 1 summarizes specifications for various materials. Most producers who sell internationally meet these specifications.

Granular materials are much preferred over powdered products for bulk blending. Procurement of materials should take into account two potential problems: (1) Excessive amounts of fines (minus 28 mesh) cause segregation of components during handling and distribution; best results are obtained from uniformly sized granules. (2) Moisture content that is too high can lead to caking during storage. Urea can be especially troublesome in this regard. This study assumes that use of conditioned urea (45% N) will avoid problems with it in bulk storage. Bulk storage time should be minimized for most fertilizer products in humid areas.

Importers need to become familiar with the various organizations that export and import fertilizers and constantly monitor the world supply-demand-price situation. Such organizations as Transammonia, Inc.; International Ore and Fertilizer Corporation (INTERORE); H. J. Baker and Bro., Inc.; International Commodities Export Corporation (ICEC); Woodward and Dickerson, Inc.; Central Resources Corporation; Mitsubishi International; and others deal internationally and assume responsibility for ship chartering and insurance and guarantee the quality of the product upon arrival.

TABLE 1

TYPICAL SPECIFICATIONS FOR RAW MATERIALS FOR BULK BLENDING (a)

Name of Material	Type of Particle	Analysis,(b) Wt.% N	P_2O_5	K_2O	Particle Size (c) (Tyler Mesh)-U.S.	Moisture Content (d) % H_2O Maximum
Normal Superphosphate (NSP)	Granular	0	20	0 (125)	90%-6+16	4.0
Triple superphosphate (TSP)	Granular	0	46	0	90%-6+16	4.0
Monoammonium phosphate (MAP)	Granular	11	48	0	90%-6+16	2.0
Diammonium phosphate (DAP)	Granular	18	46	0	90%-6+16	2.0
Nitric phosphate (NP)	Granular	20	20	0	90%-6+16	4.0
Ammonium sulfate (AS)	Granular	21	0	0 (245)	90%-6+16	1.0
Urea	Prills (e)	46	0	0	90%-6+16	0.5
Ammonium Nitrate (AN)	Prills (e)	33.5	0	0	90%-6+16	1.5
Potassium Chloride (KCl)	Granular	0	0	60	90%-6+16	0.5
Ammonium Nitrate Sulfate (ANS)	Granular	30	0	0 (5S)	90%-6+16	1.5
Potassium Sulfate (f)	Granular	0	0	50 (175)	90%-6+16	0.5

(a) Most materials available in the world market when sufficient supplies available; specifications are usually met by most producers in international trade.
(b) Some materials such as ammonium phosphate require a more detailed analysis.
(c) Essentially all material should be caught on a 28-mesh screen to avoid fines.
(d) Excessive moisture can possibly cause caking in storage.
(e) Not usually available in granular form, although some plants are starting to produce; usually has chemical conditioner. A 45-0-0 grade usually has a clay conditioner.
(f) Sometimes specified for tobacco to eliminate chloride; potassium nitrate also used for tobacco in United States rather than KCl.

Bulk Handling Facilities

Most bulk fertilizer is unloaded from the hold of the ship with a crane and clamshell; the crane may be either track-mounted or available as ship's gear. Many of the newer ships, which have capacity for up to 15,000 mt or more, are equipped for bulk unloading. The more modern ports are usually equipped for bulk loading and unloading. A person interested in bulk blending should survey the ports at or near the potential sites for the bulk storage-blending facility. Bulk fertilizer should not be purchased unless it can be unloaded at about 150 mt/hour.

Some LDC's have developed ways to unload in bulk without modern facilities; methods include use of a rope-mat or tilting buckets. By using multiple units of a combination of these methods and a large amount of manual labor they have unloaded at the rate of 120 mt/hour. Guatemala plans to modernize the port of Santo Tomas to allow bulk loading-unloading, including fertilizer.

Once material is off-loaded several alternate methods can be used to place the material in storage. They range from a fleet of trucks to covered conveyors. Expensive installations, such as marine legs and conveyors, cannot be justified for only a few shipments of fertilizer per year.

Bulk Storage

It is highly unlikely that a bulk storage facility will be available near the discharge point, although this should be investigated prior to making a decision to build all new facilities. Perhaps an existing building could be modified by addition of conveyors, retaining walls, etc., for bulk storage use. Renting or leasing such a builing might be cheaper than building a new one. If it is determined that a new building is required an engineering firm should be employed to survey the site, check soil-bearing characteristics, and design the structure.

Brazilian producers have large bulk storage facilities in conjunction with both bulk blending and granulation facilites. They use large amounts of wood and concrete and a minimum of steel. A common building in Brazil has concrete floor and sidewalls and wooden overhead beams (although steel is used in some). The top and sides are covered with pressed asbestos sheet. For the load-bearing walls, wood poles (about 12'' in diameter, 30 ft-long) are set in concrete with two poles spaced about 6 inches apart in rows. The double poles aligned in rows are matched so that 1'' x 6'' timber can be laid in with wood spacing blocks to build up the walls. Anchor rods are sometimes used for added strength.

A wood-concrete type of structure would appear to be an economical type of construction if a country has wooden poles and facilities for treating them to retard decay. This type is recommended for Guatemala. Guatemala should have wooden poles available although treatment to retard decay may be a problem.

Based on urea with a density of 46 pounds per cubic foot and an angle of repose of 30°, a 15,000-mt bulk storage building would need to be about 120 ft by 300 ft, with a peak height of 30 ft. This would allow a 14-ft aisle for the payloader (front-end loader) to operate. Brazil would be a good source of information for this type of building.

The floor should be above grade to prevent moisture penetration from run-off water. It should have a smooth finish, but not be slick. Uneven areas in the floor can cause damage to the pay loader. The use of a pole building for Guatemala should be investigated in more detail prior to making a decision on steel-concrete combination.

In the United States and other countries basically two types of raw material storage are found, vertical storage or horizontal storage.

Vertical Storage--In small blending plants, about 3,000 mt per year (Fig. 2), vertical or elevated storage is sometimes used. Elevated storage can be in the form of tanks or bins above ground where the materials are placed in storage by an elevator and reclaimed by gravity. However, in high-humid areas where caking is a problem flow by gravity is not dependable. It has been necessary to dehumidify this type of storage in the southern United States, for example.

Horizontal Storage--Blending plants having a relatively large annual production, greater than 5,000 mt per year, use horizontal or ground-level storage. The most common building has a relatively smooth concrete floor, although Brazil uses in-laid stones and mortar in some cases. This type of floor can cause some problems with a front-end loader. Horizontal storage is cheaper than vertical storage and is recommended for Guatemala if a bulk blending plant is built.

Raw Material Metering Systems

Numerous types of metering systems have been used to feed the proper quantities of raw materials to be blender or mixer. In some cases even a wheelbarrow was used; some systems are totally automatic with electronic controls. Others use a payloader to dump directly into a weigh hopper. Other systems have overhead hoppers holding small quantities of raw materials which feed to a weigh system. In some plants raw materials are metered by volumetric feeders. For bulk blending, it is recommended that a weigh type of system be used to assure accuracy.

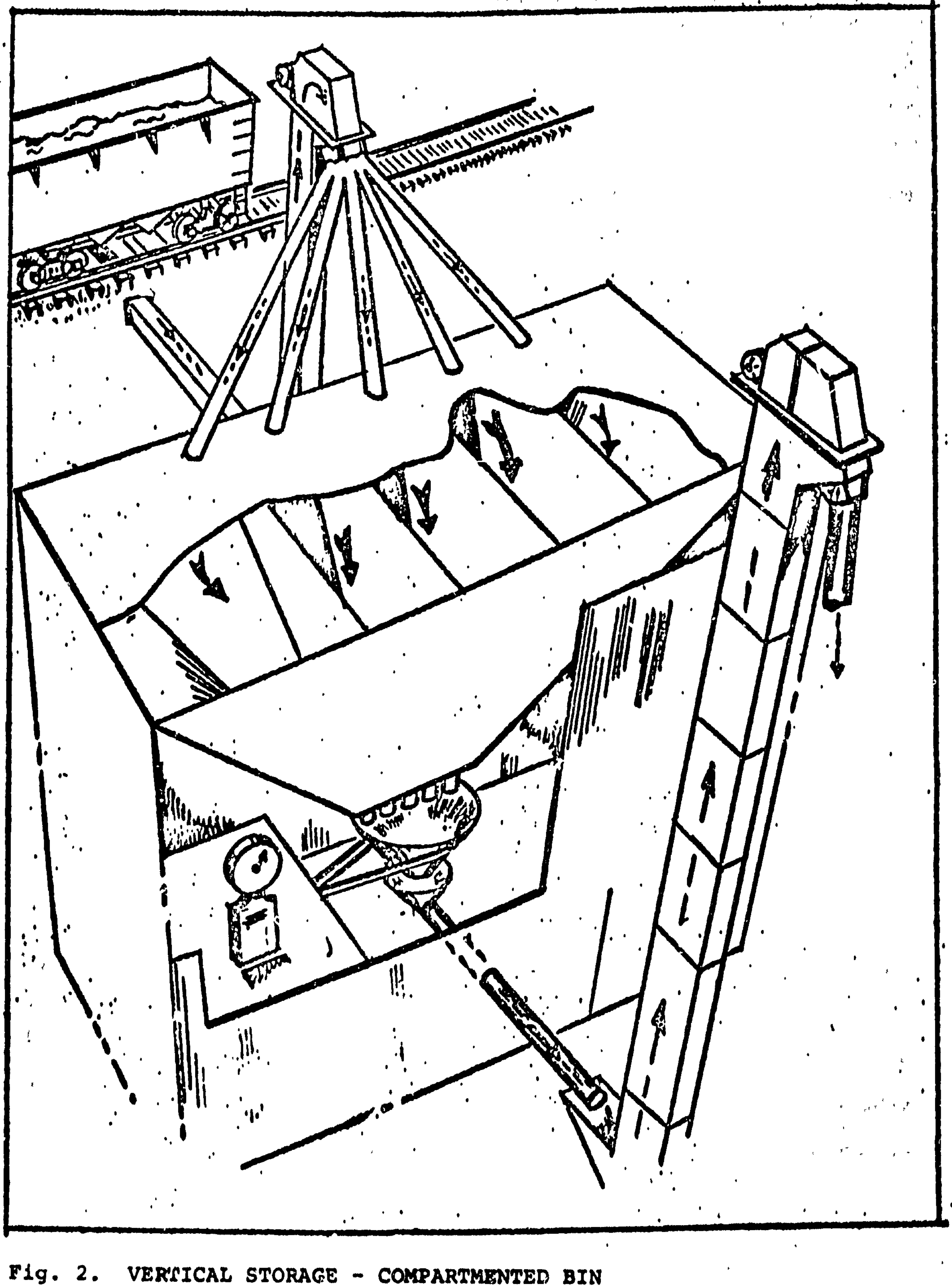

Fig. 2. VERTICAL STORAGE - COMPARTMENTED BIN

The hopper-type of weigh system has proven to be very satisfactory in many installations, although the initial cost is higher than for some systems. In this system, a front-end loader removes a material in bulk from storage and dumps it into a lump-breaker; the lump breaker feeds an elevator which discharges from a movable spout to one of several hoppers arranged in cluster. The front-end loader thus keeps each hopper filled with the proper raw material. An indicating system shows the loader operator which hopper needs additional material. A weigh hopper capable of holding 1, 2, 4, or 6 mt is located directly beneath the cluster hoppers. The weigh operator opens a valve, manual or automatic, allowing material to fall into the weigh hopper while observing the weigh scale. When the correct amount of material has been added, he starts the weigh sequence for the next material until the complete batch has been weighed. He then dumps the total weighed batch into a feed hopper conveyor system feeding the mixer. This way, it is relatively easy to make a small batch of one grade to meet the requirements of an individual customer. This prescription type of formulation for a specific crop or soil is one of the main advantages of bulk blending. Such flexibility is not practical in a granulation plant.

Mixers

Rotary--Many bulk blend plants in the United States and Brazil use a rotary mixer. This mixer can be installed in an elevated position so that materials flow by gravity from it to the bagging machine; or it can be located at ground level, in which case the product is elevated for bulk loading or to a bagging machine.

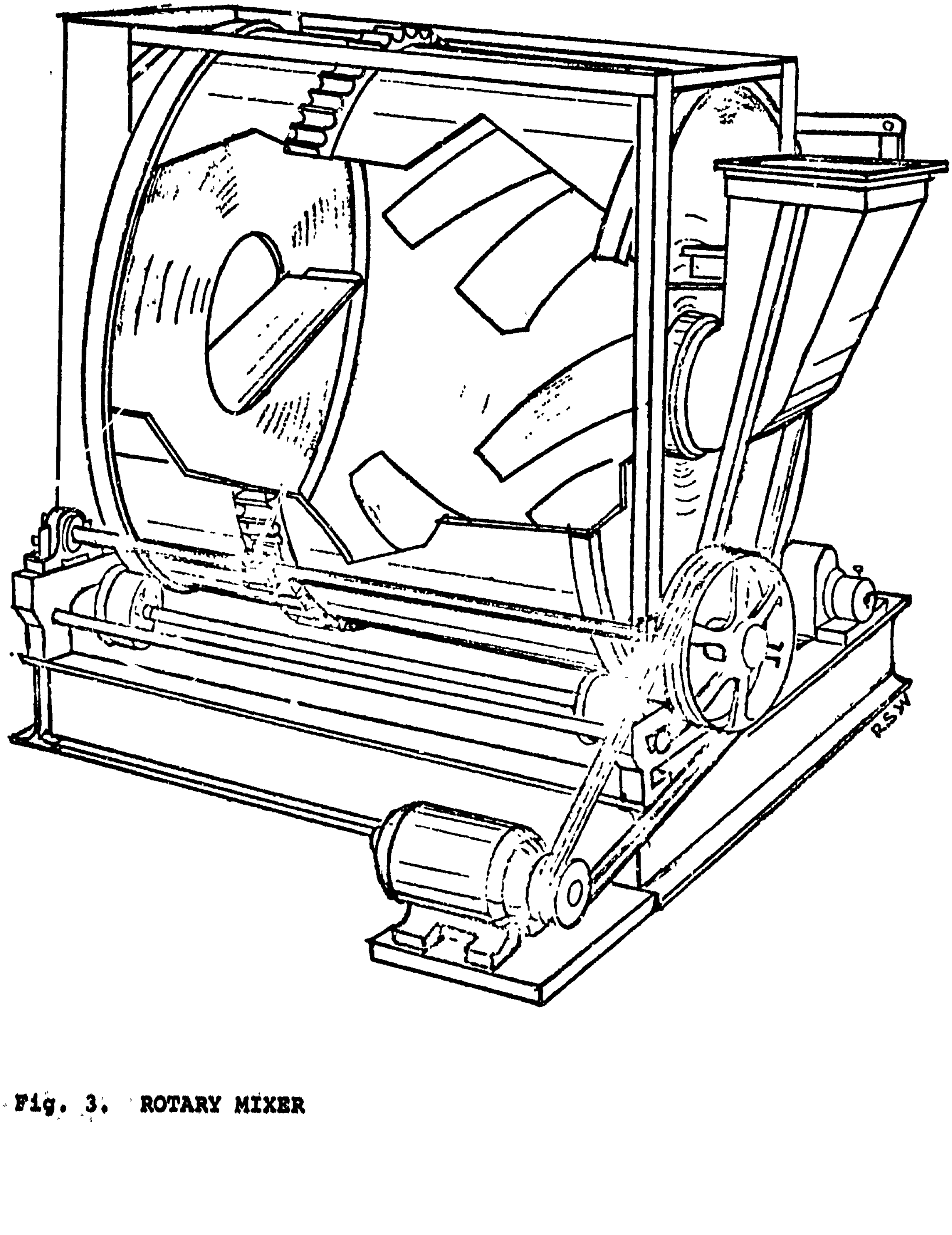

Fig. 3. ROTARY MIXER

There are two basic types of rotary mixers--those which rotate in one direction only, (Fig. 3) and those which rotate in one direction for mixing but reverse direction to discharge product. The latter is the type of mixer used for mixing concrete

The one-direction mixer's diameter is relatively large in relation to its length. A typical size unit will handle a 2-ton charge. The charge can be weighed, charged, mixed and discharged in about 3 minutes, which give a maximum capacity of about 40 tons/hour. However, the actual production rate likely will be less, so that one bagging machine will be sufficient for the immediate need.

Concrete-type mixers are available with up to 6-mt capacity, they have essentially the same throughput as the other type of rotary mixer, but segregation is more likely during discharge from concrete mixer type.

Fig. 4 shows a rotary mixer and other equipment.

Mixing Screw Conveyor--This is a simple mixer in which a screw conveyor has been modified to accomplish mixing (Fig. 5). Mixers of this type have slots cut in the flights to provide for a longer reteintion time and better mixing. Often two screws are used together, one horizontal and the other vertical. Generally, the capacity or throughput with this equipment is less than for a rotary-type mixer.

Ribbon Mixer--Mixing is accomplished by a ribbon-type agitator that tumbles the bed of material in the mixer (Fig. 6). After mixing, material is discharged by opening a gate at the bottom. This is relatively efficient and micronutrients can be added rather easily. This mixer is mounted on a set of scales and generally is charged with a front-end loader. Capacity is from 1 ton to 4 tons. This mixer is not as popular as the rotary mixer.

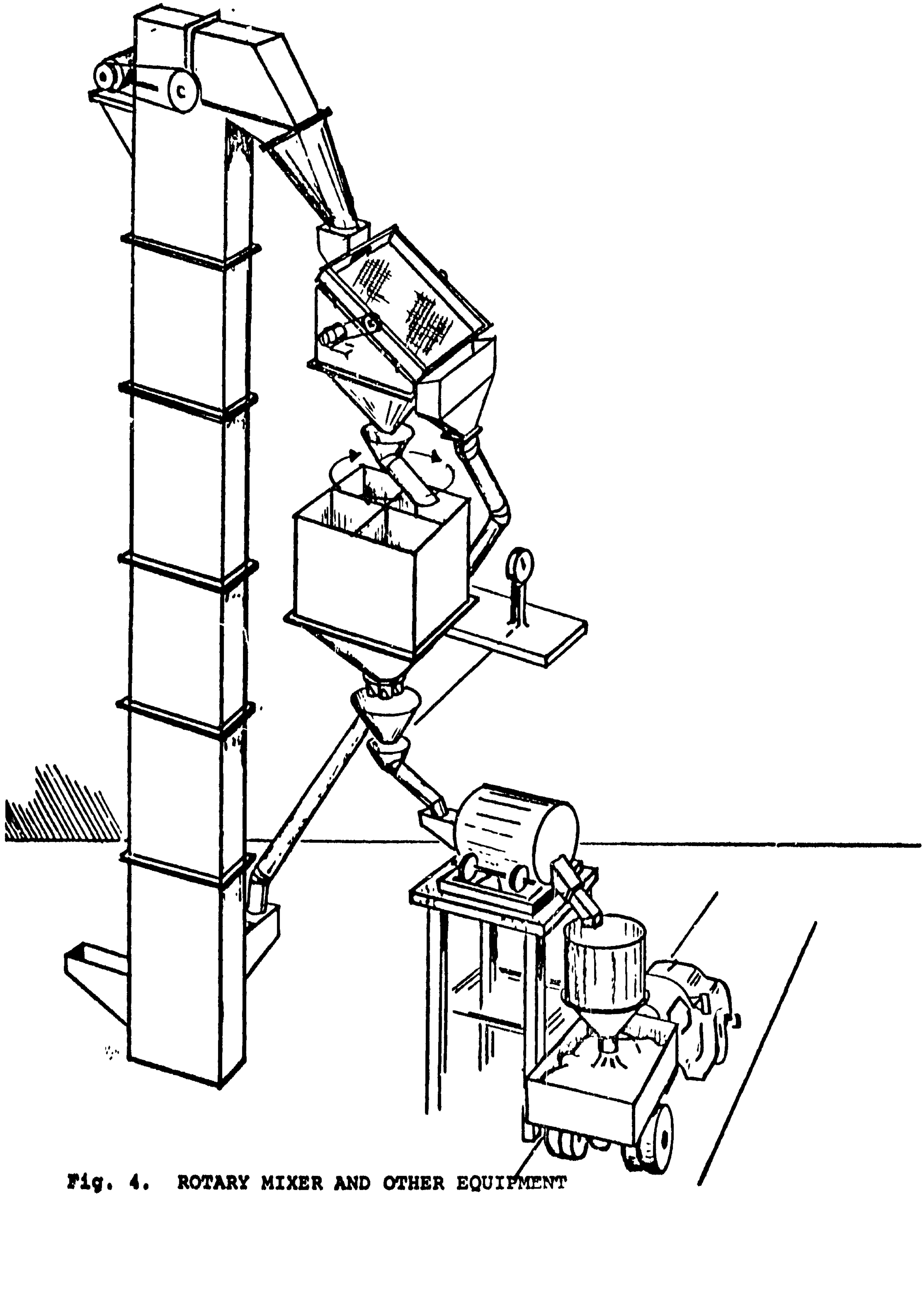

Fig. 4. ROTARY MIXER AND OTHER EQUIPMENT

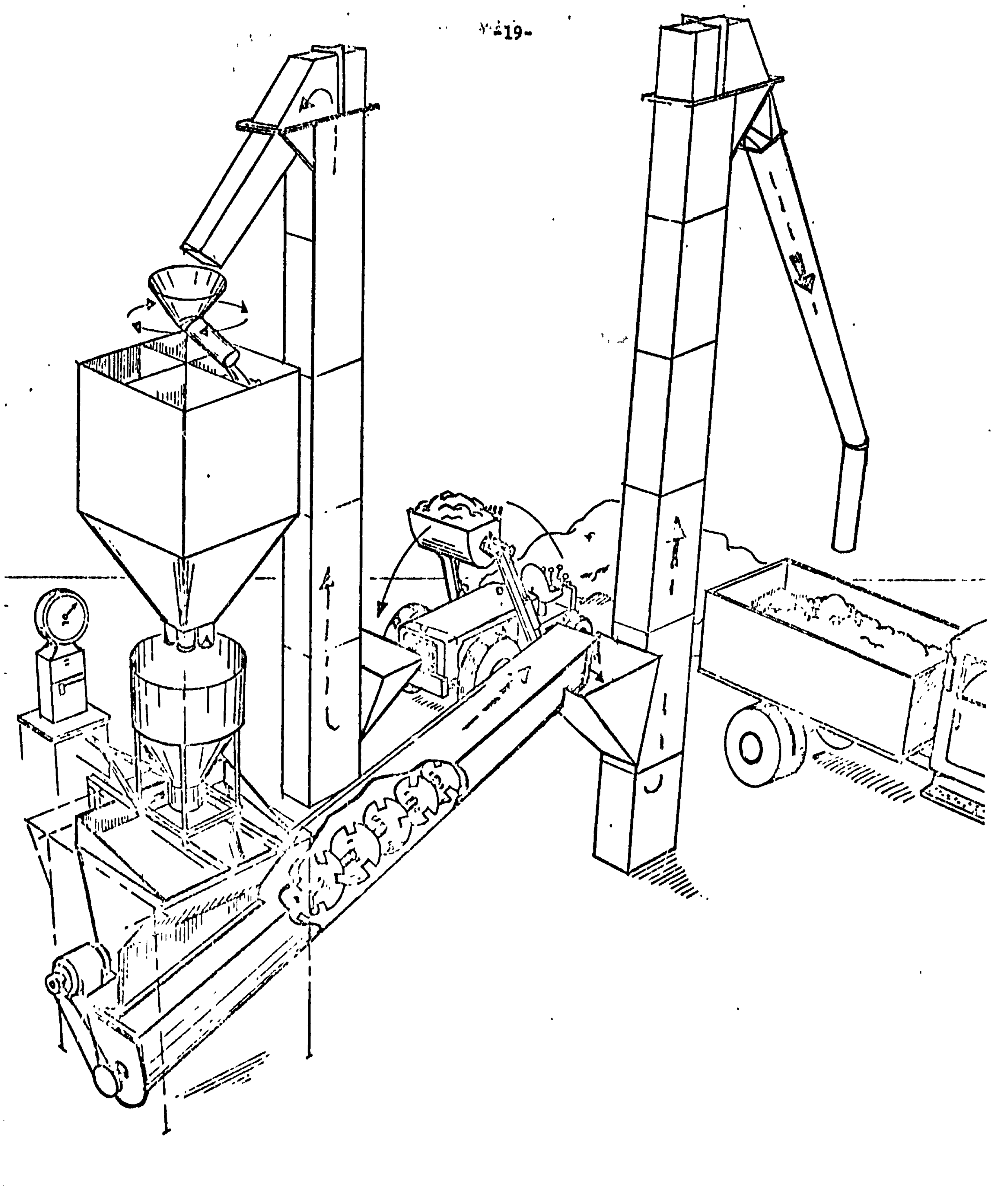

Fig. 5. BLENDING PLANT WITH SCREW CONVEYOR AS MIXER

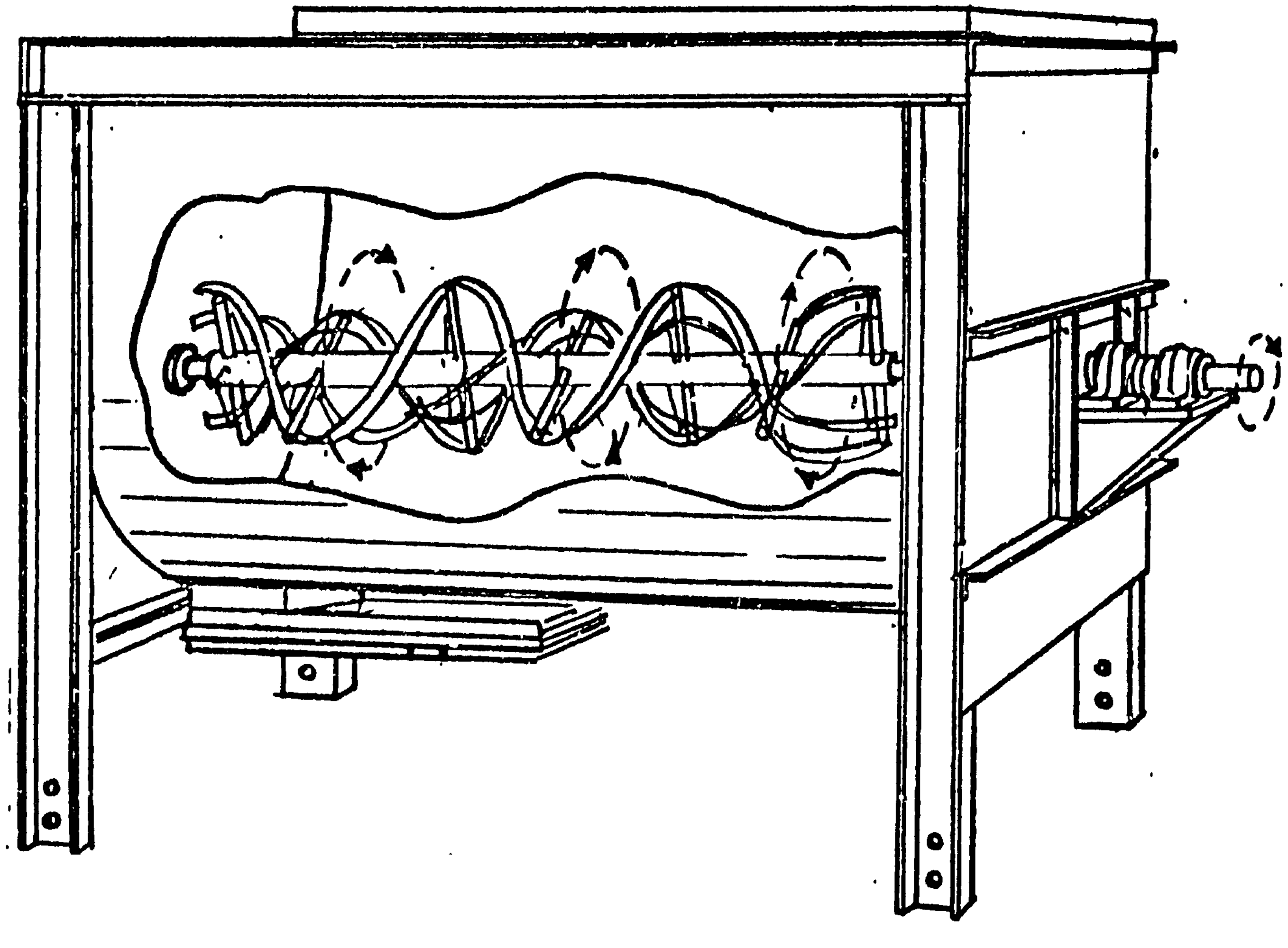

Fig. 6. RIBBON MIXER

Gravity Flow Mixers--There are several types of gravity-flow mixers. Some are very simple, others more elaborate. In general, materials are metered and fed to a holding bin(s) at the top of a tower then a gate is opened, allowing the materials to fall by gravity over a mixing section.

TVA designed a simple mixing tower of this type from wood (Fig. 7). It contains a holding section at the top. Inside the tower, baffles set at an angle cause the materials to mix as they fall.

Other types of mixing towers are constructed of metal and contain inverted cones (Fig. 8). Some plants combine this mixer with a screw-type mixer (conveyor) in parallel to ensure complete mixing and to convey the mixed product. Both types of these mixers reportedly work well with granular materials.

Recommended Plant

The following summarizes recommendations for a bulk blending plant in Guatemala if the decision is made to build one:

HORIZONTAL (GROUND LEVEL) STORAGE IN WOOD-AND-CONCRETE BINS; ELEVATOR AND OVERHEAD CONVEYOR FOR RECEIVING RAW MATERIALS; FRONT-END LOADER FOR RECLAIMING FROM STORAGE; WEIGH-HOPPER TYPE OF FEED SYSTEM; 2-TON ROTARY MIXER TURNING THE SAME DIRECTION FOR FILLING AND EMPTYING INSTALLED AT GROUND LEVEL; ELEVATED HOPPER FOR BAGGING MACHINE; AUTOMATIC BAGGING MACHINE CAPABLE OF AT LEAST 30 MT/HOUR OF 45-kg (100 LB) BAGS; AND A SET OF SCALES TO CHECK THE BAGGING ACCURACY.

A sketch of the plant is shown in Fig. 9 and an estimated cost for the plant is given in the appendix.

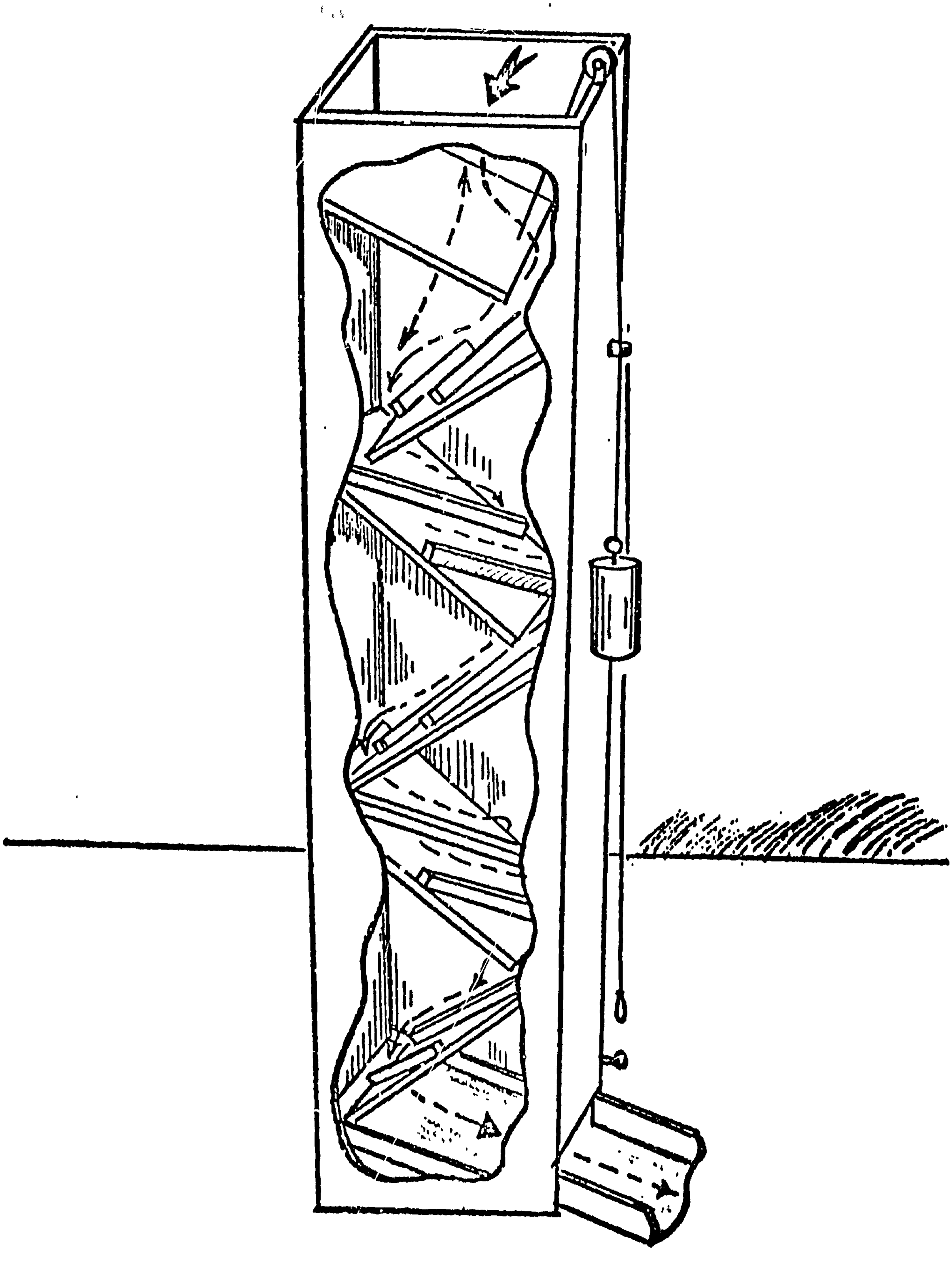

Fig. 7. GRAVITY MIXING TOWER

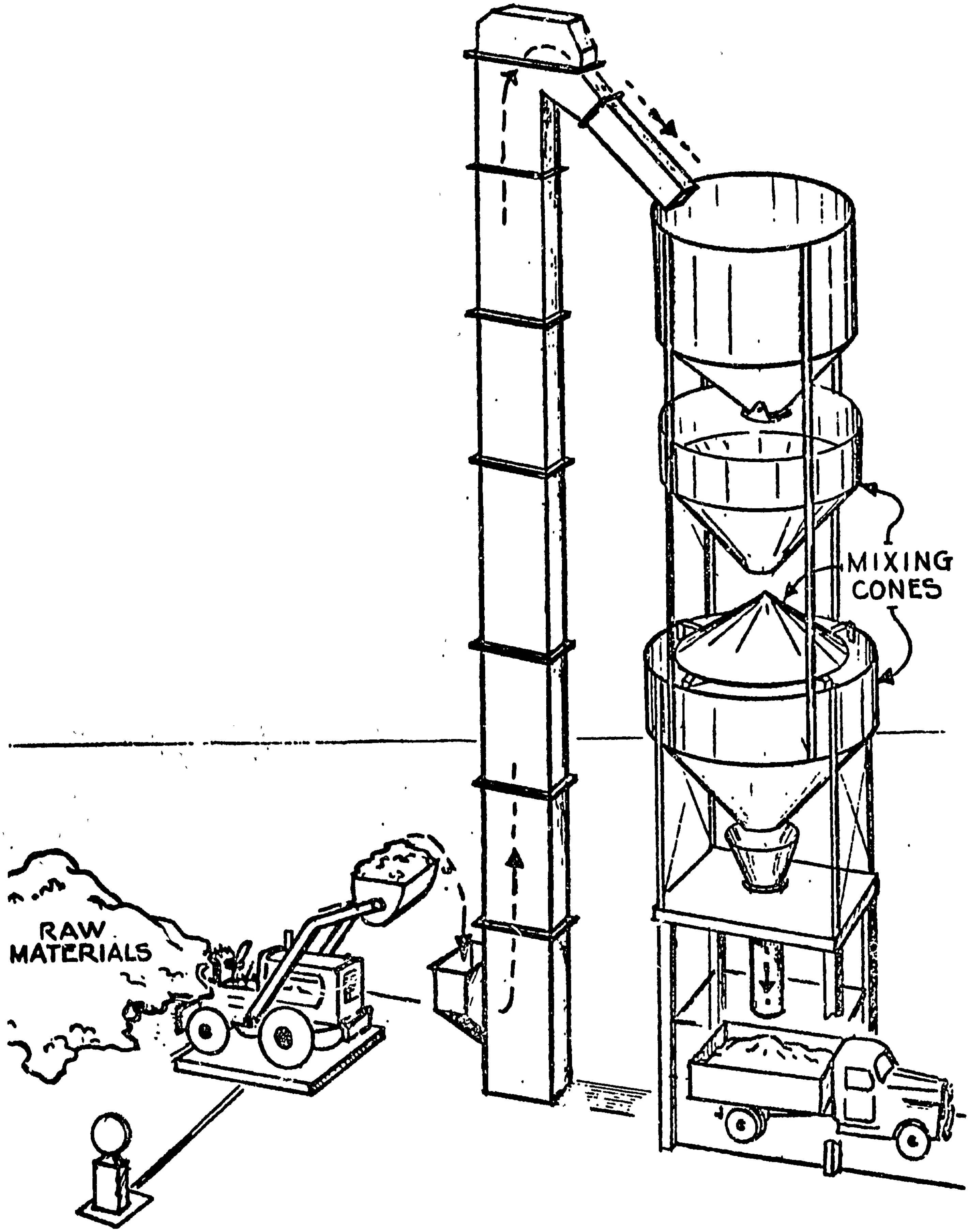

Fig. 8. BLENDING PLANT WITH CONE-TYPE MIXER

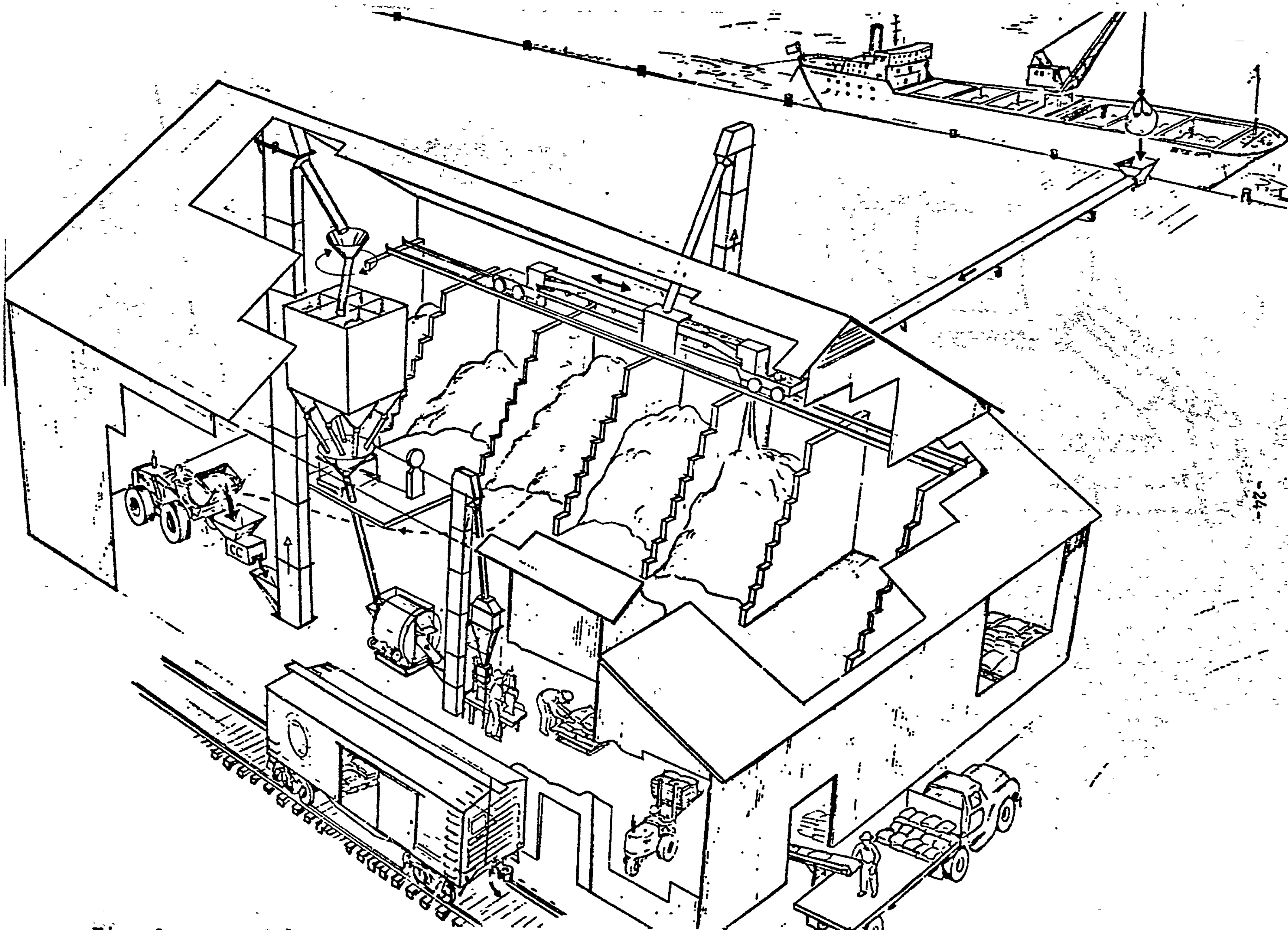

Fig. 9. PICTORIAL VIEW OF PROPOSED FERTILIZER FACILITY

Heat sealing should be studied for use in Guatemala, although the tied liner will be sufficient for the moment. Heat sealing gives an air-tight seal, which is especially desirable in humid areas for such materials as urea. Also, a heat-sealed bag cannot be opened and resealed without which would discourage tampering with the product.

Storage of Bagged Product

Any production facility whould have adequate storage. A bag storage building should permit easy entry into the storage areas. A smooth concrete floor is recommended. A minimum quantity of poles should be used allowing maximum use of floor space. The roof can be made of wood covered with tin or asbestos sheeting. Asbestos is quite popular in Brazil.

Wooden pallets often are used for storage and handling of bagged fertilizer near the processing plant. The pallets are handled by a fork lift. The bags are removed from the pallets for shipment by truck or rail. A loading conveyor for trucks or rail is helpful but not necessary.

In Brazil, large quantities of bagged fertilizer are stored outside by stacking up to 10 bags high on wooden pallets. The stack is then covered with a polyethylene sheet. This method can be used around the processing plant to increase bag storage capacity temporarily during the peak season.

Plant Operation

Operation of a bulk blending plant is relatively simple but some precautions are necessary to assure good operation. In addition to providing the best types of equipment it is necessary to avoid the mixing of certain materials and to operate the equipment in a manner that minimizes segregation of component ingredients.

Compatibility of Materials

Many different types of intermediate fertilizer materials can be used in a blending plant. The more common are listed below:

	Analysis, wt% $N-P_2O_5-K_2O$ (S)
Normal superphosphate, granular	(0-20-0)
Triple superphosphate, granular	(0-46-0)
Monoammonium phosphate	(11-48-0)
Diammonium phosphate	(18-46-0)
Nitric phosphate	(20-20-0)
Ammonium nitrate	(33.5-0-0)
Ammonium sulfate	(21-0-0)
Urea	(45-0-0)
Ammonium nitrate sulfate	(30-0-05S)
Potassium chloride, granular	(0-0-60)
Potassium Nitrate	(15.5-0-44.5)
Potassium Sulfate	(0-0-50-17S)
Potassium magnesium sulfate	(0-0-22.2,22.2S,11.2 Mg)

Some areas require such micronutrients as magnesium, boron, copper, iron, manganese, and zinc. Most of these materials can be purchased either in granular or powder form. Procedures are available to use both powdered and granular materials in blends. Best results are usually obtained with the use of powdered micronutrients, provided that a binding agent is used to stick the powder to fertilizer granules.

Some materials should not be blended as undesired chemical reactions occur which result in a sticky unusable product. Compatibility charts have been constructed which show which materials should not be mixed.

Urea and Ammonium Nitrate--These two materials should not be blended under any circumstances; the mixture has a critical relative humidity of 18%, and stickiness or even severe wetting is almost certain within a few hours. Care should also be taken to prevent cross-contamination in storage.

Urea and Superphosphates--Urea can react with unammoniated normal or triple superphosphate and become "wet" due to the reaction of urea with monocalcium phosphate monohydrate. The adduct that forms releases water of hydration. This is not a problem with ammoniated superphosphate.

Diammonium Phosphate and Superphosphate--Ammonia from diammonium phosphate can react with unammoniated superphosphate to release water of hydration. Monoammonium phosphate crystals form, causing caking. This mixture is not recommended, especially for bagging and storage. If it must be used, a conditioner is recommended.

Segregation

Segregation is the "unmixing" that can occur during handling, storage, and transport. The main reason for segregation is the difference in particle size among the ingredients. Therefore, the importer should buy good quality, properly sized materials. Minimizing the number of ingredients in a formulation through use of multinutrient materials will reduce the segregation problem. Since large granules roll farther than small ones they end up on the outside edge (and fines in the center) when materials are allowed to "cone" during handling. Thus, minimizing coning will minimize segregation of ingredients of unmatched particle size. A movable spout, multi-point discharge, or telescoping fill-pipe is helpful in this regard.

Fillers or inert materials used to adjust the grade should also be closely sized to match the fertilizer ingredients. A filler can be an inexpensive material such as limestone, but it should be similar in size to the fertilizer particles. It should be dry and free flowing. The filler is only used to make the proper grade in a given ratio and has no fertilizer value. Although not recommended due to the small particle size, sand could be used if no other material is available; the mix probably will segregate badly.

Moisture absorption during storage should be minimized such as by covering the pile with a polyethylene sheet. In severe cases, dehumidification equipment can be installed.

TABLE 2

LABOR SCHEDULE FOR BLENDING PLANT

(Operation Only)

BASIS: 2-ton rotary mixer capable of producing 40 mt/hr, but operating at 30 mt/hr.
Operation for 8-hr/shift, 5 day per week or 240 mt/day or 1200 mt/week.

The plant is assumed to have the annual employees below for production and is able to obtain hourly workers as needed.

Annual[b]

Plant manager, $400/month x 12 months		4,800
Operator		
weighing and mixing,	$150/month x 12 months	1,800
front end loader,	$100/month x 12 months	1,200
bagging machine,	$ 80/month x 12 months	960
Analysts		
fertilizer	not required	--
soil	not required	--
mechanic	$100/month x 12 months	1,200
	Total annual salary	9,960

CASE I (Annual production, 10,000 mt/year)

Annual, salaries and benefits		9,960
Hourly laborers		
4 bagging		
3 loading truck or storage		
1 raw materials unloading		
8 at 42 days at $3.00/day		1,008
	Total, $/year	10,968

$$\$/mt = \frac{\$10,968}{10,000} = \$1.10/mt$$

(a) Not including sales and administrative personnel.
(b) Fertilizer and soil analyses to be done by outside laboratory.
(c) Some plants in LDC's tend to have more employees.

Economics of Bulk Blending

In order to make some economic comparisons, a bulk blending plant installed in Guatemala in 1975 was estimated to cost $176,000. (See Table A-1 in appendix). The total cost of the facility, including storage for bulk and bagged product is $400,000; this does not include the cost of land and dock or extra port facilities that may be required. This plant investment is somewhat higher than for the United States, but 40% of the cost is assumed necessary for freight and installation.

Based on Guatemalan pay schedules the estimated cost for labor to operate the bulk blending plant versus annual production is shown in table 2. The plant is operated by annual and hourly employees as shown. The cost for bagging only of a straight material such as urea only is shown in Table 3; only additional hourly help is needed as the annual employees are already paid, and interest, depreciation, etc., are already charged to blending. The bagging rate is 30 mt per hour or 240 mt per 8-hour day.

Operating Costs

Fixed and variable costs for operations of the bulk blending plant versus annual production are shown in table 4 for the range of 10,000 mt to 30,000 mt per year. The plant is capable of operating at 40 mt per hour, but is assumed to only produce at the rate of 30 mt per hour. The number of working days per year to produce the quantity of product is shown also in this table.

CASE II (Annual Production, 15,000 mt/year)

Annual, salaries and benefits	9,960
Hourly laborers (63 days per year)	
8 men x 63 days x $3.00/day	1,512
Total, $/year	11,472

$/mt = $\frac{\$11,472}{15,000 \text{ mt}}$ $0.76/mt

CASE III (Annual Production, 20,000 mt/year)

Annual, salaries and benefits	9,960
Hourly laborers (84 days per year)	
8 men x 84 days x $3.00/day	2,016
Total, $/year	11,976

$/mt = $\frac{\$11,976}{20,000 \text{ mt}}$ $0.60/mt

CASE IV (Annual Production, 25,000 mt/year)

Annual, salaries and benefits	9,960
Hourly laborers (104 days per year)	
8 men x 104 days x $3.00/day	2,496
	12,456

$/mt = $\frac{\$12,456}{25,000 \text{ mt}}$ = $0.50/mt

CASE V (Annual Production, 30,000 mt/year)

Annual, Salaries and benefits	9,960
Hourly laborers (125 days per year)	
8 men x 125 days x $3.00/day	3,000
	12,960

$/mt = $\frac{\$12,960}{30,000}$ = $0.43/mt

Table 3

ESTIMATED COST FOR BAGGING [(a)] OF SINGLE PRODUCT SUCH AS UREA IN BULK BLEND FACILITY

(1) LABOR

Annual, no additional labor required

Hourly laborers

4	bagging	
3	loading truck or storage	
1	raw materials unloding	
8	men at 1 dav x $3.00/day	24.00

Tonnage per day = 240 mt

Bagging cost, \$/mt = $\frac{\$24.00}{240}$ = \$0.10/mt

(2) Electrical	$0.01/mt
(3) Pay-loader fuel, etc.	$0.01/mt
(4) Bags (22 bags @ $0.40/bag)	$8.80/mt
(5) Product loss (1%)	$0.09/mt
TOTAL	$9.01/mt

(a) Bagging rate of 30 mt/hr

<u>TABLE 4</u>

<u>ESTIMATED OPERATING COST BULK BLENDING NOT INCLUDING THE COST OF RAW MATERIALS</u>

Production, mt/year	10,000		15,000		20,000		25,000		30,000	
Operating days, days/year at 30 mt/hr [(a)]	42		63		84		104		125	
Bulk storage (b) throughput, prod/capacity	0.67		1.0		1.3		1.7		2.0	
Bag storage (c) throughput, prod/capacity	2.0		3.0		4.0		5.0		6.0	
PLANT INVESTMENT										
Plant equipment, installed,	176,000		176,000		176,000		176,000		176,000	
Buildings, bulk and bag storage	225,000		225,000		225,000		225,000		225,000	
Total equipment and buildings	401,000		401,000		401,000		401,000		401,000	
FIXED AND VARIABLE COST (d)	$/mt	Annual $/year	$/mt	Annual $/year	$/mt	Annual $/year	$/mt	Annual $/year	$/mt	Annual $/year
Operating labor (annual + hourly) [(e)]	1.10	11,000	0.76	11,400	0.60	12,000	0.50	12,500	0.43	12,900
Electricity	0.05	500	0.05	750	0.05	1,000	0.05	1,250	0.05	1,500
Maintenance (5% of plant equipment)	0.88	8,800	0.59	8,800	0.44	8,800	0.35	8,800	0.29	8,800
Building maintenance (1% of cost)	0.23	2,250	0.15	2,250	0.11	2,250	0.09	2,250	0.08	2,250
Equipment depreciation (15 yr)	1.17	11,733	0.78	11,733	0.59	11,733	0.47	11,733	0.39	11,733
Building depreciation (25 yr)	0.90	9,000	0.60	9,000	0.45	9,000	0.36	9,000	0.30	9,000
Taxes and insurance (2% of total)	0.80	8,020	0.53	8,020	0.40	8,020	0.32	8,020	0.27	8,020
Interest on investment (8% of ½ total)	1.60	16,040	1.07	16,040	0.80	16,040	0.64	16,040	0.53	16,040
Periodic check analyses (5/shift at $10) [(f)]	0.21	2,100	0.21	3,150	0.21	4,200	0.21	5,250	0.21	6,300
Gasoline, tires, etc.	0.15	1,500	0.11	1,700	0.10	1,900	0.08	2,100	0.08	2,300
Real estate taxes (not applicable)	----	------	----	------	-----	------	----	------	----	------
Miscellaneous (office supplies, telephone)	0.09	900	0.06	900	0.05	900	0.04	900	0.03	900
Manager, travel and expenses	0.05	500	0.03	500	0.03	500	0.02	500	0.02	580
Bags, kenaf plus liner @ $.40 each)	8.80	88,000	8.80	132,000	8.80	176,000	8.80	220,000	8.80	264,000
Contingency and overhead (100% labor)	1.10	11,000	0.76	11,400	0.60	12,000	0.50	12,500	0.43	12,900
Product loss (1%)	0.17	1,700	0.15	2,250	0.13	2,600	0.13	3,250	0.12	3,600
Total operating cost (bagged)	17.30	173,043	14.46	219,893	13.36	266,943	12.56	314,093	12.03	360,743

(a) Plant capable of producing 40 mt per hour
(b) Bulk storage, 15,000 mt
(c) Bag storage, 5000 mt
(d) Bulk storage, 15,000 mt
(e) From labor schedule
(f) Outside laboratory
(g) 100-lb bags

The plant manager needs to know the fertilizer use pattern on a monthly basis in order to plan his production schedule. He has the option also of paying overtime and operating more than one shift per day in the peak season. The plant described is capable of producing 40 mt per hour or 320 mt per day in an 8-hour day; if operated 50 weeks per year at 5 days per week it could produce 80,000 mt per year (320 mt/day x 250 day/year). It is apparent that the plant then is only partially utilized to its potential. This is the case of most bulk blending plants in the United States.

In Guatemala a typical breakdown by month for the fertilizer usage is shown in this tabulation:

1	2	3	4	5	6	7	8	9	10	11	12	
JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
5.4%	22.3%	30.2%	26.7%	7.4%	5.4%	2.5%	0%	0%	0%	0%	0%	= 99.9%

This shows that the fertilizer is used only 7 months and nearly four-fifths of it in the February-April period. The 12-week peak season is similar to that in the United States. Bulk blending in Guatemala will differ considerably from that in the United States, however, for several reasons: (1) U. S. plants have a lower ratio of storage capacity to annual production as raw materials are received continually during production, a trend that is changing somewhat due to transportation problems, (2) in the U. S. the blend is usually not produced until the customer is ready to receive it on the farm in bulk, (3) essentially no bagging of blends is done in the United States, (4) blending plants are located close to the farmer (plants may serve a radius of up to 25 miles), and (5) the U. S. blender does not need regional warehouses for storage of bulk or bagged product.

Economics for a Specific Case

The fixed and variable operating costs shown in table 4 also are shown in Fig. 10. To arrive at a specific case for economic comparison it is necessary to define the situation. The following tabulation assumes that the plant will bulk blend three grades to produce typical ratios used in Guatemala:

Ratio	Grade	Raw Material lb/mt	Annual Production % of Total	Annual Production mt/year	Mt Raw Mat. Mt Product
1-2-1	12-24-12	Urea- 147	30	6,000	0.067
		DAP- 1100			0.500
		KCl- 440			0.200
		Filler-513			0.233
		2200			1,000
1-3-1	10-30-10	DAP- 1222	20	4,000	0.555
		TSP- 213			0.097
		KCl- 367			0.167
		Filler-398			0.181
		2200			1.000
1-1-0	20-20-0	Urea- 582	20	4,000	0.265
		DAP- 957			0.435
		Filler-661			0.300
		2200			1.000
1-0-0	45-0-0	Urea- 2200	30	6,000	
			100%	20,000	

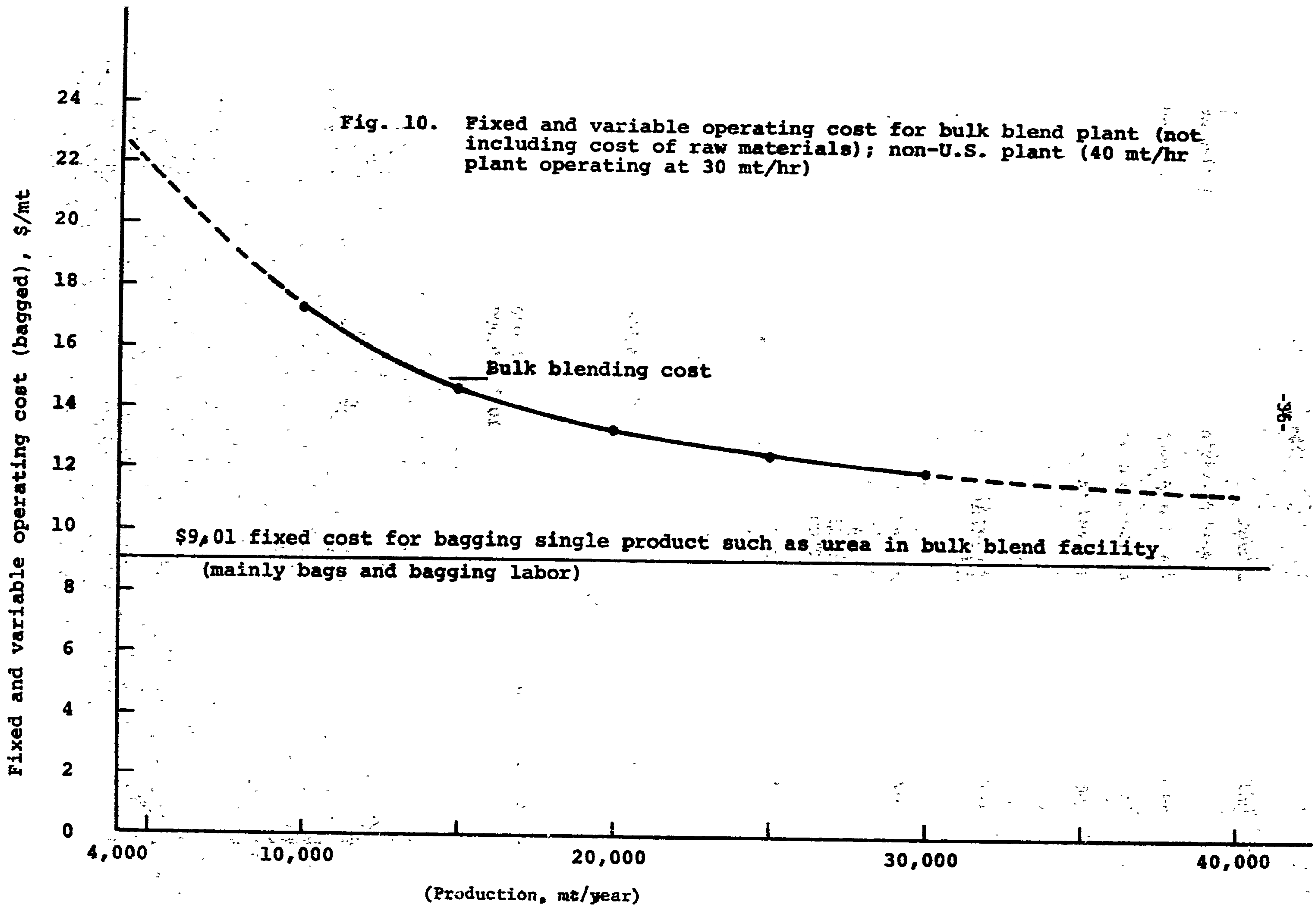

Fig. 10. Fixed and variable operating cost for bulk blend plant (not including cost of raw materials); non-U.S. plant (40 mt/hr plant operating at 30 mt/hr)

The plant will import the raw materials in bulk to blend the three formulas and import bulk urea for direct bagging. The annual requirement for the raw materials is as follows:

Urea (direct bagging)	6,000	
(12-24-12)	401	
(20-20-0)	1,058	
Total Urea (Annually)	7,459	37.3
DAP (12-24-12)	3,000	
(10-30-10)	2,222	
(20-20-0)	1,740	
Total DAP (Annually)	6,962	34.8
TSP (10-30-10)	387	
Total TSP (Annually)	387	1.9
Filler (12-24-12)	1,399	
(10-30-10)	724	
(20-20-0)	1,202	
Total Filler (Annually)	3,325	16.6
KCl (12-24-12)	1,200	
(10-30-10)	667	
Total KCl (Annually)	1,867	9.3
Total Annual mt/yr	20,000	99.9%

<u>Fertilizer Prices</u>--To estimate the total production cost per mt of blended product, it is necessary to know the imported prices of the raw materials. The current market situation is extremely tight with respect to nitrogen and phosphate; supplies are scarce and prices are quite high. In fact, it is difficult to purchase some N-P materials at any price. It is impossible to predict future prices with any degree of accuracy, although the situation probably will ease somewhat from 1975 onward as announced new plants come on stream throughout the world. The prices may never return to the levels of 1970-1971.

Table 5 gives an indication of the current market prices, F.O.B. and delivered, for some popular materials used in blending. For comparison, the mid-1971 prices are also shown. This is not to say that these prices will be achieved or when, but may be helpful in working out various economic estimates for comparison.

Production costs--In the example the plant will be used to blend 14,000 mt per year total of 12-24-12, 10-30-10 and 20-20-0, and bag 6,000 mt per year of straight urea. Everything will be bagged prior to shipment from the blending plant.

Table 6 shows the effects of escalating costs of raw materials on prices of blended product. N-P and N-P-K products cost dramatically more than in early 1971 when prices began rising sharply.

The cost of product is used in estimating the cost to the various delivery points in this study.

Table 7 combines materials cost, blending and bagging costs and interest on working capital to give the cost of producing a blend in the different grades. To this should be added a return on investment.

TABLE 5

ESTIMATED IMPORT PRICES FOR BULK BLENDING RAW MATERIALS

Material, bulk	F.O.B. Gulf $/mt	Freight (a) $/mt	Insurance 1%	Unloading $/mt	Delivery(b) $/mt	C.I.F. in warehouse (c) $/mt
	December 1973 Market Prices					
Urea (45-0-0)	180	18	1.98	1.00	0.50	201.48
DAP (18-46-0)	175	18	1.93	1.00	0.50	196.43
TSP (0-46-0)	175	18	1.93	1.00	0.50	196.43
KCl (0-0-60)	52	18	0.70	1.00	0.50	72.20
Urea (45-0-0), bagged in U.S.	200	18	2.18	1.50	1.00 (10% duty 22.27)	244.95[e]
	Mid-1971 Market Prices (d)					
Urea (45-0-0)	93	12	1.05	1.00	0.50	107.55
DAP (18-46-0)	88	12	1.00	1.00	0.50	102.50
TSP (0-46-0)	75	12	0.87	1.00	0.50	89.37
KCl (0-0-60)	50	12	0.62	1.00	0.50	64.12

(a) Rate from U.S. Gulf coast to Guatemalan Caribbean port, Santo Thomas or Puerto Barrios; add $2.00/mt additional if brought to Pacific Port; not able to have bulk at Pacific.
(b) Delivery by truck fleet from pier to company warehouse near port.
(c) Import duty of 10% not paid if material is to be processed further such as by bulk blending or granulation.
(d) Higher prices than were in effect in early 1971 when prices began to rise.
(e) Inserted to show the higher cost for importation of bagged material; with bags and labor etc.=$10.00; freight to Esquintla = $12.38; unloading = $1.00; Int. = $2.25; and sales and adm. exp.=$20.07; C.I.F. Esquintla = $290.65

Table 6

Cost of Raw Materials for Blended Grades 12-24-12 10-30-10, and 20-20-0 and Straight Urea

Grade	Raw Materials	Mt R.M./mt Product	Cost of Raw Materials $/mt Current	Cost of Raw Materials $/mt Mid-'71		Cost of Product Raw Materials only, $/mt Current	Cost of Product Raw Materials only, $/mt Mid-'71
12-24-12	Urea	.067	201.48	107.55		13.50	7.21
(48% pl. food)	DAP	.500	196.43	102.50		98.22	51.25
	KCl	.200	72.20	64.12		14.44	12.82
	Filler	.233	5.00	5.00		1.17	1.17
					Total	127.33	72.45
					/mt nutrient	265.27	150.94
10-30-10	DAP	.555	196.43	102.50		109.02	56.89
(50% Pl. Food)	TSP	.097	196.43	89.37		19.05	8.67
	KCl	.167	72.20	64.12		12.06	10.71
	Filler	.181	5.00	5.00		0.91	0.91
					Total	141.04	77.18
					$/mt nutrient	282.08	164.36
20-20-0	Urea	.265	201.48	107.55		53.39	28.50
(40% Pl. Food)	DAP	.435	196.43	102.50		85.45	44.59
	Filler	.300	5.00	5.00		1.50	1.50
					Total	140.34	74.59
					$/mt nutrient	350.85	186.48
45-0-0	Urea	1.00	201.48	107.55	Total	201.48	107.55
(45% Pl. Food)					$/mt nutrient	447.73	239.00

Table 7

Estimated Production Cost of 12-24-12 10-30-10, 20-20-0 and Bagged Urea

Grade	Cost of Raw Materials[(a)] $/mt Product: Current	Cost of Raw Materials[(a)] $/mt Product: Mid-'71	Fixed and variable Operating Cost, $/mt	Total Production Cost $/mt Product F.O.B. Plant (Port) including interest on working capital, but no Return on Investment: Current[(b)]	Total Production Cost $/mt Product F.O.B. Plant (Port) including interest on working capital, but no Return on Investment: Mid-'71[(c)]
12-24-12 Blend	127.33	72.45	15.00	144.53	88.71
10-30-10 Blend	141-04	77.18	15.00	158.24	93.44
20-20-0 Blend	140.34	74.59	15.00	157.54	90.85
45-0-0 Bagged	201.48	107.55	9.01	212.69	117.82

(a) From table [illegible]

(b) Interest on working capital = $2.20/mt

(c) Interest on working capital = $1.26/mt

Working capital is taken as 1-month supply of raw material plus the value of 3-months in-plant production. From a previous tabulation the annual requirement is as follows:

Urea	7,459		1,502,839	802,215
DAP	6,962		1,367,546	713,605
TSP	387		76,018	34,586
Filler	3,325		16,625	16,625
KCl	1,867		134,797	119,712
		TOTAL	3,097,825	1,686,743
Working Capital (Raw Materials)=$ Total : 12) 1 month value			258,152	140,562
Products				
12-24-12	6,000		853,980	524,700
10-30-10	4,000		624,160	368,720
20-20-0	4,000		621,360	358,360
45-0-0	6,000		1,262,940	699,360
		Total	3,362,440	1,951,140
Working Capital (Products)= (Total : 4)			840,610	478,785
Total working capital =			1,098,762	628,347
Interest on working capital, annually			43,950	25,134
(8% of W.C.:Ann. Prod.),$/mt			2.20	1.26

From table 7, the total production cost is estimated using the production cost and interest on working capital from the tabulation; this does not include return on investment.

In estimating the price and profitability for fertilizer in Guatemala the usual price is quoted as F.O.B. Esquintla; therefore, if the blending bagging plant is located in the Caribbean area near Santo Tomas, it is necessary to transport the product approximately 200 miles (333 km) to Guatemala City and an additional 25 miles (42 km) to Esquintla. The trucking time (one way) from the port to Guatemala City is in the range of 10-15 hours (See Transportation section). Not much difference in freight cost is now possible between truck or rail, so that by truck the charge is about $11.00 counting port charges, or by rail $10.30 for the distance from Puerto Barrios or Santo Tomas to Guatemala City. If the truck or train does not need to be unloaded it can continue to other locations at the rate of $0.33/km/mt. Any unloading-loading will cost extra as it moves between regional warehouses. Total freight charge from the Port of Esquintla was taken as $12.38 ($11.00 + $1.38), with Esquintla unloading of $1.00.

Current quotes on fertilizer--A recent tender was evaluated in Guatemala for some mixed NPK grades and straight urea. The prices quoted for bagged material delivered either to Guatemala City or Esquintla are as follows:

Grade	Plant Food	$/mt	Delivered Price Esquintla $/100 lb bag	Delivered Price Esquintla $/mt nutrients
10-30-10	50	154.78	7.04	309.56
15-15-15	45	136.08	6.19	302.40
16-20-0	36	129.92	5.91	360.89
46-0-0	46	160.94(a)	7.32	349.89
12-24-12	48	200.20	9.10	417.08
15-15-15	45	189.20	8.60	420.44

(a) Offer was withdrawn at this price; price has probably increased substantially since offer was made.

Investment Potential in Guatemala--Guatemala encourages business by giving tax breaks and reduction or elimination of import duties for certain production operations. According to information available, the income tax ranges from 5 to 48% on business, with an average of 22%, but an exemption of 100% is allowed for the first 5 years and 50% for the next 5 years.

Table 8

Profitability factors for bulk blending plant in Guatemala

(current price basis)

Plant investment, $400,000 Working Capital $1,098,762 Total Capital investment $1,498,762
Annual depreciation, $/year 20,733

Total annual manufacturing cost, $/year:			
Operating:	14,000 x 15.00	=	210,000
	6,000 x 9.01	=	54,060
Port to Esquintla freight	12.38 x 20,000	=	247,600
Esquintla handling	1.00 x 20,000	=	20,000
Int. on work. capital	2.20 x 20,000	=	44,000
Sales and am. exp.	20.07 x 20,000	=	401,460
Total Ann. Op. cost, $/yr		=	977,120
Annual raw materials cost, $/yr		=	3,097,825
Total annual cost		=	4,074,945

Annual Production Mt/year	Sales price $/mt	Net Fert. sales rev. $/year	Total Ann. Cost $/year	Gross Income $/year	Net Income after taxes $/year	Cash flow N.I. + Dep. $/year	Ann. Ret. on Cap. Inv. NI:C.I.,%	Payout Period PI:C.F.(yr)
20,000	198.00[a]	3,960,000	4,074,945	-114,945	-114,945[f]	-94,212	Neg.	Inf.
20,000	220.00[b]	4,400,000	4,074,945	+325,055	+325,055[f]	+345,788	21.7	1.1
20,000	209.00[c]	4,180,000	4,074,945	+105,055	+105,055[f]	+125,788	7.0	3.2
20,000	203.50[d]	4,070,000	4,074,945	- 4,945	- 4,945[f]	+ 15,788	Neg.	25.3
20,000	214.50[e]	4,290,000	4,074,945	+215,055	+235,788[f]	+235,788	14.3	1.7

(a) Average at $9.00/cwt (b) Average of $10/cwt (c) Average of 9.50/cwt

(d) Average of $9.25/cwt (e) Average of $9.75/cwt (f) Taxes start after 5 years operation at 50% level; assumed zero for this case.

TABLE 9

Profitability Factors for Bulk Blending Plant in Guatemala (Future Price Basis)

Plant investment, $400,000 Working Capital, $628,347 Total Capital investment $1,028,347

Annual depreciation, $/year $20,733

Total annual manufacturing cost, $/year: Operating	14,000 x 15.00	=	210,000
	6,000 x 9.01	=	54,060
Port to Esquintla Freight	$12.38 x 20,000	=	247,600
Esquintla handling	$ 1.00 x 20,000	=	20,000
Int. on in. Cap.	$ 1.26 x 20,000	=	25,200
Sales and Am. Exp.	$20.07 x 20,000	=	401,460
Total annual operation cost		=	958,320
Annual Raw material cost		=	1,686,743
Total annual cost, $/year		=	2,645,063

Annual production	Sales price	Net Fert. sales Rev.	Total Ann. cost	Gross Income	Net Income after taxes	Cash Flow N.I. + Dep.	Ann. Ret. on Cap. Inv.	Payout period
Mt/year	$/year	$/year	$/year	$/year	$/year	$/year	$/year	$/year
20,000	176.00[a]	3,520,000	2,645,063	+874,937	+874,937[h]	+895,670	87.1	0.4
20,000	154.00[b]	3,080,000	2,645,063	+434,937	+434,937[h]	+455,670	42.3	0.9
20,000	143.00[c]	2,860,000	2,645,063	+214,937	+214,937[h]	+235,690	20.9	1.7
20,000	132,00[d]	2,640,000	2,645,063	- 5,063	- 5,063[h]	+ 15,670	NEG	25;5
20,000	137.50[e]	2,750,000	2,645,063	+104,937	+104,937[h]	+125,670	10.2	3.2
20,000	140.00[f]	2,800,000	2,645,063	+154,937	+154,937[h]	+175,670	15.1	2.3
20,000	135.00[g]	2,700,000	2,645,063	+ 54,937	+ 54,937[h]	+ 75,670	5.3	5.3

(a) Average = 8.00/cwt (b) Average = 7.00/cwt (c) Average = 6.50/cwt (d) Average = 6.25/cwt

(e) Average = 6.25/cwt (f) Average = 6.36/cwt (g) Average = 6.14/cwt (h) Taxes start after 5 years operation at 50% level; assumed zero for this case.

TABLE 10

Estimated Sales Price for Each Product[(a)] (10% return on Investment)

Basis: 20,000 mt at average of $211.25/mt, bagged Esquintla = $4,225,000 (Fig.11)

based on relative cost of production.

Current Prices of Raw Materials C.I.F. warehouse Puerto Barrios or Sto. Tomas $/mt		Product Tonnage Mt/year		Estimated Sales Price (b) F.O.B. Esquintla bagged $/mt	$/cwt
Urea (45-0-0)	201.48	12-24-12	6,000	179.26	8.15
DAP (18-46-0)	196.43	10-30-10	4,000	196.25	8.92
TSP (0-46-0)	196.43	20-20-0	4,000	195.40	8.88
KCl (0-0-60)	72.20	45-0-0	6,000	263.81	11.99
Filler (0-0-0)	5.00				

BASIS: 20,000 mt at average of $137.50/mt, bagged Esquintla = $2,750,000 (Fig.12)

Possible Future Prices of Raw Materials C.I.F. warehouse Puerto Barrios or Sto. Tomas, $/mt

Urea (45-0-0)	107.55	12-24-12	6,000	124.18	5.64
DAP (18-46-0)	102.50	10-30-10	4,000	130.81	5.95
TSP (0-46-0)	89.37	20-20-0	4,000	127.19	5.78
KCl (0-0-60)	64.12	45-0-0	6,000	164.94	7.50
Filler (0-0-0)	5.00				

(a) At 10% annual rate of return on investment, including cost of manufacturing, raw materials, freight and handling, sales and administrative costs:
Freight, port to Esquintla = $12.38/mt (rail or truck)
Unloading at Esquintla = $ 1.00/mt
Sales and administrative exp. = $20.07/mt
Does not include warehousing costs in Esquintla.

(b) Sales price based on proportional production cost for each product.

A 100% exemption on import duty is granted for the first 10 years. This information was used in estimating the economic viability of the bulk blending plant for Guatemala. Fertilizer imported from outside the Central American region has a 10% import duty; raw material for processing is excluded.

Profitability factors--To determine the relative investment potential for the bulk blending plant, return on investment and payout period were calculated in tables 8 and 9 as affected by average sales price; the data for return on investment is plotted in Fig. 11 and 12. The data is calculated on the current cost of raw material (table 8, Fig. 11) and on possible future cost (table 9, Fig.12). For these calculations, it is assumed that the product would be sold starting in year one over the plant life of 15 years; this is only a theoretical situation to indicate the trend. It is assumed that a 10% annual rate of return would be attractive. Each company has its own criteria for analysis of investment potential. A bulk blending plant has a relatively high ratio of working capital to plant investment since plant investment is relatively low. Reduction is costs such as transportation, sales and administrative expenses, etc., will significantly affect the economic picture for sales prices of product to the farmer.

Economic Conclusions--Bulk blending is a process in which the cost of product depends primarily on the cost of input raw materials. For example, raw materials cost $70-140 per mt and processing costs only about $15/mt. Therefore, it is necessary to know the cost and availability of raw materials prior to making any investment decisions.

If a blender must go to the current world market to secure raw materials, starting a bulk blending business would be questionable, primarily due to the high cost and shortages for raw materials, especially urea. At current import prices he would need to sell the bagged urea for about $264.00 per mt or about $12.00 per 100 lb bag for a 10% return on investment, as shown in table 10. In reality he could reduce the mark up on straight urea and increase somewhat the cost of other products to offset the lower urea price. It is not clear at what price it becomes uneconomic to use fertilizer in Guatemala. Some quoted prices now are in the range of $9.00-10.00/cwt ($198-220/mt). It is possible, and even probable, that urea in Guatemala will reach $12.00/cwt ((264/mt). It would seem that under current conditions with Guatemala having no basic production facilities, such as for urea, DAP, etc., the installation of one or more bulk blending plants would not lower the cost of fertilizer to the farmer. If Guatemala had basic production based on locally available raw materials such as phosphate rock, natural gas, sulfur, the outlook would be different. Or if some imports could be obtained through a parent company, the economic situation could change. Under the assumed conditions, the argument for introduction of bulk blending to lower the fertilizer cost significantly especially to small farmers, would not appear to be valid. The cost of blending and bagging overshadows somewhat the elimination of 10% import duty for materials to be further processed; the key to a potential investment is really the C.I.F. prices of materials for use in blending.

The technical feasibility of bulk blending in Guatemala presents no serious problems. Certain improvements could be made in port facilities to improve fertilizer handling capability. Improved transportation, especially the rail system, would be helpful. The rail cars in Guatemala are not suitable for bulk shipment. The track is sound and bulk cars are certainly applicable in Guatemala. Although humid in the Caribbean port area, no significant problems would be present in bulk storage provided adequate precautions are taken.

The prime reason for bulk blending's popularity in the United States is the service offered to the farmer. He can order directly from the dealer who will bring the fertilizer to the farm in bulk and bulk-spread it without having to bag the material. This degree of service cannot now be utilized in Guatemala as product must move in bags and relatively long distances to small farms.

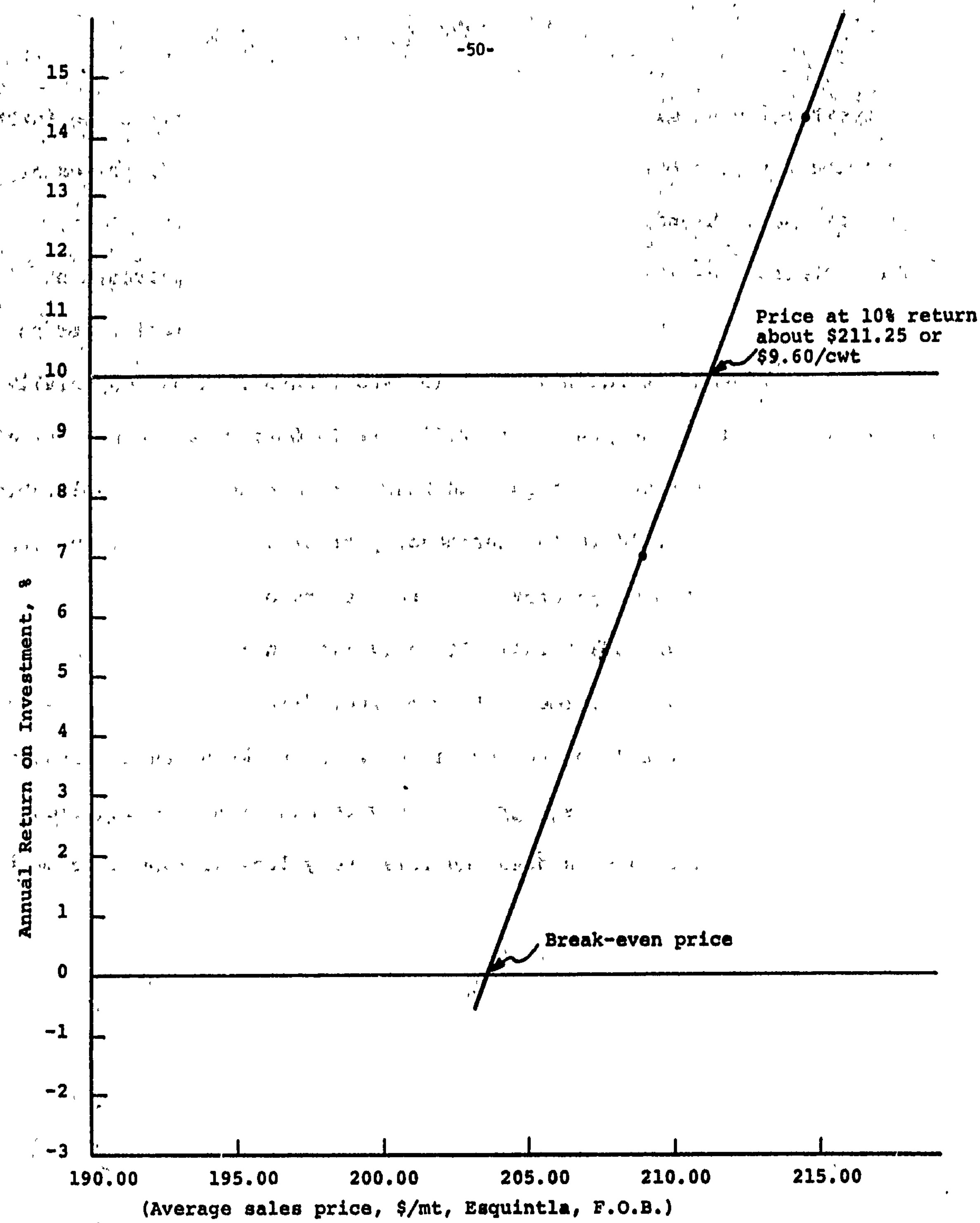

Fig. 11. ESTIMATED ANNUAL RETURN on Investment vs average product sales price at current raw material prices, F.O.B., Esquintla, bagged

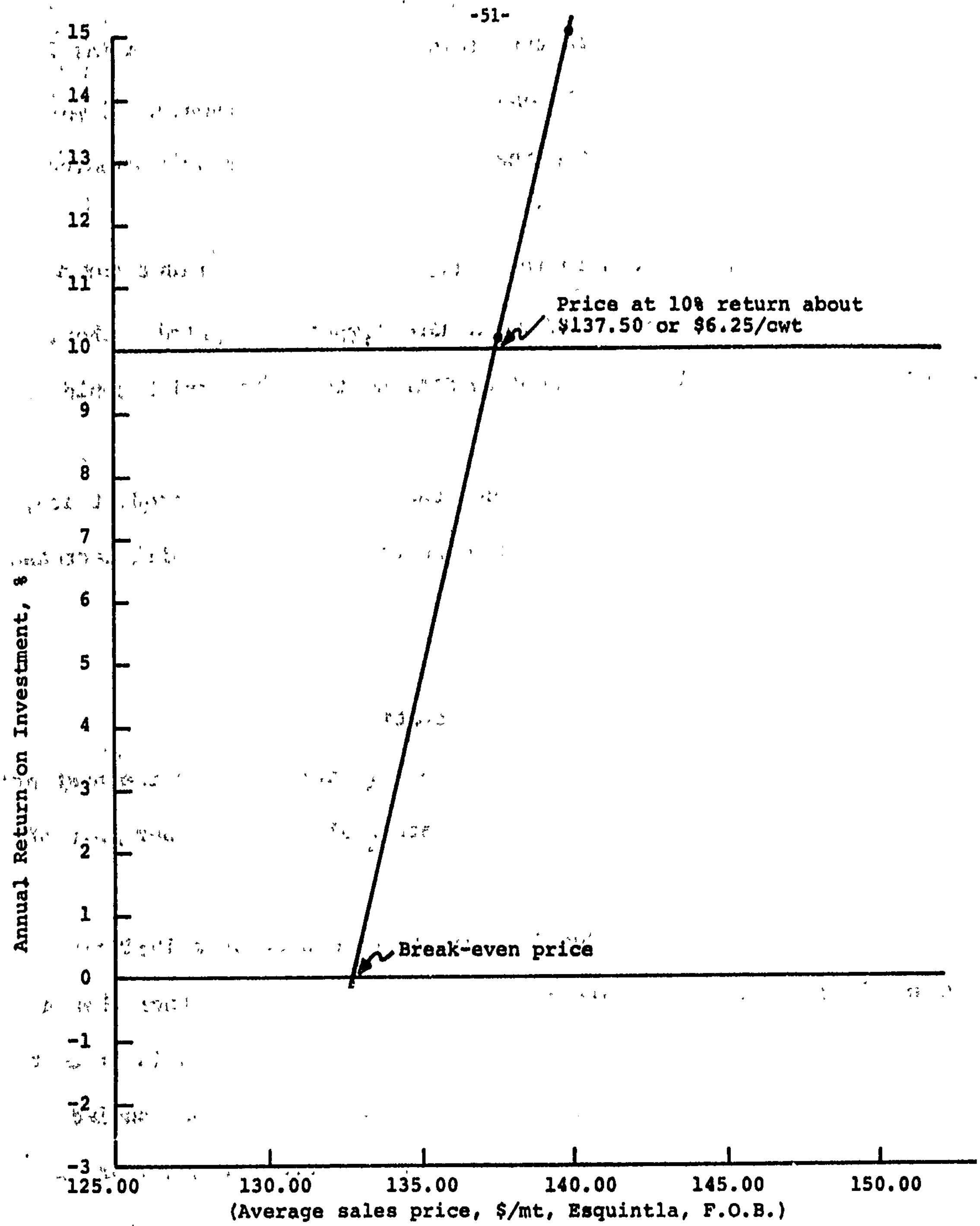

Fig. 12. ESTIMATED ANNUAL RETURN on Investment vs average product sales price at future raw material prices, F.O.B. Esquintla, bagged

On the other hand if raw material prices in the future (say 1976-1978) again return to levels somewhere in the vicinity of 1971, the potential for blending should be re-evaluated. If one can assume the Guatemalan farmer will buy fertilizer at the world market price, then bulk blending is economically feasible now.

It is possible, as shown in table 11, to operate the plant for a short time at no return on investment to allow a more competitive price. Then, if in the future, raw material prices tend to decline the sales price could be eased upward for some profit.

Some of the possible ways to reduce the cost per mt of product are:

1. Put more annual throughput through the plant; this will decrease operating cost per mt.

2. A decrease in freight charge.

3. A reduction in sales and administrative expense.

4. Attempt to buy raw materials at spot locations where the best price can be found and attempt to substitute other materials if price per unit of nutrients is lower.

5. Blend the maximum grades in a given ratio such as a 19-19-19 rather than 15-15-15, 15-30-15 rather than 12-24-12; 28-28-0 rather than a 20-20-0; and 12-36-12 rather than 10-30-10. This will result in lower cost per unit of plant food delivered and require less tonnages to be handled. This will require some farmer education effort to get away from the price per bag concept.

Possible Plant Sites

There was insufficient time to make a detailed study of possible plant sites, but some pertinent comments and alternatives are given below. Imported goods can come into Guatemala from Atlantic or Pacific Ports. Ports on the

TABLE 11

Estimated Fertilizer Sales Prices at Various Levels of return on Investment

Selling Prices	Return on Investment		
	0%	5%	10%
Current import Prices (Fig.11)			
Average per mt of product	203.60	207.50	211.25
Average per 100 lb (cwt) bag	9.25	9.43	9.60
Per mt of 12-24-12	254.25	259.12	263.81
Per mt of 10-30-10	172.76	176.07	179.26
Per mt of 20-20-0	189.14	192.76	196.25
Per mt of 45-0-0	188.32	191.93	195.40
Future Prices (Fig.12)			
Average per mt of Product	132.75	135.10	137.50
Average per 100 lb (cwt) bag	6.03	6.14	6.25
Per mt of 12-24-12	158.29	161.09	163.95
Per mt of 10-30-10	119.18	121.28	123.44
Per mt of 20-20-0	125.54	127.76	130.03
Per mt of 45-0-0	122.06	124.22	126.42

Pacific can be ruled out for the moment; lighters are required at Ports of Champerico and San Jose and seas are frequently rough. No floating piers capable of unloading bulk fertilizer are now available. From a proximity standpoint, San Jose port would be ideal, but ships must anchor in 8-9 fathoms of water in sand about ¼ mile from the pierhead.

At the moment the best possibility for importing bulk fertilizer is in the Caribbean ports of Santo Tomas or Puerto Barrios; but port improvements must be made for bulk handling (planned for future)[a]; the port of Livingston is served by lighters. Santo Tomas has a controlling depth at entrance of 26 feet; at the wharf 33 feet. Six ships up to 10,000 tons can be served at the same time. It is planned to install bulk handling facilities so that fertilizer could be handled. A Buhler leg is now being used for corn and soybean meal. The port is run by the National Port Authority. Warehouse space is available, but a dealer should consider building his own storage space on available land near the port area. This port has rail access.

Puerto Barrios is under the control of the Ferrocarriles de Guatemala (rail system) and was formerly part of the United Fruit Company. The depth in the channel approach is 28 feet. Some improvements are needed for unloading and handling of bulk fertilizer. It was reported that something like rock phosphate is now being unloaded in bulk via crane-clamshell. Rail is alongside and could receive bulk cargo, but no bulk cars are available. For bulk fertilizer the facilities still need further improvement.

The best alternate site for the future appears to be in the vicinity of Santo Tomas with bulk importation through the improved port and bulk storage nearby; the blending plant would be located in the company-owned storage building and product would be shipped in bags to distribution points in the

(a) Bids now being taken on $3 million improvement for bulk fertilizer and other commodities.

interior by rail or truck. The product probably could also move into Honduras from this location.

The other alternate is to locate the plant near the Pacific port of Acajutla in El Salvador and ship the product via rail or truck to distribution points in Guatemala. The rates are essentially the same from Acajutla to Guatemala City as from Puerto Barrios to Guatemala City. It is assumed that for a number of reasons tax breaks, customs, employment, etc., that the Guatemalans would prefer that the plant be built in their own country.

Bulk wheat is now moving from Santo Tomas via rail to Guatemala City so some experience with bulk transport is being gained. With bulk cars, the bulk fertilizers could be imported and off-loaded into bulk cars for shipment to Guatemala City of Esquintla for blending. This cannot now be done, but it is a possibility for the future. This might also be considered as a second plant in the future.

Higher Analysis Through Blending

Bulk blending often makes possible the preparation of mixtures higher in plant food content than is available in common, granulated N-P or N-P-K products. For example, a 15-15-15 (1-1-1 ratio) can be a 19 19-19 or a 20-20-0 (1-1-0) can be a 28-28-0. Even though raw materials may cost more, the higher analysis will result in a lower cost per mt of plant nutrients to the farmer after addition of fixed costs such as freight, handling, storage, and distribution. The farmer will need to be taught about buying by the cost per unit of plant food rather than on a cost-per-bag basis. Table 12 shows some formulas for this. Without repeating the complicated economic analysis, the same fixed and variable costs were added, but raw material cost for each formula was different. This shows that higher analysis materials can be delivered to the same location at a lower cost per mt of nutrients. If blending is done in Guatemala, the production of higher-analysis grades should be considered.

TABLE 12

Potential Higher Analysis Formulas for Guatemala

Ratio	1-2-1		1-3-1		1-0-1	
Grade, $N-P_2O_5-K_2O$	12-24-12	15-30-15	10-30-10	12-36-12	20-20-0	28-28-0
Units of Plant Food	48	60	50	60	40	56
Raw material, (a) mt/mt product						
Urea @ $201,48/mt	13.50	14.71	109.02	--	53.39	76.36
DAP @ $196.43/mt	98.22	128.07	19.05	131.02	85.45	119.63
KCl @ $ 72.20/mt	14.44	18.05	12.06	14.44	---	---
Filler @ $ 5.00/mt	1.17	.13	0.91	.09	1.50	.07
TSP @ $196.43/mt	---	---	---	22.79 (b)	---	---
Raw material cost, $/mt	127.33	160.96	141.04	168.34	140.34	196.06
$/mt nutrient	265.27	268.26	282.08	280.57	350.85	350.11
Fixed Charges						
Blending and bagging	15.00	15.00	15.00	15.00	15.00	15.00
Freight	12.38	12.38	12.38	12.38	12.38	12.38
Handling	1.00	1.00	1.00	1.00	1.00	1.00
Sales and Adm. Exp.	20.07	20.07	20.07	20.07	20.07	20.07
Total	48.45	48.45	48.45	48.45	48.45	48.45
Total cost, $/mt	175.78 (c)	209.41	189.49 (c)	216.79	188.79 (c)	244.51
$/mt nutrient	366.21	349.02	378.98	361.32	471.98	436.63
Difference		(-17.19)		(-17.66)		(-35.35)

(a) Current import prices, C.I.F. Guatemala, bulk.

(b) Blending of unammoniated TSP and DAP is not recommended without use of conditioner if product is to be stored.

(c) Varies somewhat from previous values because of interest on working capital and the effect of plant depreciation.

Suggested References

1. Investment opportunities in the Central American Common Market, Central American Bank for Economic Integration, Investment Development Department, Tegucigalpa, D.C. Honduras, C.A. 1971.

2. Fertilizer Progress. July-August, 1973 Vol 4, No. 4.

3. The TVA Bulk Blending Tower, Reprint CD 402 TVA, Muscle Shoals, Alabama 35660.

4. Bulk Blending of Fertilizer Materials: Effect of Size, Shape, and Density on Segregation, Reprint CD 354 TVA.

5. Supplying Micronutrients in Solid Bulk-Blended Fertilizers, Reprint CD 352, TVA

6. Different methods of Adding Pesticides to Bulk Blends, Reprint X-167, TVA.

7. Bulk Blender, Environmental Control and OSHA, Reprint X-144 TVA.

8. Bulk Blended Fertilizer. Usage and Materials, Reprint CD-516 TVA.

9. Bulk Blender Costs-all the way from Raw Materials to the field, Reprint X-126 TVA.

10. Adding nutrients to Fertilizers, Reprint CD439, TVA.

11. Future Construction Abroad, Guatemala from Commerce Today Aug. 6, 1973.

Table A-1. Estimated Investment Cost for Bulk Blending Plant (non- U.S. Plant)

	Equipment (a)	Cost, $/1973
(1)	Elevator to bulk storage building (150 mt/hr)	6,000
(2)	Belt conveyor (shuttle) for bulk storage (150 mt/hr)	8,000
(3)	Front-end loader (30 cu ft)	8,500
(4)	Bulk blending package (40 mt/hr) Scalping screen, elevators, cluster hopper, weigh hopper and scales, rotary blender (2-ton), outside holding hopper, and lump breaker.	70,000
(5)	Bagging machine, complete with sewing machine, conveyor and portable scales (30 mt/hr)	20,000
(6)	Bag load-out conveyor (portable)	2,000
(7)	Office equipment, adding machines, typewriter communication equipment, desks, etc.	3,000
	Equipment subtotal (1973 basis)	117,500
	Delivery and installation (40% of cost)	47,000
	Equipment, delivered and installed (1973 basis)	164,500
	Equipment, delivered and installed (1975 basis)[c] (1.07 x 1973 cost)	176,015
	Equipment plant investment	176,015
	Bulk storage (15,000 @ $10/mt) [b]	150,000
	Bag storage (5,000 mt @ 15/mt)	75,000
	Total buildings	225,000
	Total cost including buildings	401,015

(a) Not including the cost of land or the cost of facilities for bulk unloading such as dock, crane, and receiving hoppers; equipment complete with all electric motors, drives, etc. Not including vehicles such as trucks or automobile for plant manager.

(b) Approximately one-half of United States building cost; bulk storage equivalent to annual production; this quantity is much greater than usually required in the United States where transportation allows frequent receipt of raw materials.

(c) It is highly likely that at least one set of truck-scales will be needed at the storage site; scales cost about $10,000 for 30 mt capacity.

Potential Equipment Suppliers

Atlanta Utility Works
East Point, Georgia

Fertilizer Engineering and Equipment Co.
Green Bay, Wisconsin

Fertilizer Engineering Sales Co.
Doraville, Georgia

Longhorn Construction Co.
Sulphur Springs, Texas

Edward Renneburg and Son Co.
Baltimore, Maryland

The A. J. Sackett and Sons Co.
Baltimore, Maryland

Steadman Foundry and Machine Co., Inc.
Aurora, Indiana

Bernard and Leas Mfg. Co.
Cedar Rapids, Iowa

Centralia Engineering & Machine Corp.
Centralia, Illinois

Speed King Mfg. Co., Inc.
Dodge City, Kansas

Helpful Hints to Potential Investors

Potential investors who inquire of vendors for information on a bulk blending facility should make their request as complete as possible. Typical information needed is as follows:

(1) How will materials be received and what rate?

(2) What kind and how much bulk material is to be stored?

(3) How much bag storage is needed?

(4) The bagging rate desired, type of bags and method of closure.

(5) What type of season is expected and what rate of output is expected?

(6) Is bulk product to be shipped?

(7) Is it planned to store bulk product?

(8) The desired type of building construction and any available details about specific location.

(9) Any information concerning the production of specialty materials such as those containing micronutrients or pesticides-herbicides.

(10) How will bagged product be handled and shipped?

(11) Any information that may be pertinent such as road access, availability of labor and rates, etc. should be helpful.

This will allow the vendor to make a more accurate quote and to make specific recommendations for achieving a well-designed and operated facility.