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INDUSTRY PROFILE #9

STARCH, OIL, AND FEED
FROM SORGHUM GRAIN

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Starch, Oil, and Feed from Sorghum Grain
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[C] 1987, Volunteers in Technical Assistance**INDUSTRY PROFILES****Introduction**

This Industry Profile is one of a series briefly describing small or medium-sized industries. The Profiles provide basic information for starting manufacturing plants in developing nations. Specifically, they provide general plant descriptions, financial, and technical factors for their operation, and sources of information and expertise. The series is intended to be useful in determining whether the industries described warrant further inquiry either to rule out or to decide upon investment. The underlying assumption of these Profiles is that the individual making use of them already has some knowledge and experience in industrial development.

Dollar values are listed only for machinery and equipment costs, and are primarily based on equipment in the United States. The price does not include shipping costs or import-export taxes, which must be considered and will vary greatly from country to country. No other investment costs are included (such as land value, building rental, labor, etc.) as those

prices also vary.

These items are mentioned to provide the investor with a general checklist of considerations for setting up a business.

IMPORTANT

These profiles should not be substituted for feasibility studies. Before an investment is made in a plant, a feasibility study should be conducted. This may require skilled economic and engineering expertise. The following illustrates the range of questions to which answers must be obtained:

- * What is the extent of the present demand for the product, and how is it now being satisfied?
- * Will the estimated price and quality of the product make it competitive?
- * What is the marketing and distribution plan and to whom will the product be sold?
- * How will the plant be financed?
- * Has a realistic time schedule for construction, equipment, delivery, obtaining materials and supplies, training of personnel, and the start-up time for the plant

been developed?

* How are needed materials and supplies to be procured and machinery and equipment to be maintained and repaired?

* Are trained personnel available?

* Do adequate transportation, storage, power, communication, fuel, water, and other facilities exist?

* What management controls for design, production, quality control, and other factors have been included?

* Will the industry complement or interfere with development plans for the area?

* What social, cultural, environmental, and technological considerations must be addressed regarding manufacture and use of this product?

Fully documented information responding to these and many other questions should be determined before proceeding with implementation of an industrial project.

Equipment Suppliers, Engineering Companies

The services of professional engineers are desirable in the design of industrial plants even though the proposed plant may be small. A correct design is one that provides the greatest economy in the investment of funds and establishes the basis of operation that will be most

profitable in the beginning and will also be capable of expansion without expensive alteration.

Professional engineers who specialize in industrial design can be found by referring to the published cards in various engineering magazines. They may also be reached through their national organizations.

Manufacturers of industrial equipment employ engineers familiar with the design and installation of their specialized products. These manufacturers are usually willing to give prospective customers the benefit of technical advice by those engineers in determining the suitability of their equipment in any proposed project.

VITA

Volunteers in Technical Assistance (VITA) is a private, non-profit, volunteer organization engaged in international development. Through its varied activities and services, VITA fosters self-sufficiency by promoting increased economic productivity. Supported by a volunteer roster of over 5,000 experts in a wide variety of fields, VITA is able to provide high quality technical information to requesters. This information is increasingly conveyed through low-cost advanced

communication technologies, including terrestrial packet radio and low-earth-orbiting satellite.

VITA also implements both long- and short-term projects to promote enterprise development and transfer technology.

STARCH, OIL, AND FEED FROM SORGHUM GRAIN

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PRODUCT DESCRIPTION

1. The Product

The products are starch, oil, and feed made from sorghum grain.

Starch - With only 0.5 percent protein, it is not as high quality as maize, potato, and rice starch. Yet it is suitable for a wide range of industrial and food uses. Some of these include textile sizing, adhesives for corrugated, paper, coatings, ingredient in molding sand for foundries, foods, and laundry. The range of uses is extended by additions to the plant for chemical modification of the starch.

Oil - It is unrefined vegetable oil that is high on unsaturates. It is fit for all food oil uses after refining.

Feed - It comprises a mixture of fiber, spent oil cake from the expeller, gluten, and steepwater.

2. The Facility

This profile describes a small plant operating with three shifts on a seven-day work schedule and processing about 200 tons of sorghum a day. Two shifts are down per week for maintenance.

This facility may be considered a heavy industry because of the emission from the boiler and dryers and the noise from its high speed machinery.

GENERAL EVALUATION

This industry is similar to the wet milling of maize and uses the same basic technology for processing the sorghum grain. The plant is capable of providing a support infrastructural base for many other industries, such as textile, paper, mining, oil drilling, foundry, and livestock feed. As a heavy industry, the plant will require large amounts of capital, energy, and access to road and rail transport. It also will need a good supply of clean water (1600 m³/day) to use as boiler feedwater and for processing and cooling. A stable supply of electric power is also needed as unexpected outage may cause expensive delays in getting the

process on line.

1. Outlook

A. Economic

The rate of profit in the industrialized nations is marginal due to competition. However in protected markets, the profit can be between 10-20 percent.

B. Technical

2. Manufacturing Equipment Flexibility

With minor modifications, it is possible to use the same equipment to process other agricultural products, including maize, cassava, broken rice, and wheat.

3. Knowledge Base

The personnel must be highly trained, and the supervisory staff must have both mechanical and chemical (including microbiology) engineering backgrounds.

4. Quality Control

With the machinery in good working order, the quality of the products is ensured once the production process is carried on according to standards. If production and maintenance standards

are not maintained, it can result in microbiological growth and product contamination, which may lead to nonacceptance of the product. Worst of all, a dust explosion may occur that may wreck parts of the plant and possibly cause injury to personnel. The most common effect of a failure to follow maintenance standards is higher operating costs and frequent outages.

5. Constraints and Limitations

Dust emission may be objectionable unless new air drying technology is used. Danger from explosion is real because of organic dusts. Suitable safeguards in construction and operation are required. Waste loading from plant sanitation and cleaning, plus accidental spills may overload a municipal system. However, connection to a municipal system through an equalization and neutralization tank is recommended since the waste stream alone is lacking in nutrients for the stable operation of an activated sludge system.

MARKET ASPECTS

1. Users

Oil - As unrefined vegetable oil, it could be sold in bulk to a firm that would then refine and market it to individuals and restaurants as cooking or salad oil. When treated with hydrogen, it may be an ingredient in fats and spreads like margarine.

Feed - This is a feed stock used generally to feed animals. It is

sold in bag and bulk.

Starch - This is similar to maize starch. It is suitable for a wide range of industrial and food uses, where a thick, boiling starch is desired. Sales may be in bag or bulk.

2. Suppliers

The grain sorghum supply will come directly from farms or from country elevators.

3. Sales Channels and Methods

Sales of unrefined oil will be made directly to refiners. Sales of the feedstuffs will be made through local brokers or to blenders of feeds. Sales of starch will be to various users.

4. Geographic Extent of Market

Markets for feeds are generally local or regional, but export is feasible. Sales could be made to enterprises based on fattening animals for market or raising fowl by mass methods, or to farmers when hay and silage are in short supply. Sales of oil and starch may be regional or for export.

5. Competition

All of the products are standard commodities and are subject to competition worldwide. The success of the venture depends on the

isolation of the market by transport cost, tariff, or subsidy. Some competition may come from local small-scale projects making starch from cassava or white or sweet potato. These operations will produce crude material, but since the capital cost is so low, they could be competitive in periods of depressed prices.

6. Market Capacity

Because of the variety nature of the products, the market may be national and international.

PRODUCTION AND PLANT REQUIREMENTS

Requirements Annual Output:

1. Infrastructure, Utilities Small Plant Medium Plant

Land 6-7 Hectares _____

Building 4400 m2 _____

Power 140KW/Ton grind 28,000 kw/day _____

Fuel natural gas or oil 520,000,000 kcal/day _____

Water potable 434 m3/day

cooling 4211 m3/day

Sewer to municipal plant 200 m3/day at 2 Ton BOD

Equalization basin 100 m3

2. Major Equipment & Machinery Small Plant Medium Plant

Tools & Machinery

grain dryer

elevators and conveyors

steep tanks
double runner mill
germ hydroclones
germ washing screenbends
germ press; germ dryer
oil expeller
filter press
pin mill
screenbend fiber washing system
fiber dryer
disk stack centrifuges
gluten filter (vacuum drum belt type)
gluten dryer
starch washing system of 13 stages of Dorrclones
starch dewatering centrifuge with filtrate concentrator
flash dryer
Support equipment & parts
truck and rail track scales
grain storage bins for continuity of operation
boiler
security and fire protection
office and equipment
locker rooms for labor
mechanical and electrical shops with tools
roads & rail, site storm drainage
transformer and electric rooms
(*)TOTAL ESTIMATED COSTS
(for 200 ton a day plant (erected basis) \$38m _____

(*) Based on \$US 1987 prices. The costs provided are estimates; they are not intended to be used as absolute prices. Costs still need to be determined on a case by case basis.

3. Materials & Supplies Small Plant Medium Plant

Raw Materials

sorghum grain, 200 Tons

12-15% moisture

Supplies

liquid sulfur dioxide 0.4 Tons

Detergent, alkaline to
ca. 10 pH for cleaning

Packaging

Multiwall 5-ply paper bags

50 kg size

4. Labor Small Plant or Medium Plant

Skilled

Superintendent 1

foremen 3

chief operators 3

chemist 1

lab technician 1

plant engr. & maint. supervisor 1

general mechanics 4

electrician & instrument mechanic 1

**Semi-skilled
operators 6
loader 1**

**Unskilled
packers, warehouse, grounds, and
cleaning 8**

**Indirect
Management and Sales 1
Secretary 1
Bookkeeper 1
Store & shipping clerk 1**

5. Distribution/Supply flow Small Plant Medium Plant

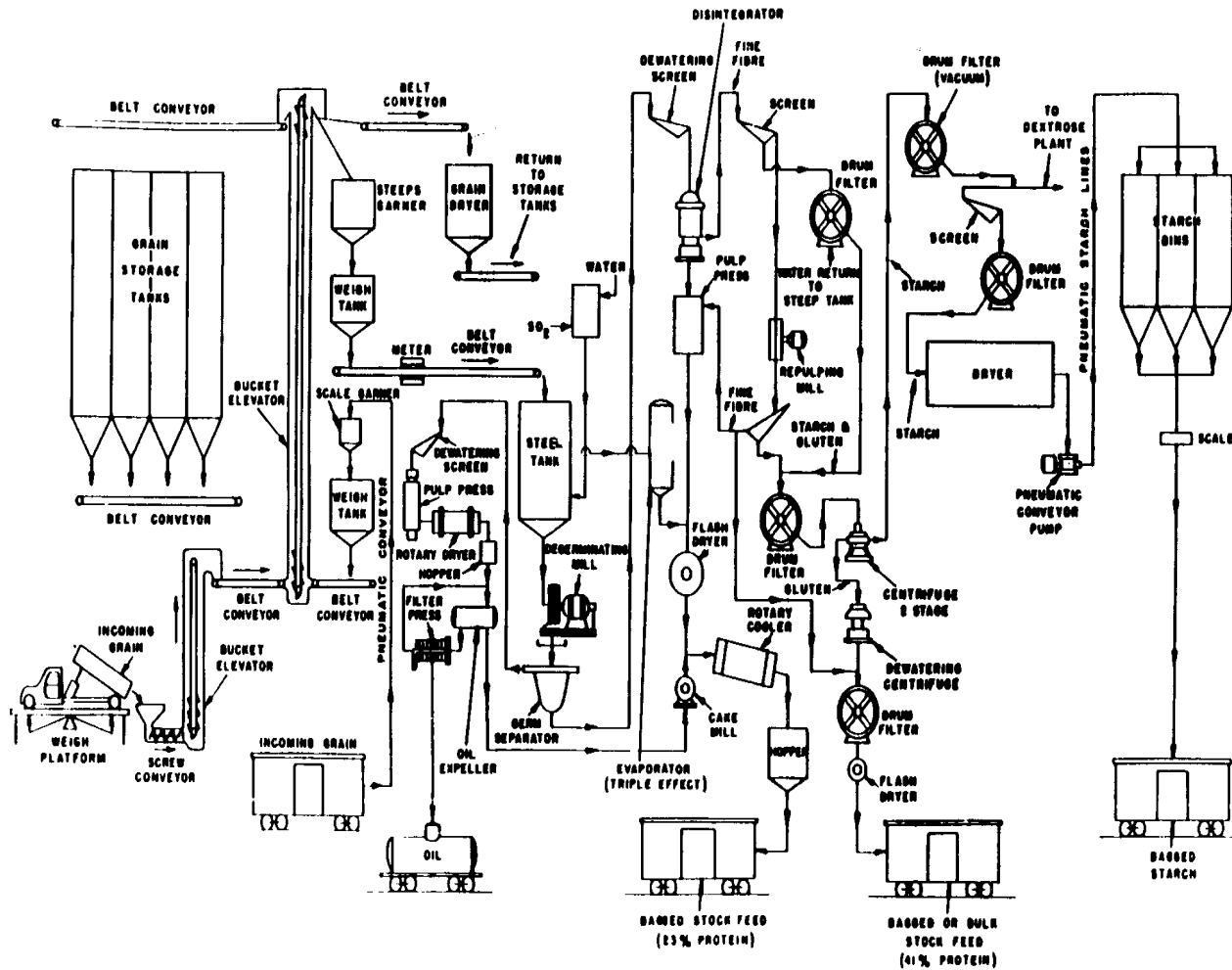
**Amount in per day
Amount out per day**

<FIGURE>

01p06.gif (600x600)

STARCH, OIL, AND FEED FROM SORGHUM GRAIN

Clean grain is soaked in sulphur dioxide solution and cracked to release the germ, which is separated by hydroclones and pressed, dried, and expelled to release the oil. The underflow from the hydroclones is screened, milled, washed, pressed, blended with gluten and evaporated steepwater, dried, and blended with oil cake to make animal feed. The washings are screened, concentrated, and separated into starch and gluten. The gluten is concentrated and combined with fiber. The starch fraction is washed countercurrent with fresh water, concentrated in an automatic centrifugal batch filter, and flash dried and screened.



REFERENCES

Unless otherwise stated, these addresses are in the United States.

1. Technical Manuals & Textbooks

Hall, C.W. (1981). *Drying and Storage of Agricultural Crops*. AVI. 1981.

National Fire Protection Association, *Standard for Pneumatic Conveying Systems Handling Feed Flour, Grain, and other Agricultural Dusts* (1973), NFPA No. 66.

Standard for Prevention of Fire and Dust Explosions in Feed Mills (1973), NFPA No. 61C.

2. Periodicals

Cereal Chemistry

Journal of Japan Agricultural Chemistry

Journal American Oil Chemists

3. Trade Associations

Corn Refiners Association, Inc.
1001 Connecticut Ave., NW
Washington, D.C. 20036

American Feed Manufacturers Association, Inc.
53 West Jackson Blvd.
Amarillo, Texas 79106

4. Equipment Suppliers and Engineering Companies

The services of a professional engineering firm experienced in the design of a wet-milling plant for maize should be engaged for making a preliminary estimate leading to consideration of a project. In addition, an independent expert in the design and operation of wet milling plants should be engaged to provide liaison and control.

Firms having such experience are:

Intensa, Mexico City
PSI-Processing Systems, Memphis, Tennessee
Daniel Construction Company, Greensboro, South Carolina

CPC International,
Englewood Cliffs, New Jersey 07632
(If the project has proceeded beyond the preliminary stage, technical assistance might be obtained from this source).

The following firms are suppliers of equipment and capable of designing portions of the process:

Dedert
20000 Governors Drive

Olympia Fields, Illinois 60461
Evaporators, Reineveld centrifuge, Vetter dryers and presses,
flash and PTD dryers for starch.

APV Crepaco Alfa Laval Inc.
395 Fillmore Ave. 2115 Linwood Ave.
Tonawanda, New York 14150 Fort Lee, New Jersey 07024
(Plate heat exchangers)

C-E Bauer
3200 Upper Valley Pike
P.O. Box 968
Springfield, Ohio 45501 - Doublerrunner plate mills

Eimco Process Equipment Co. Mixing Equipment Co.
PO Box 300 135 Mt. Read Blvd.
Salt Lake City, Utah 84110 Rochester, New York 14611

Chemineer Dorr-Oliver
PO Box 1123 Standford, Connecticut 06904
Dayton, OH 45401

Centrico
100 Fairway Court
Northwale, New Jersey 07647
(North American representative for Westfalia centrifuges)

5. Directories
Directory of The Edible Oil Industry

Institute of Shortening & Edible Oils, Inc.
815 Connecticut Ave. NW, Washington, D.C. 20006

6. VITA Resources

7. VITA Venture Services

VITA Venture Services, a subsidiary of VITA, provides commercial services for industrial development. This fee-for-service includes technology and financial information, technical assistance, marketing, and joint ventures. For further information, contact VITA.

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