AGRO-ALLIED INDUSTRIAL PROJECT PROFILES - BRIQUETTING OF AGRICULTURAL AND FORESTRY RESIDUES

BY

ABIGAIL ANDAH (MS.)
(NATIONAL CONSULTANT)
FOOD RESEARCH INSTITUTE
P. O. BOX M.20
ACCRA, GHANA.

PREPARED FOR
INDUSTRY AND HUMAN SETTLEMENTS DIVISION
UN ECONOMIC COMMISSION FOR AFRICA
ADDIS ABABA

MAY 1989

PROJECT PROFILE

BRIQUETTING OF AGRICULTURAL AND FORESTRY RESIDUES

1. THE PROJECT AND PRODUCT

1.1 Objectives of Project

The project has the following objectives

- to produce combustible sawdust briquettes suitable for use as substitute for fuelwood and charcoal in burning appliances;
- to elleviate the problem of sawdust disposal which is currently faced by the wood processing industry in Ghana;
- to provide a new option for conserving fuelwood resources which are becoming increasingly scarce; and
- to provide employment.

1.2 The Product

Briquettes to be produced will have these characteristics:

low moisture content of about 10%;

low combustible point;

calorific value of 4,500 kcal/kg;

diameter of 48mm;

length 12-300mm (adjustable) and

density of about 1000kg/m^3.

1.3 Scope of Product Development

Other raw materials that can be used for combustible briquettes are corn cobs, rice hulls, bagasse, groundnut shell, coconut shell, rice straw and other similar agricultural wastes.

Briquettes can be converted to charcoal by a carbonizing process in a kiln. This unit of operation can be added later to diversify product type and widen the product market.

2. THE MARKET

2.1 Consumer Analysis

Current users of fuelwood and charcoal are potential consumers envisaged for the product. These two fuels contribute about 76% of total energy consumption.

Briquettes are suitable as fuel for some commercial operations that currently use fuelwood and charcoal for heating purposes These operations use heating equipment such as brick kilns, lime kilns, boilers, furnaces, bakery ovens and other similar appliances. Institutions such as restaurants, hospitals, universities and boarding schools are another group of potential consumers that can use briquettes for cooking.

The product can also be used as fuel for household cooking. Commercial operations mentioned above that use fuelwood and charcoal as source of energy are located in urban centres in most parts of the country.

A Consumer survey on the various sources of fuel indicated that rural dwellers in the forest zone of Ghana usually collect their fuelwood requirements from their immediate surrounds. This segment of the market is therefore excluded from potential users of briquettes.

Households that use purchased fuelwood and charcoal for cooking are located in urban centres and rural areas in the coastal belt. In addition to these, areas with perceptible fuelwood shortage such as in the Upper East, Upper West and Northern regions of Ghana are potential markets for briquettes.

Neighbouring countries in the Sahelian zone such as Mali, Niger and Burkina Faso have often been cited as potential export markets for briquettes.

In 1985 a national consumption rate of 5.3 million M.T. was recorded for fuelwood. Of this total quantity, 89% was used for household cooking and other domestic purposes; 5% for cottage industries; another 5% for commercial and government sector and 1% for the traditional fish smoking industry.

Fuelwood consumption in Ghana averages 0.93m^3 per person per year (1983, 1986). The northern part of the country consumes less while the southern part consumes more than this average. Consumption in the last 5 years is static.

Estimate for total charcoal consumption in 1985 was 0.46 million M.T. Charcoal is the main fuel for at least 80% of urban population whose per capita consumption is estimated at 140kg/yr. This is equivalent to 1 M.T fuelwood/person/year.

The Ghana Export Promotion Council records indicate that only 130 tonnes of charcoal was exported in 1987 to the United Kingdom.

2.1.1 <u>Sources of Data and Collection of Market Information</u>

Production figures and market information on biomass fuel can be obtained from the Forest Products Research Institute, the Forestry Department and the Forestry Commission. Information on all sources of energy can be obtained from the National Energy Board which is responsible for advising government on national energy policy and development projects.

The Ministry of Industries, Science and Technology collates information on industrial capacity and output. Information on briquette production can be obtained from this source.

2.1.2 Public Institutions that Assist in Feasibility Studies

Institutions such as the Management, Development and Productivity Institute; the Ghana Institute of Management and Public Administration have consultants who do market research and provide market information to entrepreneurs. In addition, these agencies conduct feasibility studies for all scales of industrial operations.

2.2 Competition and Product Environment

The long term broad objectives of government on energy are to reduce the dependence on petroleum fuel imports and to manage forestry resources such that their productivity is increased and they provide sustainable quantities of wood for fuel.

Domestic energy output satisfies 87% overall energy requirement. The deficit is supplied through imports of crude petroleum. A breakdown of domestic output is 76% fuelwood; 20% hydropower, 3.6% crop residues and less than 0.5% petroleum.

Briquette is a suitable fuel for heating appliances. Substitute sources of fuel for heating in Ghana are fuelwood, charcoal, kerosene, liquified petroleum gas (LPG), residual fuel oil and electricity.

Forestry Resources: Sawdust briquetting is recently introduced in Ghana. Current total production is 3100 tonnes per year. As part of its energy programme, the National Energy Board has proposals to encourage the increase of sawdust briquette production. Projected level of production by 1995 is 50,000 tonnes.

Fuelwood production (including portion for charcoal) in 1985 was 8.6 million M.T. The bulk of fuelwood used in Ghana is derived from natural forests. It is collected by the rural population in the intermediate forest zone who sell the surplus of their requirement. The Forestry Department has collection points in parts of the country including the forest reserves where fuelwood is harvested.

Estimated charcoal production for 1985 was 0.46 million M.T. (3.3 million M.T. fuelwood). This activity is concentrated in the intermediate forest zone on the periphery of the high forest areas - Small scale producers account for most of the supplies while minor amounts are also produced by the Forestry Department.

In the north and southern transitional zones migrating charcoalers produce a heavy, high-quality charcoal. Farmers in the high forest zone also produce lighter and less appreciated charcoal as a source of secondary income.

Electricity: Total installed generating capacity is about 1072 MW from 2 hydro plants and a number of diesel-based plants. Generation of hydro electricity has ranged from 1,800GWh to a peak of more than 5,000 GWh in the last 10 years.

Petroleum: Virtually all requirements for petroleum fuel are met through imports of crude oil. The 1985 output from the State-owned refinery amounted to 1 million M.T. A breakdown of output is 41% gas oil (diesel); petrol 32%; kerosene 15%; fuel oil 7%; jet fuel 3.5% and LPG 0.5%.

2.3 Marketing Strategy

Other Fuels

Marketing of fuelwood and charcoal is highly organised. It involves producers, transporters, wholesalers in towns and urban centres who purchase truck loads and resell in fairly large quantities and retailers who sell to consumers.

Petroleum companies - both foreign and public - have distribution outlets in urban centres where consumers purchase their oil and gas for heating. Transportation of oil to these centres is by road in tankers. Liquified petroleum gas is distributed in cylinders.

Distribution of electricity is solely handled by the Electricity Corporation of Ghana which is also responsible for electricity generation in isolated load centres. Electricity is available mainly in regional urban centres and some provincial towns.

Prices of fuelwood and charcoal are market-determined.

The price structure of petroleum products is controlled and based on ex-refinery prices to which are added special levies (fiscal revenue and fund for specific energy projects), transportation and distribution costs.

Electricity tarriffs are made up of demand and energy charges for commercial and industrial consumers while residential consumers bear energy charges only.

Strategy for briquettes

Marketing strategy for sawdust briquettes needs to include a promotion exercise aimed at counteracting possible consumer resistance to the product. The suitability of briquettes as a fuel will have to be demonstrated in an educational campaign. Other attributes such as its low ignition point, high heating value and reduced storage space as compared to fuelwood need to be highlighted.

Competitive Pricing will attract consumers. The product will sell at US $63.0 (including 15% profit) per tonne. Price per heating value compares favourably with fuelwood and charcoal as shown below:

Prices of Energy per Gross Kcalorie

Fuel	Calorific Value (Kcal/kg)	Price/tonne (US $)	Price/Kcal US Cent
Fuelwood	3500	35	0.0010
Charcoal	6900	100	0.0014
Sawdust) Briquette)	4500	63	0.0014

Sales forecast is estimated at 480 tonnes per annum.

Consistent availability of the product will assure consumers of regular supply.

In the initial phase of the project, commercial users within the same town and nearby industries will be the target consumers.

3. THE PROCUREMENT

In Ghana, about 18.3 million ha, making up three quarters of total land area are under tree cover but actual forests amount to 8.8 million ha.

Of the 2.1 million metric tons wood that is cut annually for processing into building materials and for timber exports, about 55% is estimated as wood wastes.

Sawdust is the raw material for this project. The wood processing industry produces 300,000 tons wood waste each year as by-product. In the absence of any massive use of this by-product, its disposal poses a problem for the industry. Sawmilling is concentrated in the Ashanti region, specifically in Kumasi where more that 50 sawmills and veneer mills operate. Other towns with 3 or more sawmills are Nkawkaw, Akim Oda, Samreboi, Sekondi/Takoradi and Accra. Only about 25% of woodwaste is used by the mills for energy purposes.

Currently, sawdust has little or no economic value.

4. THE TECHNOLOGY USED AND LABOUR REQUIREMENT

As a general rule, the more stages that can be avoided, the cheaper and economical will be the briquetting.

Selection of equipment should take into account raw material type. Communition may be necessary for certain raw materials in order to shred or mill tham to small uniform size required for effective densification.

Drying prior to briquetting is necessary for raw materials with moisture content higher than 18%. Driers may be fuelwood, woodwaste, oil, gas or electrically fired.

They may also take different forms eg. rotary, cabinet, tunnel pneumatic conveyor etc. As much as possible, energy requirement for drying of sawdust should be minimum and economical.

The range of technology found in briquetting machinery is wide as illustrated by the types listed below:

- Hand-operated machines with low output of about 10kg/hr; pressure applied is low, briquettes crumble readily so may require addition of binders; labour intensive, price very low.
- Bullock-operated machines with low output of about 25kg/hr pressure applied is low, briquettes crumble readily so may require binder, price low.
- Power-operated:
  - (i) Low pressure applied; output of about 150kg/hr, preheating done before briquetting, manual raw material feeding, reasonable energy consumption, hard briquettes, no need for binders, low price.
  - (ii) Low pressure applied, output about 100-150kg, manual raw material feeding, briquetted crumble readily binding agents needed, energy consumption low, price low.
  - (iii) high-pressure applied, high energy requirement, capital intensive, good quality briquettes, no binders required, low to high output of 150-3000kg/hr; automated raw material feeding.

Selected Technology

Installed capacity of this project is 300kg/hr. It will operate eight hours a day and 200 days per year. Equipment selected are easy to operate and reasonably priced. Skills for its operation and maintenance are available locally.

Necessary equipment comprise:

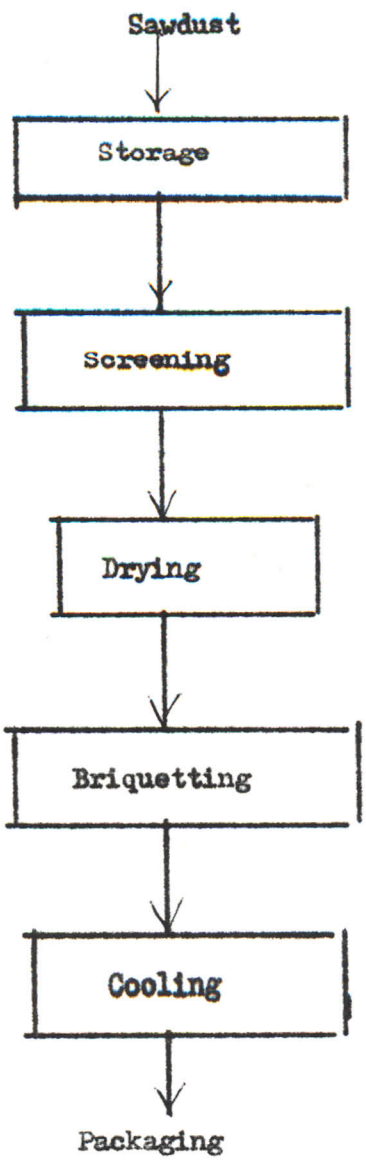
- Two sawdust-fired driers with total capacity of 300kg/hr;
- An electrically operated screening machine with a capacity of 300kg/hr;
- A briquetting press which is electrically operated; applies high pressure, with automated raw material feeding and has output capacity of 300kg/hr.

Skills necessary for operating the plant are detailed in Appendix I. Total manpower requirement is 8 with 6 people involved in direct production and 2 others in administrative/indirect labour.

Economic Scale of Operation

Briquetting is highly capital intensive and requires high energy input. These factors contribute to a high production cost. The project therefore needs to operate at 100% capacity utilization in order to be economically viable. The availability of adequate quantities of raw material and other inputs throughout the year is essential for continuous operation.

Diagram of the Processing System for Sawdust Briquetting



PROCESS DESCRIPTION

By means of densification process, dry sawdust (and other agricultural wastes) is agglomerated to make it more dense. The energy content is thus raised to a level approximately equivalent to that of fuelwood.

Storage

To ensure that raw materials are not exposed to rain which would result in high moisture content, a shed is needed to store the sawdust.

Screening

It is important to screen the sawdust in order to remove foreign matter such as stones and metal pieces which could cause damage to machinery. Screening also ensures separation of particles of uniform size from the bigger wood pieces which are rejected.

Drying

In general, the moisture content of raw material needs to be reduced from up to 50% (as in baggase) to approximately 10% in order to ensure that a good quality product with high heating value is produced. Materials with higher moisture content have lower heating (calorific) values. In addition low moisture content enhances the densification process.

Drying is done in two driers which are heated by brick furnaces that use woodwastes as fuel.

Briquetting

The briquetting machine which is electrically operated consists of a main horizontal pressing cylinder which presses the material into a chamber against a stable plate. The pressing process is hydraulically controlled and pressure applied is adjustible. The combination of high pressure and the heat generated during the compression process enables hard and solid briquettes to be produced.

After compressing the sawdust into briquette, the plate moves to the side to allow the briquette to move to the cooling line.

Cooling

From the briquette machine the briquettes are hot and therefore need to be cooled. This is done by leaving them in a well ventilated area.

Packaging

The finished product is packaged in woven polypropylene sack (50kg) to prevent reabsorption of moisture. Packaging also facilitates marketing and helps to prevent crumbling during transportation.

PLANT LOCATION

Briquetting is very site-specific. It has to be done very close to the source of raw material in order to minimise or eliminate the cost of procurement. It should be done at a reasonable distance from end users again to cut down transportation cost.

The location of the project is Kumasi where it will be built adjacent to an existing sawmill. More than 50 sawmills and veneer mills clustered around Kumasi produce about half of the total sawdust output in the whole country.

With its central location in the country, Kumasi has very good transportation network with most parts of the country. A network of roads connects Kumasi with the port towns of Takoradi in the south west; Accra and Tema in the south East and with the northern areas of Ghana. A railway network also links Kumasi with Takoradi, Accra, Tema and other southern parts of the country.

Kumasi has good supply of infrastructural requirements such as good roads, transport, communication, energy (electricity, petroleum fuels etc.), water and housing. Land requirement is 1000sq. metres with 200sq. meters covered area. Enough land is owned by an existing sawmilling company to cover this requirement.

The Investment Code, 1985 makes provision for a reduction of 15% on company income tax payable by enterprises situated within Kumasi. A five year moratorium on taxes will be enjoyed by the project on approval from the Ghana Investments Centre.

LIST OF SUPPLIERS OF BRIQUETTING MACHINERY & EQUIPMENT

Manufacturer/Supplier	Throughput	Price	Year of Quotation
Hova GmbH Bahnhofstrasse 31 D-7298 Lossburg West Germany	200-300kg/hr. with shredder, automatic feeding	US $ 21,800-27,250 DM 40,000-50,000	1989
M/S Rajico 204 Pragati House 47-48 Nehru Place New Delhi - 110019 India.	300-400kg/hr	US $50,000	1988
GAKO Spezialmaschinen GmbH Poststr. 27, D-2301 Schierensee Kiel, West Germany	60kg/hr. 150kg/hr.	US $8,800 US $13,000	1984 1984
T & P Intertrade Corporation Ld. 114, 1st Mansion, Rajadamnen Ave., Bangkok 10200, THAILAND	150kg/hr.	US $ 5,850	1984
VS Machine Factory 90/20 Ladprao Soi 1 Road Bangkok THAILAND	200kg/hr	£3,300	1982
CeCoCo Chuo Boeki Goshi Kaisha P.O. Box 8 Ibaraki City Osaka 567 JAPAN.	200-300kg/hr.	£7,070	1981

INITIAL FIXED CAPITAL

1988

Item	Cost (US $)
Land and Site Preparation (1000m^2)	-
Buildings (Wooden) and Civil Works (200m^2)	7,690
	$7,690
Equipment and Machinery:	
2 driers (sawdust-fired)	1,000
1 Screening Machine	2,000
1 Briquetting Press	16,000
Electric motors and spare parts included	$19,000
TOTAL FIXED CAPITAL	US $26,690
WORKING CAPITAL (2 months)	4,610
PRE-OPERATION COST	420
TOTAL CAPITAL INVESTMENT	US $31,720

Estimated Production Costs for different CAPACITY UTILIZATION

Item	COST (US $) CAPACITY USED			
Quantity per 100% Utilization	75%	80%	90%	100%
Raw Material (300kg/hr.)	-	-	-	-
Packaging Material (9600 pieces)	4320	4608	5184	5760
Direct Labour (6)	3840	3840	3840	3840
Electricity (24Kw)	1551	1655	1862	2068
Maintenance (5% building, 10% machinery)	2285	2285	2285	2285
Lubricants	100	100	100	100
Water (12,000 gals)	321	321	321	321
Administrative Cost (Labour, insurance 3%, promotion 22%, interest stationery)	9300	9300	9300	9300
Depreciation (10% Building, 10% machinery)	2669	2669	2669	2669
Total Production Cost US $	24,406	24,778	25,561	26,343
Total output (kg)	360,000	384,000	432,000	480,000
Cost per tonne Briquette } US $	67.80	64.53	59.17	54.88

Estimated Working Capital

Item	2 Months COST (US $) 75%	80%	90%	100%
2 months production cost	4068	4130	4260	4390
5% Contingency	203	207	213	220
Total Working Capital	4271	4337	4473	4610

Sources of Finance

Sources of funding for this briquette project could be obtained from any of the development banks such as the National Investment Bank. The commercial banks also do provide financial assistance to such projects.

Shareholding

This project will operate as a subsidiary of an existing privately owned sawmilling company, a limited liability.

Majority Share holder (51%)

Four other share holders (49%).

APPENDIX I

MANPOWER REQUIREMENT

Direct Labour	No.	Cost (US $)
Briquette operator/supervisor	1	540
Drier Operator	2	840
Cooling section/packaging	1	420
Unskilled labour	2	720
		2520
12½% Social Security		315
40% other allowances		1008
Total	6	US $3843
		3840

Indirect Labour	No.	Cost
Accounts/stores	1	540
Securityman	1	400
		940
12½% Social Security		118
40% other allowances		380
		1438
	2	1440