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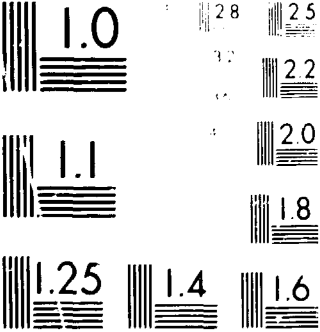
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15 October 1982
English

DEVELOPMENT OF CHARCOAL INDUSTRY AND ESTABLISHMENT OF A PILOT PLANT*

SI/SOM/78/803

SOMALIA.

Technical report: Improvement of charcoal production and development of a charcoal industry

Prepared for the Government of Somalia
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Walter Emrich, consultant in charcoal manufacturing and pyrolytic conversion technology for agricultural wastes

United Nations Industrial Development Organization
Vienna

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SUMMARY

Objectives of the Mission

- To investigate the feasibility of charcoal making from agricultural waste
- To approve a charcoal briquetting plant
- To develop an advanced charcoal fire brick kiln
- To draw up a National Charcoal Industry Development Plan for the National Range Agency (NRA)
- To establish the NRA charcoal laboratory in Afgooye

Results of the Mission

1. The charcoal situation and the predicaments connected with the production of charcoal have not improved since the first part of the mission (1979/80). The charcoal demand of Mogadiscio is surmounting the supply (30,000 - 35,000 t/y). The energy deficit of the households is made up by firewood.

2. Charcoal <u>briquettes</u>, with their energy saving effects for cooking and pyrolysis oil (by-product of charcoal production) as a substitute for industrial fuel oil, are not known in Somalia.

3. The areas of Afgooye and Jowar offer sufficient agricultural waste to sustain several carbonization plants. The feasibility of a small plant with a capacity of 2,000 t charcoal briquettes and approximately 1,600 tons of pyrolysis oil per year has been investigated (chapter 2).

4. The brick factory in Afgooye supplies appropriate fire bricks for the construction of improved commercial charcoal kilns. The design has been completed. The investment cost for a $60m^3$ kiln is US$900 and the entire material for the construction can be purchased locally.

5. For the systematic improvement of the charcoal situation in Somalia it is imperative that the NRA adopts a National Charcoal Industry Development Plan as outlined in chapter 5. To make this plan viable and functional, NRA also must create a Charcoal Development Department within its own organization.

6. The NRA charcoal laboratory has not yet been established. It had to be postponed until the necessary space becomes available in the forestry school in Afgooye.

CHAPTER 1. ASSESSMENT OF THE PRESENT CHARCOAL SITUATION

Only two comprehensive studies about charcoal in Somalia have been undertaken up to now. The results are laid down in a report by the RCA/FAO Forest Industries Advisory group for Africa in 1976 and in the UNIDO expert report of project SI/SOM/78/802 (W. Emrich) in 1980.

Since Somalia's charcoal production with its impacts on the natural resources have changed very little in the meantime, we have limited our evaluation to providing updated data only.

Therefore, for more details, reference is made to the above-mentioned sources of information.

1.10 Production and Marketing of Charcoal

The Charcoal Marketing Co-operative shows for the last three years the following sales for Mogadiscio:

1978	35,899 tons/year
1979	21,950 tons/year
1980	28,315 tons/year

For 1981 the breakdown for the total area, covered by the Charcoal Marketing Co-operative of Mogadiscio including three other townships, displays the following figures:

Mogadiscio	28,633 tons/year
Baydows	2,167 tons/year
Marka	3,171 tons/year
Jowar	2,333 tons/year
Total:	36,304 tons/year

Almost all of this charcoal was produced in the neighbourhood of Baidowa by approximately 120 charcoal camps, each camp consisting of thirty to fourty operators with their family members.

1.10 Cont....

Since 1979/80 (first part of this mission) the charcoal camps have moved farther away from Baidowa and deeper into the bush following the natural pattern for harvesting the firewood for their kilns.

Obviously the same situation prevails in the southern part of Somalia where the charcoal camps have moved to a greater distance from Kisimayo, the largest town in that area. It is estimated that the average truck transport distance of charcoal for the Mogadiscio supply is between 300-400 km. The quality of the produced charcoal, consisting of lump and charcoal fines, is very poor with an average calorific value of 5,500 to 6,200 kcal/kg. Therefore the yield of carbon by weight does not exceed 12%, decreasing the energy balance of the charring process very much.

It can be estimated that only 10% to 12% of the raw material is being converted into charcoal. The remainder is either burnt away or remains as half burnt firewood. One of the reasons for this deficiency is that the charcoal operators are paid by the weight of produced charcoal and therefore they shorten the carbonisation cycle in order to gain a higher output yield. Until now no retort or converter process has been employed in the country to improve the situation and also to produce by-products.

Spotchecks at retailers in Mogadiscio revealed that the <u>prices for charcoal</u> vary greatly and are between US$60 and $75, hence exceeding the official ceiling price of US$55 per ton. Charcoal is sold in stores in units of "kintal" which is equal to 100 kg. However, our investigation revealed that the actual kintal is approximately less by 10%. The high price for charcoal in Mogadiscio may be contributed to the fact that there is normally a shortage in charcoal supply for three days per week. In places and villages outside of Mogadiscio, charcoal is sold at the Government's ceiling price. Although the charcoal shortage is obvious here, part of the demand is satisfied by illegally burnt charcoal.

The estimate of the total annual charcoal consumption in Mogadiscio is a difficult task and becomes even more difficult for other areas. The balance sheet of the charcoal marketing co-operative of Mogadiscio shows that charcoal sales within the city may surpass 35,000 tons in one year.

Loss of charcoal during the long transportation periods does not appear in official statistics. The amount of illegally burnt charcoal also is not included in these statistics.

Although charcoal lump and fines is a major household fuel , the consumption of firewood is still exceeding charcoal. Reliable figures concerning the firewood consumption of Mogadiscio are not obtainable. However, estimates are running high and it is assumed that the amount of wood supplied legally and illegally to the city will be ten times higher than the charcoal supply. Therefore, it can be ascertained that the charcoal market in Mogadiscio and in the rest of the country is undersupplied. Consequently, charcoal consumption in Somalia is causing a strong pressure on the declining forest reserves of the country at present and in the future.

1.20 Usage of Charcoal Briquettes

For two good reasons, the trend in the charcoal utilization as a household fuel, leans heavily toward charcoal briquettes. On one side, an energy extender can be included into the charcoal briquette. The energy extender is a mineral, e.g. limestone, and extends the ability to store heat, the burning time of charcoal considerably, thus giving the user a well appreciated fuel saving effect. On the other side, the manufacturers of charcoal have to look for other raw material resources because wood has become scarce in many countries. The resources available are agricultural wastes. These raw materials however are usually discharged in particles of reduced size, e.g. sugar cane bagasse, or nut shells and therefore will yield charcoal fines, which have to be formulated and briquetted for further use and thus increasing the price. However, applying a briquetting technique to charcoal fines derived from wastes and adding a selected mineral as energy extender, Somalia's charcoal production could be increased without cutting more forests.

The utilization of briquettes will also depend on the type of stoves used. Only those equipped with a grid to separate and discharge the ashes are feasible. Because of the high content of minerals, the burning of briquettes yields more ashes than lump charcoal. Although these stoves and grids are readily available in Somalia, only a small percentage of Mogadiscio households possess them. In villages however, only the African charcoal claypot is in use which is in no way a suitable stove for briquette burning. We have estimated the possible use of charcoal briquettes within the city of Mogadiscio by checking with households, hotels and restaurants. Although our investigations are preliminary, a briquetting operation with an annual capacity of 6,000 - 8,000 tons of charcoal briquets can be well justified.

1.30 Utilization of Pyrolysis Oil

From every charcoal process a solid fuel (charcoal) and a liquid fuel (Pyrolysis Oil) can be recovered provided the proper technique is applied. Pyrolysis oil is a liquid of dark brown colour, containing acids, phenoles, methanol and other components and with a calorific value between 4,500 and 6,000 kcal/kg. It is used by industries as a raw material for chemical production and as a substitute for fuel oil. The latter makes it interesting for all developing countries lacking crude oil.

In particular, pyrolysis oil is useful for small factories to substitute fuel oil for direct processes or boilers. In Mogadiscio and in its vicinity, such industries are available. A few examples are: The brick factory in Afgooye, the sugar factory in Jowar, and a foundry and other local plants in Mogadiscio.

Although a detailed market study was not undertaken, we assume that 10,000 tons of pyrolysis oil can be consumed, replacing approximately 5,000 to 6,000 tons of refinery oil per year. Taking into account the present price for fuel oil in Somalia, the substitution accounts for 32.5 to 39.1 millions SSH per year (6.53 SSH for one kg. refinery oil).

CHAPTER 2. PRODUCTION OF CHARCOAL BRIQUETTES AND PYROLYSIS OIL FROM FORESTAL AND AGRICULTURAL WASTES

In some areas of Somalia, agricultural wastes from plantations and factories are available. We have investigated only Afgooy with its surroundings and Jowar. Both areas are rich in agricultural crops, and in particular Jowar, with its sugar factory. Although a feasibility study has still to be conducted it can be said that in any of these regions, a plant utilising agricultural waste as raw material for its power supply will be most beneficial to the area.

2.10 Process Description

Every carbonisation process yields three different products:

Charcoal (solid fueld)
Pyrolysis oil (liquid fueld)
Heating gas (gaseous fuel)

The charcoal is usually densified to briquettes and used as household fuel. Pyrolysis oil, a substitute for fuel oil, can be pumped and carried either in tank cars or barrels. The heating gas contains CO and hydrogen and usually burnt in the dryer of the carbonisation plant. The raw material is reduced in size by hogging, shredding or crashing and stored in the open air. From there, the feed is conveyed into a dryer (if the moisture content exceeds 30%). The dried feed then is transferred to the carboniser. Here thermal decomposition into charcoal, oil and heating gas takes place.

The charcoal is continuously removed from the bottom of the carboniser and, after cooling, taken to the char storage bin. The oil and gas vapours are transferred into the off-gas system on the top of the carboniser and the pyrolysis oil is condensed in a scrubber-chiller . The remaining heating gas is recycled into the burning chamber thus providing hot gas for the raw material and the briquette dryer.

The briquetting station of a normal charcoal plant consists of a mixer, roller press, dryer and, if necessary, bagging equipment. The charcoal is mixed with a binder and an energy extender material and then formed into briquettes in the roller press.

2.21 Plant Capacity and Plant Location

The proposed plant should serve as a demonstration of a new technology and therefore a capacity of 2,000 tons per year of charcoal briquettes is recommended. As already mentioned, its location has to be determined by a feasibility study.

2.20 Raw Material and Auxiliary Materials

2.21 Raw Materials

An estimate of available agricultural waste has been made already during the first part of this mission (UNIDO report DP/ID/SER.A/229 1980). In all areas, papaya trees, cotton sticks and banana trees are available and in the sugar factory of Jawar, sugar cane bagasse. As well as these, nut shells and wood waste can be considered for raw material supply also. Since the carbonisation plant should be constructed in the immediate vicinity of the waste sources, only costs for the retrieval of the raw feed will be considered which are estimated at US$5.00 per ton. To provide the feedstock for the new plant (5,000 ton/year) US$25,000 annually is required.

2.22 Auxiliary Materials

Binder and energy extender are two basic materials for the production of charcoal from wastes. Starch or molasses as binder guarantees a reliable quality of the briquette. There is no significant starch production in the country. However, molasses is readily available from two sugar factories in Jowar and Lower Juba.

A market price for molasses does not exist. Based on the world market price, the expenses for 180 tons of molasses (incl. freight) will be US$8,000 per year.

The addition of lime stone or ground fire brick gravel will make the charcoal briquettes long burning (energy extender). The annual cost for 150 tons (incl. freight and preparation is estimated at US$1,500. Cost for packaging material are not provided as all markets in Somalia are supplied with unpacked charcoal.

2.30 Factory supplies, Utilities

The factory supplies include maintenance materials such as oils, grease and cleaning material as well as spare parts and tools. It is normal practice to estimate the cost for these materials at 2% of the total plant equipment (US$12,000 per year).

The electricity consumption of the plant will be 80 kw/h or 550,000 Kw/h annually. At the present rate of US$0.06 per Kw/h, the total electricity costs will be US$33,000 per year (in the future SSH 1.10, presently SSH 0.75 Kw/h). The plant requires cooling and process water. Based on a flat rate we estimate the total expenditure to be US$1,500 per year.

2.40 Project Engineering

For the selection of the technical details, a feasibility study is necessary. Several factors have to be taken into consideration. The investment capital for the plant has to be paid in hard currency and there are virtually no parts which are produced domestically. While labour is abundant and cheap, the plant should employ as many workers as possible. The project will be located in a rural area. These prerequisites prevent a fully mechanical operation. However, to achieve a reasonable plant capacity, complete manual operation is also not feasible. Therefore the semi-mechanical plant would be an adequate solution.

In order to establish some reliable investment figures, we have approached several equipment suppliers in Europe and USA, and have obtained their most recent prices for equipment.

2.41 Equipment of the Plant

Suppliers offer usually all parts of a plant in a package which includes the charcoal converter and pyrolysis oil unit as well as the briquetting plant. The cost of this package ranges between US$300,000 and US$400,000. Our calculation therefore was based on the mean cost of US$350,000.

FOB price package	US$ 350,000
Estimated freight	45,000
CIF price Mogadiscio	395,000
Local charges for clearing transportation 7%	28,000
Total cost (import duty incl.	US$ 423,000

Other equipment costs will be for a truck and a car for personnel transport, office quipment, furniture and laboratory equipment. For these investment costs, a total of US$70,000 is sufficient.

The costs for the civil engineering works are based on the space requirements of the plant and consist of site preparation and development, cost for buildings and outdoor works. If the plant will be installed on an existing plant site, these costs will change. For the purpose of a rough financial evaluation, we have estimated the costs according to our experience with other projects, at a total of US$30,000.

Investment expenditures are summarized as follows:

Production equipment	US$423,000
Other equipment	70,000
Civil Engineering Works	80,000
Contingencies	17,000
Total Investment Costs	US$590,000

For the depreciation of the investment costs we have applied the usual percentages as shown in the following table:

Production Equipment	10% of	US$ 423,000	US$ 42,300 per year
Other Equipment	20% of	70,000	14,000 per year
Civil Eng. Works	5% of	80,000	4,000 per year
		Total Depreciation:	US$ 60,300 per year

2.50 Organizational Structure

2.51 Manpower requirements

The envisaged plant will be headed by a General Manager who will be supported by the Administrative Department and the Production Department.

The Administrative Department will be managed by the Director of Finance and Administration, who will be responsible for the overall financial conduct, accounting, budget control, personnel management, procurement of materials and supply, store keeping and marketing.

The Production Department will be headed by the Technical Director supervising the following sections:

Raw material preparation
Charcoal and pyrolysis oil station
Briquetting operation
Warehousing
Laboratory/quality control
Maintenance shop

Whereas the charcoal and pyrolysis oil station and the briquetting operation are supervised by one foreman each, the laboratory and maintenance shop report directly to the Technical Director.

2.52 Personnel Costs

The plant will employ 15 salaried people including the management. The annual costs can be estimated to be US$30,000 per year. The number of labourers working on wage basis all year round will be 46. This includes 3 foremen, one technician, 12 operators and 30 unskilled workers. The annual sum of wages compared and aligned with other industry will be US$50,000. The total personnel costs for the production therefore amounts to:

Salaries	US$ 30,000
Wages	50,000
Subtotal	80,000
Surcharges 10%	8,000
Total:	US$ 88,000

2.53 Overhead Costs

2.54 Factory Overheads

Maintenance of civil engineering works (5% of construction cost)	US$ 4,000 per year
Maintenance of plant equipment (3% of production and other equipment)	14,800 per year
Water (without process water) (2% of the market value of the buildings)	700 per year
Total Factory Overheads	US$ 19,500 per year

2.64 Interest during Construction

It is assumed that 40% of the investment in fixed assets through borrowed funds (US$ 240,000) will remain deployed during the implementation period. At an interest rate of 8% interest cost to be capitalized will amount to US$ 12,200.

2.65 Laboratory/Pilot Plant Test

It is necessary during the earliest stages of the implementation period to perform pilot plant tests with the raw materials. These costs are difficult to estimate, although an allocation of US$4,000 seems to be sufficient.

2.66 Consultancy and Personnel Training Programme

It is necessary to engage the services of an expert during the implementation phase, and also to train the Technical Manager and two foremen, the costs of which have not been determined.

2.67 Pre-Production Labour

Two months wages will be necessary, amounting to US$1,500.

2.68 Total Project Implementation Cost

Summarizing items 2.61 to 2.67, US$48,850 will be necessary. The normal depreciation rate for these costs is 5%, which is US$2,500 per year.

2.70 Working Capital Requirements/Project Financing Cost

For the total investment cost it is necessary to define the working capital requirements per year after a final decision for the plant construction has been made. At this stage of the evaluation, no details were available and we have therefore applied a flat rate method, based on fixed assets and pre-investment costs. Therefore, after start-up and at half capacity during the first production year, the working capital can be estimated to be US$ 45,000. Interest at 10% is US$4,500. After the first year, sales revenues will become active and the requirements will diminish gradually.

2.71 Project Financing Cost

This type of project is normally financed, e.g. with 50% equity and 50% by a long-term loan from a bank. There are alternatives which have to be explored in more detail. At this stage of our investigation, we have assumed a 50% equity/50% long term loan scheme.

The total investment cost including pre-investment expenditures and working capital requirements amount to US$ 684,000 (sect. 2.41, 2.68, 2.70) 50% longterm loan of US$ 342,000 will require an interest of 12% which will amount to US$ 41,000, during the first year of the start-up of the plant. Later, amortisation will decrease the interest payments.

2.80 Estimated Sales Revenues

2.81 Charcoal Briquettes

Since the production and marketing of charcoal in Somalia is regulated by the Government and controlled by the respective local co-operative, it can be safely assumed that an annual amount of 2,000 tons of charcoal briquettes will be sold in Mogadiscio.

Therefore, the sales revenues will be determined by prevailing market prices in Mogadiscio. The present ceiling price is US$50 per metric ton. At full capacity the plant would sell US$ 100,000. Allowing a 20% discount for freight and various costs, the net sales revenues at the plant site will be US$ 80,000 per year.

2.82 Pyrolysis Oil

The second product which the plant will bring forth to the market is pyrolysis oil. It can be expected under normal production conditions that 1,600 tons per year will be obtained.

The present price for industrial fuel oil in Mogadiscio is SSH 6.53 per kg. The Ministry of Finance may reduce this price for certain industries. Therefore, in our evaluation, we have applied a factor of .40 equivalent to SSH 2.61 per kg or US$ 0.21 per kg. Estimated sales revenues from the distribution of the pyrolysis oil will amount to US$ 336,000 per year.

2.90 Estimated Production Costs/Net Income Statement

2.91 Estimated Production Cost at Full Capacity

Category	Section	Total Cost
Raw material	2.21	US$ 25,000
Auxiliary material		
Binder	2.22	8,000
Energy extender	2.22	1,500
Factory supplies	2.30	12,000
Electricity	2.30	33,000
Cooling water	2.30	1,500
Depreciation	2.41	60,300
Wages/Salaries	2.52	88,000
Overhead costs		
Factory overheads	2.54	19,500
Administrative overheads	2.55	13,000
Depreciation project implementation costs	2.68	2,500
Interest		
Working capital	2.70	4,500*
Long term loan (50% of investment cost)	2.71	41,000*
Total annual production costs		US$309,800

* first year only (see sect. 2.70)

2.92 Net Income Statement

Period	Construction	Start-Up	Full Capacity
Year	1	2	3
Production Programme	0	50%	100%
1. Sales Revenue			
Charcoal briquettes	-	40,000	80,000
Pyrolysis oil	-	118,000	336,000
Total Sales Revenue	0	158,000	416,000
2. Production cost	0	150,000	310,000
3. Gross profit	-	8,000	106,000
4. Tax	-	-	-
5. Net profit	-	8,000	106,000
6. Dividends	-	-	-
7. Undistributed profits	-	8,000	106,000
8. Accumulated undistrib. profits	-	8,000	114,000

This study was limited to the preliminary feasibility of manufacturing charcoal briquettes and pyrolysis oil from agricultural wastes which have so far been untapped.

At this stage, it can be proved clearly that the project with the size proposed will have a high profitability. The project will also create job opportunities and improve the industrial capacity of a rural area considerably. In addition, savings on hard currency for crude oil imports will be expected. However, the most important benefit for the country is that the supply of household fuel will be increased without causing more damage to the forest reserves.

CHAPTER 3. PRODUCTION OF CHARCOAL BRIQUETTES FROM CHARCOAL MADE IN BHAIDOWA

One significant improvement of the charcoal supply for Mogadiscio can be achieved with the installation of a briquetting plant. The advantages of charcoal briquettes compared to the normal un-densified charcoal have been mentioned in Chapter 1. already.

A favourable location for the plant would be either in Bhaidowa itself, near the charcoal camps, if the necessary electric power can be provided, or in Afgooye. All charcoal trucks carrying the merchandise from the Bhaidowa area to the city of Mogadiscio have to pass through both towns. They are running on an almost regular schedule and operate all year round. Therefore continuous supply of the briquetting operation with raw material will be guaranteed.

3.00 Process Description

The briquetting process was partly described in the previous chapter (2.10). After screening and grinding, the charcoal will be blended with the binder (starch or molasses), the energy extender (locally available minerals having a high heat storage capacity). In some cases, it is necessary to add also small amounts of an ignition enhancer because charcoal briquettes tend to be harder to ignite compared to lump charcoal.

The mixture is then conveyed to the press for briquetting. Different types of presses are in use and they all have their special advantages, depending on the requirements for shape and quality of the finished products, production capacity and also operational conditions. For a briquetting plant exceeding an annual output of 3,500 tons, a roller press will be suitable.

The so-called "green" briquettes discharged by the press have to undergo a hardening or curing procedure in a specially designed dryer. After leaving the dryer, the charcoal briquettes are ready for storage and shipment or carried to a bagging machine if the market in Mogadiscio would require a certain type of packaging.

3.10 Plant Capacity

The size of the plant will depend on charcoal demand in Mogadiscio being substituted by charcoal briquettes. Although the use of charcoal briquettes will result in an extended cooking time of up to 30% compared to lump charcoal, it has to be borne in mind that owners of special cooking stoves only will be able to make use of this fuel saving effect.

Generally, the charcoal industry tends to install facilities with a higher output than is required at the time. The investment cost for a briquetting plant are not directly related to the built-in capacity of the plant. They rather increase gradually. The capacity question also becomes more important in view of the additional erection of a conversion plant for agricultural waste. As outlined in the previous chapter, this plant will produce a char which has to be briquetted also. Combined briquetting of the charcoal made from wood with the char obtained from the agricultural residues will be desirable and will therefore decrease the investment cost significantly.

The results from our investigations of Mogadiscio households indicate that a capacity of a briquetting plant not lower than 6,000 but not higher than 10,000 tons per year can be fully justified.

3.20 The Implementation and the Returns of a Briquetting Plant

A proposal for a feasibility study should also include pilot plant tests on charcoal mixtures in order to determine the proper composition of charcoal briquettes to meet the particular requirements of the Mogadiscio households. A well designed briquetting operation rarely creates difficulties if commercially proved equipment is used.

During the last three decades, charcoal briquetting machinery has been developed with high technical standards and has reached a high degree of reliability.

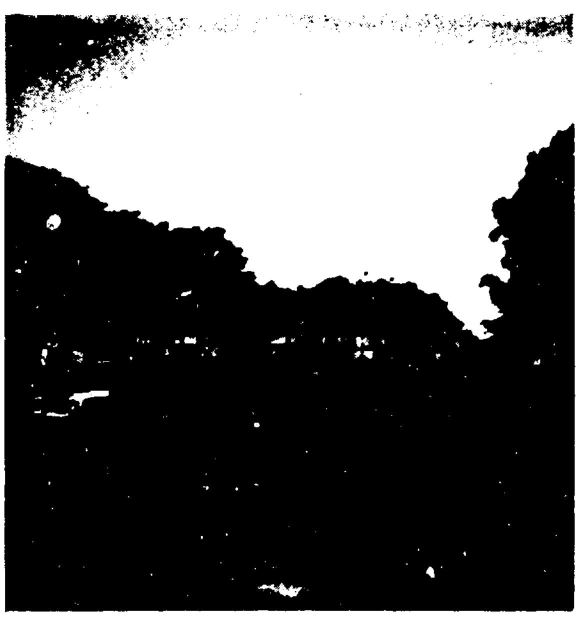
The briquetting plant can be operated with a minimum of skilled labour and the operation itself is simple. The returns from a briquetting plant are very much influenced by the composition of the charcoal briquettes. Most charcoal markets will accept the use of an energy extender up to 35%. The prices for the binder - molasses or starch - will also determine the return from such a briquetting plant. These additives are available in most developing countries at low costs and make an important contribution to the overall economics of charcoal briquetting techniques. It is assumed that the same conditions are prevailing in Somalia. Considerable savings will be made by utilizing mixed charcoal briquettes which will have a quality as good as pure charcoal briquettes but will be lower in the production costs.

CHAPTER 4. DEVELOPMENT OF A SOMALIA FIRE BRICK CHARCOAL KILN

The only factory near Afgooye producing fire bricks with the dimensions required for the kiln had been shut down. We therefore had to construct the prototype with the fire bricks made by the new factory in Afgooye. Since the dimensions of these bricks are quite different from normal kiln stoves, we had to alter the kiln design and did encounter many difficulties.

4.10 Description of the Kiln

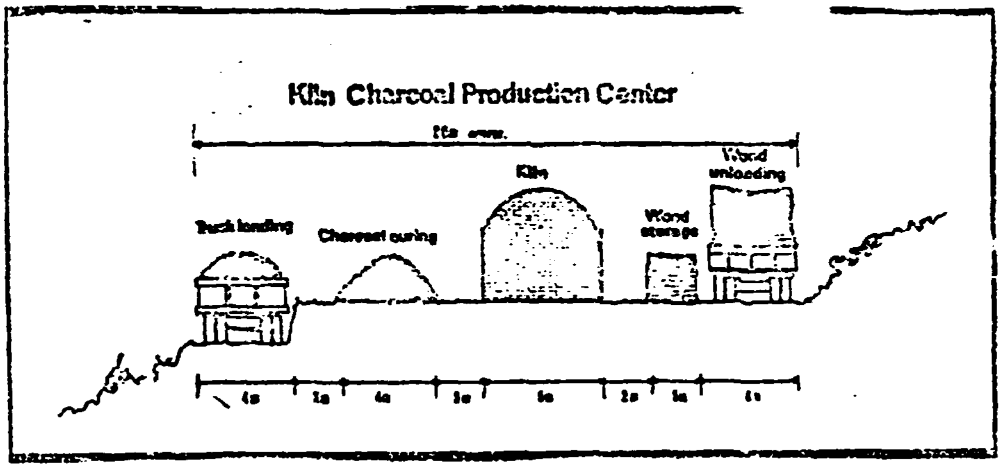
The detailed instruction about the way the kiln is built is given in the appendix to this report. Presently, more than a hundred types of charcoal kilns are in use all over the world. They are operated either with external or internal (partial combustion of the kiln charge) heating, fixed or mobile. The Somalia kiln is circular with a domed roof, and is built of fire bricks. The circular wall is totally in contact with the outside air. It is batchwise operated. This type of kiln is generally referred to as "Beehive Brick Kiln". Many thousands of these kilns are widely and successfully operated, especially in Brazil. The Somalia Beehive kiln is distinguished from the Brazilian type by employing hollow fire bricks of larger size, consequently leading to a different structure and design. The photo below shows the prototype kiln under construction.



The design of the Somalia kiln offers the following advantages:

- The gases, developed during the carbonisation cycle, pass through the kiln charge. The heat contained in the gases is partially used for drying of the kiln charge.
- Improved charcoal yield, up to 65% in volume or 25-27% based on dry weight can be obtained.
- Uniform charcoal quality (82% fixed carbon) can be obtained with an average calorific value of 6,800 - 7,000 Kcal/Kg.
- Low cost of the kiln investment. Approximately US$900 for a kiln with a capacity of 60 m^3.
- Easy construction. Two skilled men can build a kiln within 3 weeks.
- Utilization of materials which are locally available. Approximately 2,200 bricks, four iron lintels (1.15m in length) for the two kiln gates and a four sectional steel band with tightening bolts and nuts.
- No concrete is necessary. The mortar being applied to the kiln construction is composed of clay and sieved charcoal powder. The foundations are laid out with gravel.
- Easy control of the internal combustion by 18 air inlets for the entrance of the necessary combustion air.
- Easy maintenance and repair of the kiln. No wall cracks, no electricity, approximately 200 ltr. of water is necessary per kiln charge to shorten the cooling time.
- Long lifespan of the kiln. The used firebricks resist temperatures up to 1,200°C. Damages of the wall will occur only through wrong operation.
- The kiln can be torn down completely and transported by truck to a newly selected site (normal practice with all fire brick kilns).

Beehive brick kilns are usually grouped in batteries of seven or more kilns to simplify controlling of the operational cycle with a minimum of manpower. Each battery is attended by two men only; one operator and one helper. The raw material storage is always located on one side only of the kiln, opposite the charging gate, and the charcoal extracted from the kiln is kept for curing and trucking near to the discharging gate. If possible, the truck loading facilities are located on a level lower than the kiln operation level in order to facilitate lo[illegible] operation.



4.20 Implementation Programme for the Somalia Fire Brick Charcoal Kiln

For demonstration and promotion of the kiln among charcoal co-operatives the area of Bhaidowa is best suited. One kiln (better would be a small battery of three kilns) should be erected within an existing charcoal camp. For the preparation of the firewood, a set of wood cutting tools is also necessary. The training programme would include:

- construction of the Somalia kiln
- preparation of raw materials
- charging of the kiln
- ignition
- supervision of the carbonisation cycle
- discharging of the kiln
- curing of the charcoal

The local costs for this programme (one kiln) would be as follows:

Construction material	US$ 900
Transportation from Afgooye to Bhaidowa	150
Four operators for six months	1,500
Total:	US$2,550

It is further assumed that all the other expenses including one expert, wood cutting tools, etc. will be sponsored through international aid organizations. The duration of the programme should be designed for one year with possible extension. If production starts after six months of construction and test runs, the annual kiln crop can be expected to be approximately 300 tons of charcoal. This corresponds to 3,300 actual kintals which represents a market value of US$15,000 in Mogadiscio. Therefore it is very likely that the returns from the kiln operation will cover part of the expenditures of the experiment.

CHAPTER 5. DRAWING-UP OF A NATIONAL CHARCOAL INDUSTRY DEVELOPMENT PLAN

The planning of the charcoal industry should be carried out at two levels:

- National planning of the charcoal industry in accordance with the development aims of the country.
- Planning of specific projects along the lines of the national charcoal industry plan.

Planning at the national level will take into account the annual portion of raw material to be converted into charcoal, pyrolysis oil and industrial heating gas. It also focuses on the production cost, transport and marketing organizations. This appraisal is best done by an economist, working with the National Planning Department and co-ordinating the interests of the various departments. The needs and the objectives for a national charcoal plan in the Democratic Republic of Somalia can be summarized as follows:

- Co-ordination of all charcoal activities, research and testing programmes under supervision and guidance of the National Range Agency (NRA)
- Implementation of a more effective kiln technology and improvement of the present quality of charcoal.

- Installation of a briquetting plant for the use of energy extenders.

- Installation of a continuously operating conversion plant for the production of charcoal and pyrolysis oil from agricultural waste.

5.11 Personnel

- One Manager. His suggested title should be Charcoal Department Officer (CDO) His background should be a senior forester with sufficient knowledge of charcoal production methods.

- One assistant to the CDO. Forester with technical background.

- Two office clerks/secretary.

- Two laboratory technicians.

- Three laboratory helpers.

- One charcoal expert should be provided for the CDO for the duration of three years.

The manager (CDO) and one office clerk may be located within the premises of the NRA in Mogadiscio. All other personnel should be located within the charcoal research and testing centre in Afgooye.

5.12 Buildings

Actually, all the necessary buildings will become available after the forestry school in Afgocye has been moved to their new premises. They consist of three houses which can be utilized for office space and storage. The lecture room has to be converted into a laboratory.

5.13 Equipment

- Test facilities: one metal kiln, available but needs repair; one Somalia fire brick charcoal kiln available as model; one hangar kiln to be erected from local materials.

- Laboratory equipment completely available, presently stored at UNDP.

- Additional equipment to be purchased locally at a total of US$1,500.

- Transportation: one normal car

- For field work: one landrover or other four wheel drive, two caravans, two trucks, two chain saws, complete set of tools for wood cutting.

- One pony transceiver set available, presently stored at UNDP.

5.20 The Planning of Specific Projects

Three projects for the improvement of Somalia's charcoal situation have been investigated and the basic results are laid down in the previous chapters of this report. If the decision by the Ministry of National Planning was made that these three projects are likely to make significant contributions to the forest preservation programme and that they also will offer sound economic benefits, the NRA should be given the task of ensuring that maximum effort would be put into the implementation of the proposed projects.

The charcoal department officer (CDO) together with an expert would have the following duties:

- Investigation of all possible raw material sources

- Survey of the local markets

- Establishment of a research programme

- Evaluation and selection of consultants for the necessary feasibility studies

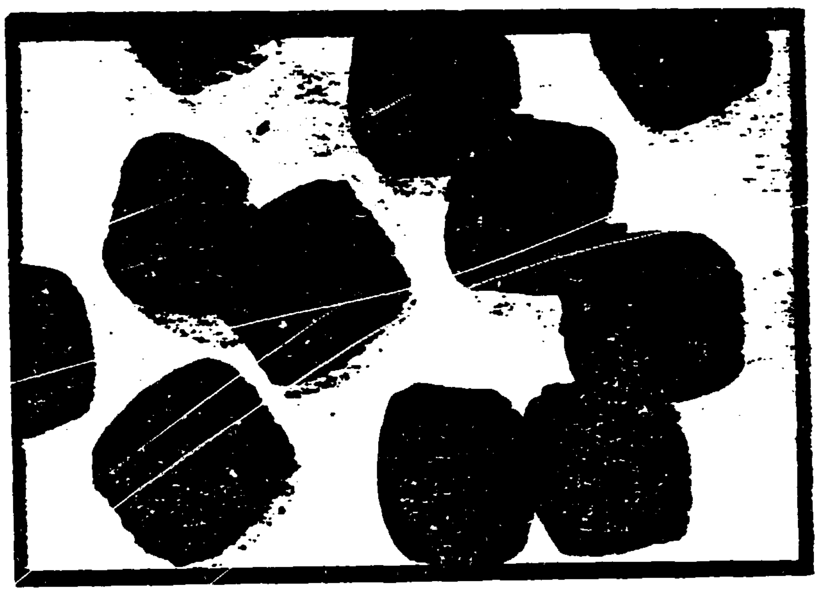
- Testing of raw material

CHAPTER 6. ESTABLISHING A CHARCOAL LABORATORY IN AFGOOYE

UNIDO has purchased laboratory equipment for approximately US$15,000 which had arrived before the commencement of this mission. However, the envisaged laboratory space in the forestry school in Afgooye could not be made available by the NRA. Three small houses, a lecture room and the kitchen are occupied by a class of students.

Presently a new forestry school nearby is under construction and almost finished. The NRA expects that the forestry students will move to their new quarters in early fall (see appendix: letter of NRA to UNDP/Mogadiscio).

By this time the laboratory should be installed to serve as an essential part of the Charcoal Department of NRA and as the future training centre for charcoal trainees.



Pillow shaped charcoal briquets made

from plantation waste

APPENDIX 2

Construction of the Somalia Fire Brick Charcoal Kiln

Construction Material

2,200 Fire bricks from the Afgooye factory, 25 cm x 15 cm x 12 cm, design hollow.

4 Iron lintels (an el) for the two kiln gates 1.15 m in length.

1 Steel belt (10cm x 0.8cm) for the kiln dome, consisting of four sections, each with two welded angles at the ends, approximate length of the belt 18.50 m.

4 Bolts and nuts as connectors of the steel belt sections.

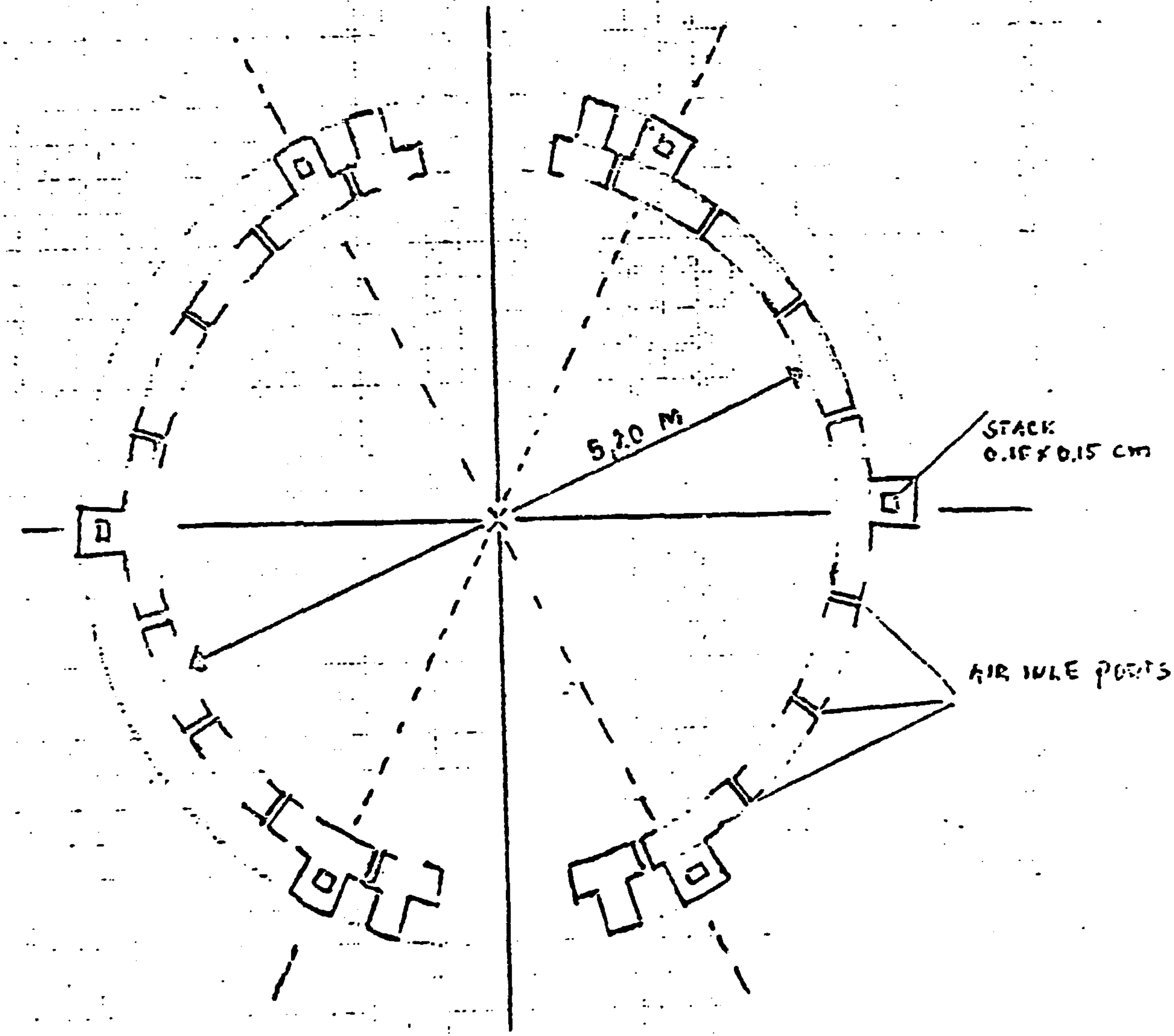
The mortar is composed of clay and 20% charcoal powder (screened).

> We were not able to locate steel bands of the desired dimensions in Mogadiscio or elsewhere. Therefore two iron bands with the dimension 6 cm x 0.4 cm had to be welded together resulting in the required thickness. For commercial use it seems advisable to employ two belts at the dome rim, one above each other.

Construction of the Kiln

One kiln requires a space of 10 m in length and 25 m in width. If more than one kiln is to be built, the length of the space has to be multiplied by the number of kilns. At first the centre of the kiln is marked and each kiln should be apart from the other at least by 8 m. The inside circumference of the kiln is traced at a 5.20 m diameter, the outside limits which include the stacks at 5.60 m.

The two one meter wide gates are marked also and the foundations for the six stacks and door pillars.



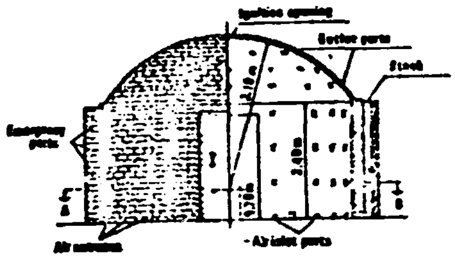
The excavation of the footing trench will depend on the soil consistence in the selected area. However, it is advicable to dig out at least 60 cm below surface and fill this trench half with gravel.

Then two courses of bricks are laid in reaching 5 cm above ground. All courses must be laid carefully and levelled.

The mortar is made of 8 parts of clay mud and 2 part of charcoal powder, which has been previously sieved.

When laying the first course of bricks above ground, leave the openings for the gates (1 m) for the necessary air inlets (0.10m width, C 08 m height) and the chimney ports (0.12m x 0.10m). The inside measure-ment.: of the flues are the same. The air inlets are symetrically distributed, three between each pair of chimneys.

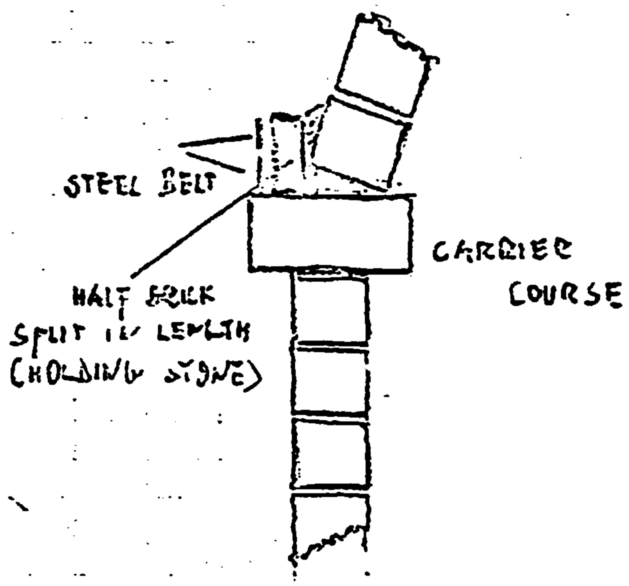
When continuing in building the wall and the stakes, care must be taken that the different courses of the bricks are level. Between each paid of chimneys, five emergency outlets have to be symetrically distributed. The emergency openings are 0.07 m x 0.07 m. The first two emergency outlets will be placed in the fourth course of bricks above ground.



When the wall has reached approximately the height of 1.60 m, the four steel angle lintels a-e placed on top of the door pillars to carry the following courses of bricks over the doors.

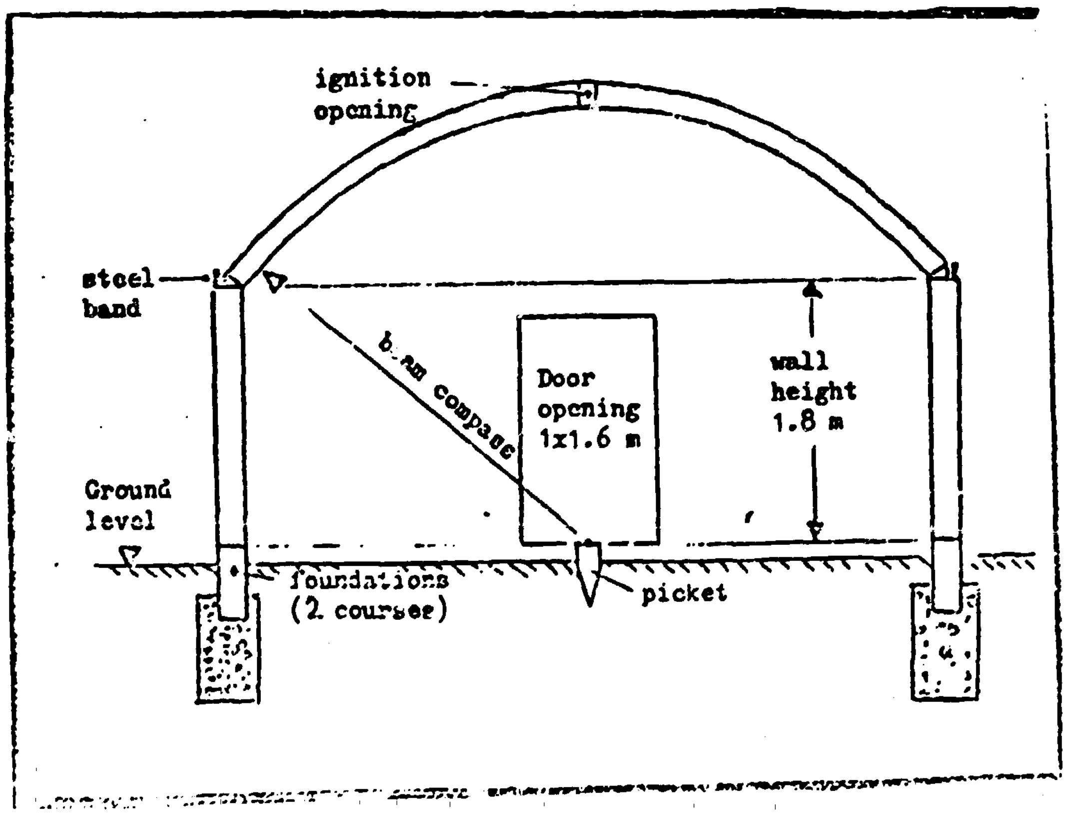
The wall construction is then to be continued with two courses of bricks without providing any emergency outlets. The total height of the kiln wall then will be approximately 1.80 m.

On top of the last brick layer the carrier course of the dome has to be arranged according to the following sketch.



It is most important that the four sectional steel belts are made to fit exactly with the circle of holding stones. After arranging the steel belt into place, the holding stones (half stones) are put on and the bolts of the belt sections are slightly tightened.

For the construction of the dome it is imperative that every stone put in place is adjusted by the beam guide as shown in the following figure.



Starting with the second course of the dome bricks, 26 emergenc outlets are symetrically distributed over the entire dome surface. At the top of the dome the triangle shaped ignition opening is left. Aft terminating the dome structure, the steel belt is firmly tightened.

All walls must be plastered with a fine clay mud and charcoal powder mixture wherever necessary and the dome is brushed over with a clay slurry to assure that all cracks will be closed firmly and entranc of undesired air will be prevented.

Later on, before ignition of the kiln charge, all emergency outlet must be closed with wedge shaped bricks but without mortar. To make them airtight, they are brushed over with the same clay slurry as applie to the dome. The purpose of the emergency outlets is to prevent a kiln explosion and relieve high pressure if it has built up in the kiln. In all these cases the wedge shaped bricks will just fall out and can be reinserted immediately.

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مقديشو الصومال

Cable : Somalrange
علف صومالرنج

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Mugdisho
cc: Mr. Walter Emrich
Charcoal Expert
Mugdisho
CC: Ministry of National Planning
Mugdisho

Ref: Development of Charcoal Industry
Project Nr. DI/SOM/78/803

Dear Mr. Svennovik,

I like to reassure you our continuos interest in this Project. Unfortunately, until now the UNIDO laboratory programme, including the training of personnel, has not been conducted, because we have not yet available the necessary space for the laboratory equipment.

I believe that we are able to move the forestry school in Afgoye to their new quarters at the begining of next fall. Then three houses and the lecture room will become vacant and can be utilized for the charcoal laboratory, a storage and necessary office.

I have been assured that this will be sufficiently, to quarantee the conducting of the UNIDO programme.

I like to ask you to emphasize our intentions also to UNIDO and appreciate your further support.

Looking forewards to your reply, I remain.

Your's Sincerely

Dr. Abdullahi Ahmed Karani
General Manager N.R.A.

(T.P)