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JANUARY 1989

CHARCOAL PRODUCTION

SI/BHU/88/801/11-01

The Kingdom of Bhutan

TECHNICAL REPORT*

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

Based on the work of Albert Zorge
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Acknowledgements

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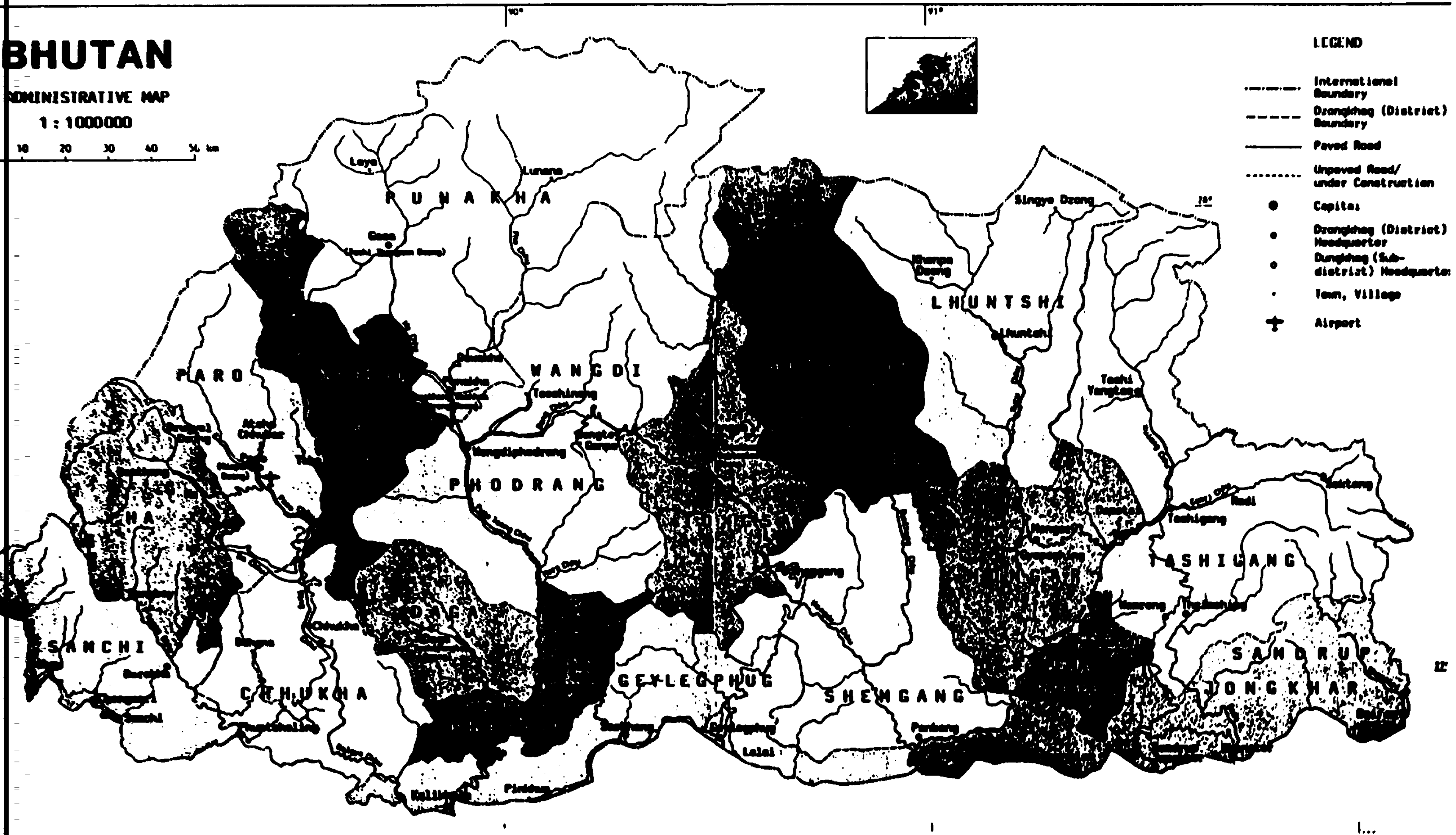
- and to all who contributed to a succesful accomplishment of this mission

Albert Zorge.



BHUTAN
ADMINISTRATIVE MAP
1 : 1000000
10 20 30 40 50 km
90°
91°
LEGEND
International Boundary
Dzongkhag (District) Boundary
Paved Road
Unpaved Road/ under Construction
Capital
Dzongkhag (District) Headquarter
Dungkhag (Sub-district) Headquarter
Town, Village
Airport
PUNAKHA
Laya
Lunana
Gasa
PARO
WANGDI
PHODRANG
Wangdiphodrang
LHUNTSHI
Lhuntshi
Singye Dzong
Tashi Yangtse
TASHIGANG
Tashigang
SANCHI
CHHUKHA
DAGA
GEYLEGPHUG
Lalai
SHEMGANG
SAMDRUP JONGKHAR
Pinsdung

SUMMARY

In Chapters I - VIII all basic information is recorded concerning the numerous aspects of the present situation, including consultants findings.

In Chapters IX and X the entire organization for the manufacture of charcoal is designed viewing the present and expected demands.

Chapters XI and XII deal with the rehabilitation of the recently abandoned Charcoal Demonstration Plant at Chimakothi. This rehabilita-tion is proposed to be realized in a transfer to the Bangthar Reafforestation Project where the plants equipment can be optimalised resulting in a medium scale production capacity.

The gradual transfer of the carbonization sites from the softwoodareas to the hardwoodareas, as described in Chapter XIII, offers significant advantages.

Overall strategy for the next 5 years, to start in 1988/1989, is explained in Chapter XIV.

Computerization of the filing system to steer and control fieldopera-tions can be found in Chapter XV, whilst transfer of technology and training courses are recorded in Chapter XVI.

A short report on consultants movements during his mission is given in Chapter XVII.

Conclusions and recommendations conclude as usual the report in the last two chapters.

INTRODUCTION

When it was decided to build a large calcium carbide plant, Bhutan Carbide & Chemicals Ltd. in Pasakha near Phuntsholing, the Charcoal Department of the factory was immediately confronted with an enormous task.

Up to only two years ago no charcoalproduction whatsoever existed in Bhutan as rural and urban population were using firewood as a domestic fuel and so did small local industries.

Now suddenly at least 1,000 metric tons per month were required to keep the plant running.

Two young officials from the Charcoal Department, both trained foresters, were assigned to establish an organization for charcoalproduction to secure the necessary supply.
Started enthusiastically they and the Management of Bhutan Carbide & Chemicals Ltd. soon realized that having a forest arsenal that is covering 64% of the country is one thing, producing 15,000 tons of charcoal - even in industrialized countries an impressive figure - is something completely different.
Still, in 18 months time they did a remarkable job.

The United Nations Development Programme, since 1979 involved in many projects in Bhutan, was requested to assist in the improvement of the meanwhile established, very decentralized charcoalproduction.

In this report numerous details of the mission are recorded as the project proved to be not only very interesting but at the same time complex and comprehensive.

It happens not so often that an extensive industry, be it widespread and small scale based, is originated and developed within a relatively short time.

From what he observed during his mission the consultant is convinced that the Royal Government of Bhutan as the counterpart, the Bhutan Carbide & Chemicals Ltd. as the beneficiary and the United Nations Industrial Development Organization as the donor of technology can be assured that in a few years from now their common target will be achieved.

CHAPTER I

1.0 Charcoal consuming industries in Bhutan.

1.1 Bhutan Carbide & Chemicals Ltd. in Phuntsholing, a town situated on the Bhutanese-Indian border, 170 km due south of Bhutans' capital Thimphu, is one of the two charcoalconsuming industries in Bhutan and by far the largest.

Bhutan Carbide & Chemicals Ltd., abbreviated BCCL, was established in October 1984 as a joint ventue of the Royal Government of Bhutan (80%) and Tashi Commercial Corporation (20%). The latter, by far the largest private commercial organization in Bhutan - annual sales in 1984 the equivalent of US $. 20.-- million - is providing the management support in the implementation of the carbide production.

Day-to-day operations of BCCL are closely supervised by the appointed Managing Director and Member of the Board of Directors, Dasho Ugen Dorji, the leading Bhutanese industrialist and founder and proprietor of Tashi Commercial Corporation.
From authors personal observations arises a picture of a fine gentleman, an excellent host, a multi-talented captain of industry with many surprising ideas and gifted to select a team of dedicated and hardworking staffmembers.

1.2 The Calcium Carbide Plant.

The construction of the huge carbideplant, the first major industrial complex in Bhutan, started mid 1986 at Pasakha, some 15 km from Phuntsholing, and was finished by May 1988. Although at present (October 1988) production of carbide is in full swing, the official opening is scheduled for early December 1988.

The formula for the production of carbide is basically simple: 1 ton of charcoal + 1,5 ton of limestone + 0,5 ton of coke (petrol coke, anthracite or anthracite coke) produces one ton of calcium carbide.
However, to convert these raw materials into the final product an industrial project had to be accomplished, costing almost US $. 25,- million.

Yet in a few months time production already reached high levels, setting an impressive world record when producing on several occions the highest quality of carbide ever achieved by a carbideproducer, resulting in 347 litres of acetylenegas out of 1 kg of carbide.

1.3 Charcoal requirements.

The annual charcoal requirement is estimated as follows:

for the 1st year	5.500	tons
2nd	8.625	-
3rd	9.855	-
4th	11.090	-
5th afy	14.260	-

(Source: Appraisal of the Calcium Carbide Project; 1984; page 24)

1.4 Activated Carbon Ltd.

The second large consumer of charcoal is Activated Carbon Ltd., its plant situated at about 1 km distance from the BCCL-plnat at Pasakha.

Activated Carbon Ltd., a Tashi Commercial Corporation enterprise, produces activated carbon in two rotary furnaces, where charcoalfines, purchased from BCCL are heated at a temperature of 700-800 C.
This process is aimed to open the fine, tar-filled structure of the charcoal and remove by burning all residues that block the openings thus creating a high porosity and absorption capacity.

The quality of this activated carbon is suitable for a limited number of applications. To cope with the increasing demand however the plant is renovated and expanded at present.

The annual requirement for charcoal is estimated at 3,500 tons, the major part being supplied by BCCL at a price being about 10% of the selling price.

1.5 Other charcoal consumers.

Finally some hotels in Thimphu and Phuntsholing are using small quantities of charcoal in kitchenfurnaces. Together with minor quantities used by gold- and silversmiths the total consumption in this category will not exceed 20 tons per year.

CHAPTER II.

2.0 Charcoal production.

2.1 Background.

Apart from the medium scale factorized charcoalproduction at Chimakothi, with which will be delt in Chapter XI, untill 1986 no charcoalproduction existed elsewhere in Bhutan.

The households and small industries in this country used and are still using solely firewood as a domestic fuel, for cooking as well as for heating.
This aspect must be considered very rare in developing countries where next to firewood the use of charcoal is widely spread. In the case of Bhutan it seems even more remarkable as in the surrounding countries all-scale charcoalproduction for both domestic and industrial use shows a long tradition.

2.2 Start of production.

Foreseeing that the production of carbide would involve simultaneously the production of charcoal, Bhutan Carbide & Chemicals Ltd. iniated the latter in 1984 by building a non-destructive distillation plant at Chimakothi.
As the productioncapacity of this demonstrationplant would not exceed 100 tpy in August 1986 two groups of Indian charcoalmakers started earthmound carbonization at two other locations, one at Gedu and one at Geylegphu. (see map)
This production howvever was terminated in March/April 1987.

From then on the indigenous production was taken over and largely expanded by Bhutanese contractors, operating in various areas.

2.3 Present situation.

Nowadays charcoal production is executed by 19 contractors, employing a large number of labourers mostly non-nationals. From the map as well as from Appendix I it can be learnt that these contractors have their numerous teams operating at sites in all climatic zones.
They committed themselves to supply a total of almost 9,500 tons of charcoal for the period of 1.10.1988-1.10.1989.
Also deliveries up to 700 ton from Bihar (India) were secured for this period.

CHAPTER III

3.0 Organization of the Charcoal Production.

3.1 The Charcoal Division of BCCL.

Already in 1986 the establishment of a charcoal division was iniated by the Management of the Bhutan Carbide & Chemicals Ltd. This division, consisting of an assistant-manager, one administrative-assistant and one clerk, was assigned to organize the charcoalproduction in Bhutan. This small staff was trained and equipped by the Tashi Corporation and started the charcoalproduction by inviting independent Bhutanese traders to enter into supply contracts. These contractors were then assisted in hiring labourers for the carbonization and given basic information about building earthmounds and implementing kilning techniques. At the same time they were allocated various carbonization sites, mainly in the northern, the coniferous zone.

Presently the Charcoal Division of BCCL is manned as showed on the Organization Chart. The Division has no general manager of its own but is supervised by the General Manager of BCCL.

Both the assistant-manager, Mr. D. Acharya and the Beat-Officer, Mr. Ph. Dorji, are trained foresters, the former disposed by the Forestry Department for a period of two years.

3.2 Suggested rearrangements.

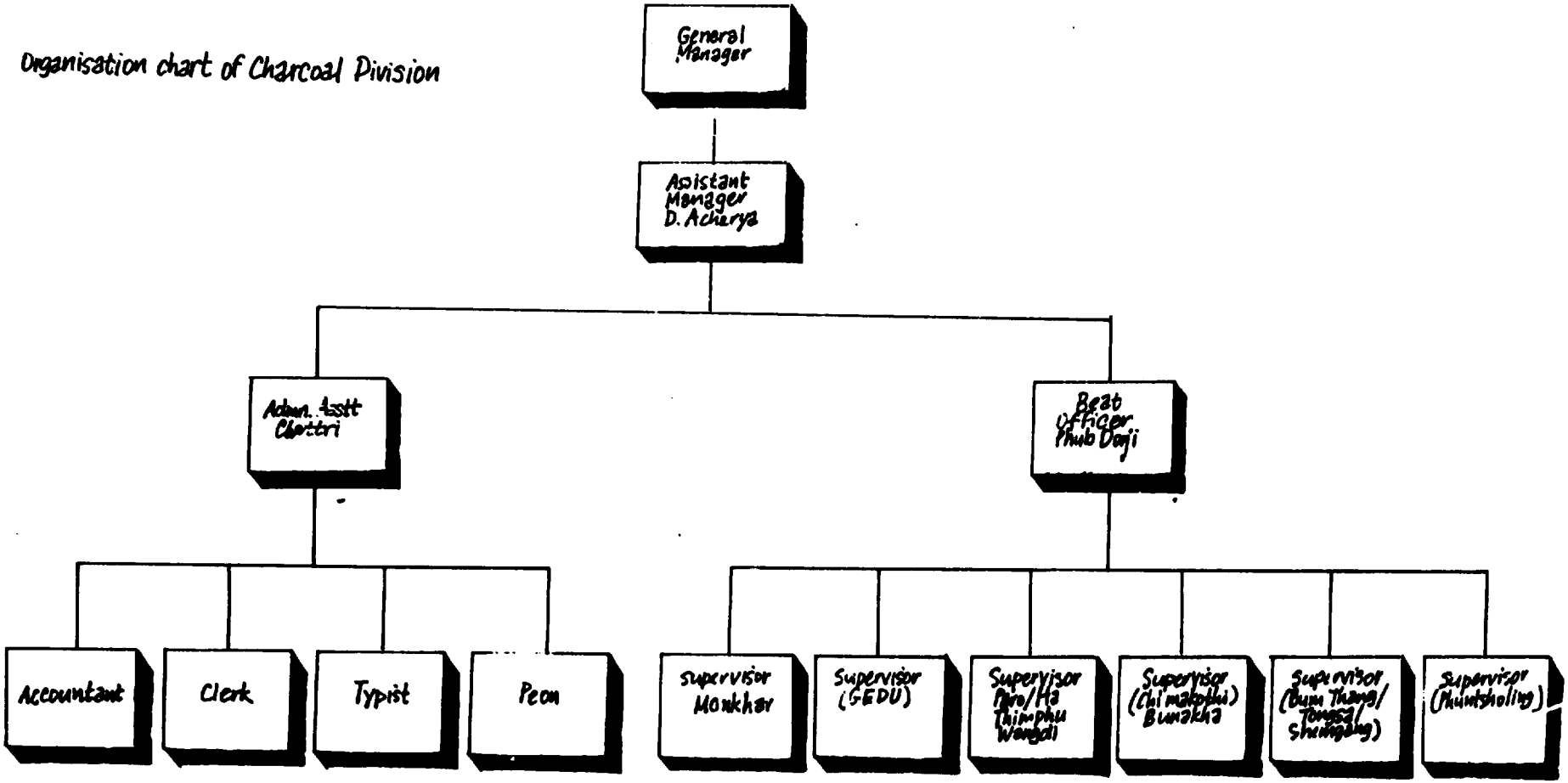
To benefit the build-up of the entire organization of the charcoalproduction in Bhutan it is the consultants' opinion that

A. the Charcoal Division should operate with a considerable autonomy within the framework of BCCL's Purchase Department
B. that the assistant-manager should direct the division and by doing so be contracted for a number of years. He is familiar with the organization as he was involved in the build-up from the start and moreover has picked up considerable knowledge of kilning techniques.
C. In his place a new assistant-manager should be appointed to co-ordinate the office- and fieldduties.

3.3 Supervision.

The Division has appointed resp. will appoint 6 supervisors, one in each productionarea.
These supervisors have a full time job, travelling from site to site, controlling - not directing - the carbonization, keep up forest control, maintain necessary

Organisation chart of Charcoal Division



liaison and communication with respresentatives of the Forestry Department in the allotted areas and report monthly to the management of the Division.

Both for the management of the Charcoal Division and the supervisors consultant designed a Site Inspection Form (Appendix II) which was often used during the 2nd phase of his mission.

Also the supervisors are advising the carbonizers on kilning techniques as they have followed or will follow training courses at BCCL's Training Centre at Pasakha.

Bhutan Carbide & Chemicals Ltd. is holding overall responsibility for forest treatment and forest safety towards the Forestry Department for as long as independent charcoal contractors are employing carbonization crews in those areas. Therefor BCCL's supervisors are contributing largely to a strict control system and are of great importance to prevent forest damage.

Both assistant-manager and Beat-Officer are visiting from time to time a number of sites and execute an intensive control on carbonization techniques as well as on forest treatment.

3.4 Administrative support.

The small administrative staff of the Charcoal Division, consisting of a clerk, a typist, an office-boy (peon) and, as already suggested, in the near future an accountant, all directed by the administrative-assistant, provides valuable administrative support.
Trained according to the Tashi Groups structure they started with only three files but can rely now on over 120 files, recording litterally all details from either the Charcoal Division or the contractors.
In the opinion of the consultant however a better use should be made of all information recorded in the files. For the moment he suggested to make diagrams of the charcoal deliveries from every single contractor, showing quantities and chemical analysis as well as a diagram showing total monthly deliveries projected against committed quantities.
This will enable the management of the Charcoal Divison to control resp. to steer the operations through the appropriate channels whenever necessary.

3.5 Transport.

The charcoal, once an earthmound is opened, is bagged and carried by the carbonizers - 2 jutebags weighing 40 - 60 kg on their backs - to depots along a forest road or main road. Distance between site and depot not seldom less than up to one hours walk along a steep, narrow track, only used before by grazing cattle. By instinct these animals always take the safer path and the bearers

are smart enough to follow these tracks.
At the depot the bags are piled, unfortunately in many cases without any cover. Thus exposed to rainfall the charcoal absorps a considerable amount of moisture, causing heavy loss of quality.
The consultant advised to shelter the piles with tarpaulins, bamboomats, flattened drums, polyethylene sheets, with leaves or with whatever cover obtainable. However, up till October 1988 only at one site these precautions were taken.

After several weeks - even sometimes months - the bags are loaded on trucks, not seldom "ad astra", which caused a high content of fines in the charcoal. Also too often the load was not covered with a tarpaulin so more moisture was absorbed. To prevent this needless loss of quality contractors and truckdrivers were instructed resp. ordered by the management of the Charcoal Division to start loading a truck once 200 bags were ready for shipment at a depot and to cover the load with tarpaulins.

3.6 Charcoal quality.

From the previous paragraph it will be totally clear that the quality of the charcoal could be improved immediately by introducing and maintaining simple precautions.

3.6.1 Required analysis of the charcoal.

The chemical analysis of charcoal for industrial use is mainly focussed on
a) moisture content
b) ash content
c) volatile matters
d) fixed carbon

Identified figures of a), b) and c) are added and the total subtracted from 100% to obtain the percentage of the fixed carbon content.

The technical staff of the Carbide plant has set demands in this respect:
a minimum of 72% fixed carbon, moisture content not to exceed 5% and volatile matters not higher than 10%.

The less the fixed carbon content the more petrol coke must be imported at considerable higher prices than being paid for the charcoal.

3.6.2 Quality delivered.

Due to the insufficient protection during storage and tran rt the moisture content of the charcoal delivered at the plant at Pasakha, showed percentages varying from 20 to 65% during the rainy season in July, August and September.
Fortunately also lower percentages were recorded - 3 to 7% - for charcoal delivered in the preceeding months.

CHAPTER IV.

4.0 Climatic conditions.

The carbonization sites are located in three different climatic zones.

4.1 The mountaineous area around Paro, Ha and Thimphu can be considered as fairly dry with only increased humidity during the period June - August due to occasional showers.
Logging and to a lesser extent carbonization can be conducted throughout the year, but best results are obtainable during September-May.

4.2 The central area, also mountaineous, situated roughly between Jakar (Bumthang) and down south to Shemgang, has a considerable higher humidity than the previous mentioned area during the summer in the northern hemisphere.
Also logging and carbonization may be possible throughout the year but bagging, storage and loading of the charcoal will require necessary precautions.

4.3 The southern zone, hilly and flat only along the Bhutanese-Indian border, has a (sub)tropical climate with only a relatively low humidity during the dry season from mid October till mid March.
The premonsoon period lasts from mid March till mid June, having occasional showers causing a medium humidity.
During the monsoon from mid June till the end of September there is often heavy rainfall ("cats and dogs") with only a few bright periods. Humidity sometimes rises up to 100%.
Carbonization in the open must be stopped during this period, only wood preparation can continue but the moisture content will hardly come down.
The carbonization sites in this zone are situated in the Gedu area, 40 km north of Phuntsholing, and in the Chimakothi/Bunakha are, halfway Thimphu and Phuntsholing. Also the Reafforestation Project in Bangthar is in this climatic zone.

CHAPTER V

5.0 Raw material.

The raw material for the manufacture of charcoal is generally wood, preferably waste wood.
In Bhutan there is basically waste wood in abundance coming from various sources:

5.1 Logging waste.

Everywhere the Forestry Department starts logging operations the tops and lops of the felled trees become available either as firewood to satisfy local demand in households or as fuelwood for carbonization. It can be expected, that, when the logging operations will be expanded to boost the export of logs, more and more fuelwood and firewood will be produced.

5.2 Junkwood.

This being waste wood from previous loggings. Before wood-consuming industries like Bhutan Carbide & Chemicals Ltd. (charcoal), Gedu Wood Processing Coy. (sawmill, veneer/plywood industry) and Bhutan Chipboard Industry were founded, this type of waste wood was almost totally negelcted as only a small portion was taken to serve as firewood.
Consultant advised to make an inventory.

5.3 Thinning of forests.

This is an option for future needs. Presently, due to shortage of manpower, no or only little thinning has been carried out with only a small yield of fuelwood.

5.4 Malformed, weak and dying trees.

The wood from these trees can be used for 100% by both BCCL and the Chipboard Industry as the logs are of inferior quality due to beetle infection and so of no value to the Gedu Woodprocessing Coy.
However logging operations have a low priority also because of lack of manpower and difficult accessibility to the infected areas. Yet, waste from this source is an additional option for charring activities.

5.5 Pollarding and branch-cutting.

The Forestry Department, reacting to a note of BCCL (see Appendix I of the Interim Report, dated July 5th 1988) has allocated test-areas, each of 1 ha, in all three climatic zones for experiments. The yield is destined for carbonization and if the results are positive this source also creates a future option.

5.6 Sawmill waste.

Here there are three potentialities.

5.6.1 Slabs and offcuts.

The assistant-manager of the Charcoal Division will start negotiations with a number of sawmills in the Paro and Ha area to obtain this type of waste wood of the coniferous species.
He intends to carbonize this waste wood in portable steel kilns on the premises of the sawmills. The waste wood is available in aceeptable sizes and has, as registered with the hygrometer, a low moisture content.

The consultant advised an inventory.

5.6.2 Overaged logs.

It seems that at some sawmills large batches of overaged logs are available. The quality of these logs is deteriorated so much, due to a long storage period, that it is no longer acceptable for timber.
The management of the Charcoal Division is entering negotiations to obtain this raw material.
Also in this case an inventory will be made.

5.6.3 Sawdust briquets.

Following an idea of Dasho U. Dorji, the Managing Director of Bhutan Carbide & Chemicals Ltd., the Charcoal Division will study the possibility to briquet sawdust. Production is intended to be executed in a mobile unit to be purchased from Taiwan or Hongkong.

Sawdust briquets proved to be an excellent domestic fuel and will be marketed to garrisons of the Indian Army in Bhutan. This army is actually a large consumer of firewood and it is expected that its share in firewood consumption can be transferred to BCCL.

5.7 Driftwood.

Recently charcoalproduction started on the banks of the Tursa River near Phuntsholing in southwest Bhutan. Carbonization is conducted by one team, operating with small earthmounds and the results are very promising, as the quality of this charcoal is excellent.
Notwithstanding the name and a suspected high content of water the wood species examined proved to be very dry (15 - 20%) and suitable for carbonization.

Also in the Kalikhola area a driftwood carbonization project is to commence soonest possible, most likely on an even larger scale than along Tursa River.

CHAPTER VI

6.0 Wood species.

In general only two major groups of wood species are being used for charcoalproduction in Bhutan.

I. Soft wood
II. Hardwood

6.1 Softwood.

Logging operations in the northern zone - Paro-, Ha-, Thimphu-, and Bhumtang (Jakar)areas - are dealing with coniferous species as they are aimed at the production of timber.
Consequently the charcoal from these areas can be marked as softwoodcharcoal, obtained from pine, spruce, fir, hemlock, cypress and larch.
The charcoal has a relatively high ash content, and, due to its open structure, a high moisture content and a relatively high percentage of volatile matters.
Often residues of tar remain in the holes and pores.
Also the charcoal has a low weight (150 - 180 kg/m3) and is rather fragile and thus vulnerable during storage and transport.

Notwithstanding these disadvantages it is possible to manufacture an acceptable quality for carbideproduction, provided that proper kilning techniques will be used and that the charcoal, after completion of the charring process, is protected against penetrating moisture and handled with proper care.

6.2 Hardwood.

The hardwood species in Bhutan, used for charcoalproduction, can be divided roughly in:

I. Hardwood from the temperate zone
II. Exotic hardwood from the (sub)tropical zone

6.2.1 Hardwood.

These species - poplar, maple, birch, alder, but also oak and rhododendron, are used in the area between Thimphu and Wangdiphodrang, in the Gedu resort and around Shemgang, in short in the midbelt of the country. With an exception for poplar this hardwood delivers a good quality of charcoal to such an extent that it easily can meet BCCL's standards.

6.2.2 Exotic or tropical hardwood

In the southern belt, roughly up to 30 km noth of the Bhutanese-Indian border, numerous species of tropical hardwood and a few varieties of tropical softwood,

mainly ceder, can be found.
The driftwood projects near Phuntsholing and Kalikhola as well as the Reafforestation Project near Bangthar in Samdrupjonkhar are almost exclusively (36 spp) dealing with this dense and heavy wood species.
Also from this zone excellent charcoal with a high fixed carbon content can be procured, again, provided that charring techniques are appropriate and carried out carefully.

CHAPTER VII

7.0 Technology.

The Charcoal Division of BCCL generally introduced 2 (two) methods for carbonization: kilning in earthmounds and charring in pit kilns.

7.1 Earth mound.

All contractors - and their carbonization crews - were and still are instructed to operate with earthmounds, indeed the most suitable method at the mountaineous sites in Bhutan.

7.1.1 Consultants findings.

The consultant observed during the first part of his mission that wet or soaked wood (moisture content 60% and more) was used, based on the erroneous conception that a high moisture content would prevent the wood from burning to ashes.
In a memorandum to the Charcoal Department of BCCL from June 27th 1988 (Appendix V of the Interim Report) he suggested to stop this waste of raw material and advised on how to dry the wood.

7.1.2 He also advised to make use of the slope of the mountain when constructing an earthmound because less digging will be necessary as one side of the mound can lean against the slope.

7.1.3 It was observed, that the cover of leaves and earth on top of the mound in almost all cases was not thick enough, only 5 instead of a minimum of 20 cm. A lot of cracks through which smoke escaped could be easily discovered by the traces of tar around the cracks.

7.1.4 During on the job training when officials of the counterpart as well as contractors and carbonizers were informed about the pyrolysis process inside the mound, the air inlets were modified and replaced to the botttom of the kiln whilst at the same time the smoke outlets were constructed on top of the mound, thus enabling the carbonizationgases to follow the natural circulation.

7.1.5 Once carbonization was completed in most events the mound was opened after just a few days without a sufficient cooling down period. Existing fires were extinguished with sand bot most of the time with water, causing a high moisture content.

7.1.6 The packing, being jute bags, was often soaked, rotten and mouldy, stored in the open without any cover and thus contaminating the charcoal once it was bagged.

7.1.7 The bagged charcoal was always (except for Bumthang in the Helvetas forest project) stored in the open without any cover, exposed to heavy or moderate rainfall, causing an ever deteriorating quality.

7.1.8 Rough loading of the bags on trucks caused an evitable increase of fines. This percentage was again raised when unloading the trucks at the plant.

7.1.9 In general the earthmounds were too large to handle and to control.

7.1.10 In several cases it was observed that charring was carried out in a so-called "open pit". In fact an unpiled stack of wood was set afire and after a while estinguished with water. From the scorched wood pieces of charcoal were scratched and bagged.

7.2 Pit kiln.

In the flat tropical area of southern Bhutan, near Geylegphu and at the Reafforestation Project at Bang-thar, charring was executed in pit kilns. Apart from the fact that the pit was loaded with only wet wood no sizeable air inlets and smoke outlets were constructed so that by lack of draught the heat inside the kiln stayed too low and consequently only a small portion was transformed in to charcoal.

CHAPTER VIII

8.0 Manpower.

This chapter will deal with the present and future availability of manpower for carbonization activities as already now shortage of labour is felt and intended production sites cannot be manned.

8.1 Government policy.

As far as consultant was informed he understood that the presence and employment of so many non-Bhuthanese is of serious concern to the Royal Government of Bhutan.

It is wellknown that the natural structure of neighbouring Nepal is heavily damaged by deforestation that at the same time that country is overpopulated and that consequently multitudes of Nepalese moved over to the promised land, the mountaineous kingdom of Bhutan.

Bhutan, with 64.000 square km. and about only one million people, is looked upon by the inhabitants of the neighbouring countries as spaceous, fertile and prosperous, notwithstanding its very low income per capita acoording to UN-standards.

Fearing that continuation of a more or less uncontrolled immigration of foreign labourers - and their families- must lead to serious problems in the near future, the Government decided that entry and stay of non-nationals must be subject to strict regulations. In general a permit will be valid for only one year.

8.2 Potential Bhutanese labourforce for carbonization.

Actually around 95% of the Bhutanese population is working in the agricultural sector as farmer or farmhand.
From the rest the major part is employed in the civil services as government official and only a minority is working in the small private sector, which is dominated by the Tashi Commercial Group.
So basically no Bhutanese labourers are available for wood preparation, carbonization etc. This can be illustrated in two examples:

8.2.1 The Carbideplant at Pasakha employs a labourforce of over 700 employees. Only a few staffmembers are Bhutanese; all factoryworkers are non-nationals.
Other small-and medium scale industries show the same pattern.

8.2.2 Out of 199 labourers involved in the carbonization on 16 sites, charring 92 mounds inspected by the consultant, 144 were non-national, so 72%.

It is very doubtful that for every expired residence permit of a non-national Bhutanese replacement will be available.

8.3 Required labourforce.

Even when the number of labourers per carbonizationteam could be reduced, which is doubtful, several hundreds of operators and assistants, both for the wood preparation and for the carbonization itself, will be required.
Alone in the preparation of the waste wood, to make it suitable for carbonization, at least 105 workers are needed, cutting and splitting in teams of three men.

In the near future the contractors will be allocated a total of 32 sites, twice as much as at the moment. It can therefor be assumed, that nearly 400 non-Bhutanese for the carbonization alone will be required when all operations are in full swing.

The supply of charcoal to the Carbideplant at Pasakha will thus require a total of over 500 labourers, involved in the preparations before the carbonization as well as in the kilning itself. Calculating 72% as in the present situation, about 360 of them will be non-nationals.

8.4 Training.

Conservatively estimated it will take at least 10 months to train non-skilled labourers to become more or less experienced carbonizers.
It is felt both a waste and not fair to the labourer and his employer alike that expiration of his residencepermit will force the former to quit his job 12 months after his entry into the country.

The damage to the charring operations as a consequence of this situation was already noticeable resulting in a considerbale loss of productioncapacity as well as bad charcoalquality when labourers, just arrived, were messing up the process.

Also the training of the woodpreparation teams will require some time, be it less than for the charcoaloperators. But having them to quit their job after a relatively short time must be considered also a waste.

8.5 Extension of stay for non-nationals.

It is therefor highly recommendable, that, on behalf of the contractors, being the employers, the management of the Bhutan Carbide & Chemicals Ltd. will negotiate resp. plead for a longer stay of the non-nationals in the country, once they are trained for the job.

To obtain an acceptable profit from the training, it is

thinkable to keep the labourers for a minumum period of 5 years. It is also thinkable that immigration authorities will be willing to co-operate but only under several strict conditions, to which the immigrants will have to adjust themselves.

The consultant begs to be forgiven when he states that here it is neither the place nor the time to go into these matters more deeply.

CHAPTER IX

9.0 Suggested Organization Structure.

In the preceeding chapters the present situation has been explained in full, mentioning many informative details.
In this and following chapters the author shall develop the structure of the entire charcoalproduction in Bhutan as he thinks is recommendable.

In the organization the Charcoal Division, as a part of the Bhuthan Carbide & Chemicals Ltd., will have following counterparts:

- the Forestry Department (allotment of waste wood)
- the contractors (woodpreparation)
- the contractors (charcoalproduction)

The lines between the Charcoal Division and its counterparts serves the communication in both ways:

to the counterparts: information, transfer of technolgy, control of progress etc.

from the counterparts: allocations of waste wood areas, (Forestry Department)
waste wood to be carbonized (WP-contractors)
charcoal for the Carbideplant (charcoal contractors)

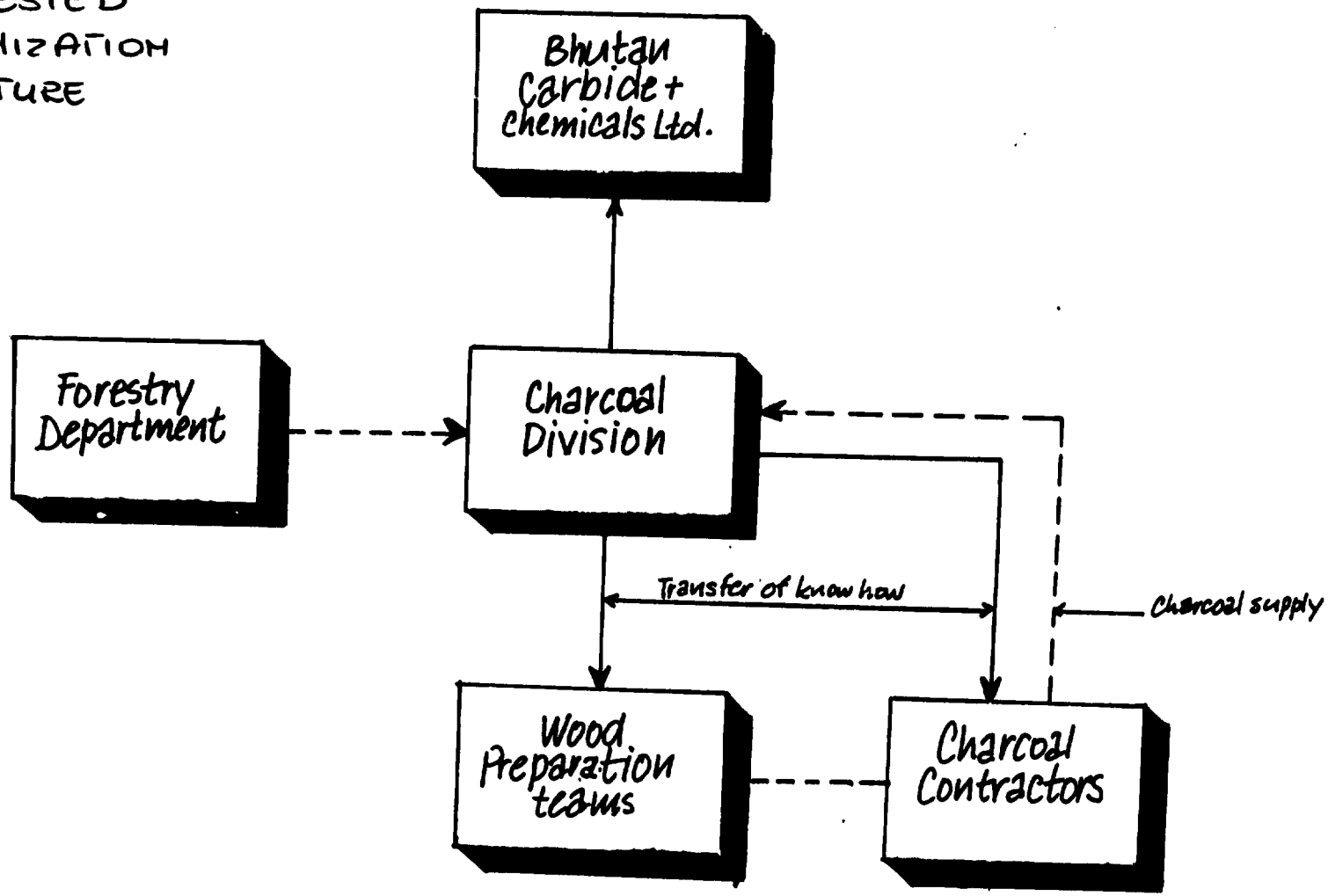
9.1 Communication with the Forestry Department.

As already mentioned in Chapter V, paragraph 5.2, there are three major wood consuming industries in Bhutan:
Because of the large quantities of waste wood involved in the wide spread production of charcoal, BCCL as the beneficiary can be regarded as an important counterpart to the Forestry Department.
This being so it is of utmost importance that a continuous and frequent communication will be established between the Charcoal Division and the Forestry Department. Matters of mutual interest:

9.1.1 Allocation of waste wood areas.

On consultants advice the Charcoal Division requested the Forestry Department to be informed every time when a logging operation is due, stating area, start of felling, duration of the logging and indicating how many trees are going to be felled.
This information will enable the Charcoal Division to decide if and when a contractor should enter such an area for wood preparation.

SUGGESTED ORGANIZATION STRUCTURE



Also the Charcoal Division having calculated the possible yield of waste wood in this area, can advise the contractor to send in the adequate number of preparation teams.

9.1.2 Reporting to the Forestry Department.

As the forests of Bhutan are considered to be a national property, managed by the Forestry Department, it is this department that releases permits to operate in the forests.
The permitholder, in this case the Charcoal Division of BCCL, is hold fully responsible for forest treatment in the allotted ares and has to report regularly.
There is no official link between the Forestry Department and BCCL's contractors, operating in the allotted areas.

Reports to the Forestry Department should mention progress in wood preparation and in carbonization, number of labourers involved in the operations, intended duration of the activities, damage if any, etc.

9.1.3 Negotiations with the Forestry Department.

It is possible that in years to come there will be a discrepancy between the number of allotted areas and the carbonization (including wood preparation) capacity of the BCCL-contractors, due to shortage of manpower or for other reasons.

In this case the Charcoal Division must decide to select potential carbonization areas, negotiating with the Department that some, less suitable areas, will not be utilized for charcoaling.
This to enable the Forestry Department to contact other waste wood consuming industries.

With regard to the accessibility to certain areas it also will be possible that charring in very high altitudes and very distant from forest road or main road proves to be rather costly. Packing, tools, personal belongings etc. has to be transported uphill, the same and bags filled with charcoal downhill over too great a distance, which will take a lot of time.
In such an event it is recommendable to start negotiations with the Forestry Department to settle an agreement that certain parts of the allotted areas will not i.e. cannot be utilized for carbonization.

9.2 Communications with the contractors.

Once intended logging areas are known the Charcoal Division should establish communication with its contractors for fuelwood preparations.

9.2.1 Preparation of fuelwood.

Thusfar only little attention has been given to the very important role wood preparation plays in the entire carbonization process.
During his mission the consultant again and again emphasized that manufacture of charcoal begins with the correct preparation of the raw material, i.e. fuelwood.
To obtain the highest possible yield and the best quality one should use only dry wood, that is (waste) wood with a relatively low moisture content, so not exceeding 30%. Preferable however is a percentage of 15 - 20%.
Moisture content in tops and lops of newly felled trees can be estimated at 60% or (much) more depending on the wood species.
Once crosscut however drying starts rapidly but mainly on both ends as the bark hinders the evaporation of the water.
To speeden up the drying process and shorten drying time the wood should be split, in halves and/or quarters depending on its diameter.
By doing this the surface exposed to the drying factors (sunradiation and wind; will be multiplied.
After being split with special axes or hammers and wedges, the fuelwood must be piled, stacked, preferably crosswise to profit most from wind and sun penetration.
Within 6 to 8 weeks the moisture content has been reduced to 30 -35% and though further drying will be slow generally it will take only about 4 to 5 weeks more to achieve an acceptable condition.

Consultant advised to cut the fuelwood in lengths of 1.00 - 1.30 m and start splitting when the diameter of the blocks is over 20 cm (in halves) or 40 cm (in quarters).

9.2.2 Charring Technology.

The Charcoal Division should also transfer to the contractors the know-how submitted in this paragraph. And at the same time make sure that the contractors pass it on to the carbonizers without delay.

As charring will be executed mainly in earthmounds it is recommendable to construct uniform mounds, for instance with sizes 3.00 x 3.50 x 1.50 (length, width and height) containing about 16 m3. Because of its limited dimensions these mounds can be controlled very easily and the carbonization crew can operate several mounds simultaneously.

Larger mounds require more frequent inspection because they are difficult to control and suffer often from leakage through cracks and holes in the top layer.

The logs or blocks should be piled upon a grate which will allow the hot carbonizationgases to pass underneath

the load, keeping the charring process going on.

The top of the pile should be covered with a layer of grass or leaves with a thickness of minimum 10 cm and on top of that a layer of earth with a thickness of minimum 15 cm.

A sufficient number of air inlets, diameter 10 to 15 cm, must be constructed at the bottom of the mound, the same number of smoke outlets on the top of the mound.

Once carbonization is completed - the colour of the smoke will indicate this - the earth mound must be completely sealed with sand, mud or clay, whatever available and allow to cool down for a certain period.

When the temperature of the cover and sides of the mound is similar to the temperature of the surrounding soil the earthmound can be opened and the charcoal bagged. Eventual existing fire must be extinguished with sand.

A crew of carbonizers should start constructing a second mound, once the first earthkiln is lit.
To augment their income they should operate as many mounds as physically possible, provided these mounds are constructed and can be controlled at the same site.

9.3 Supply of charcoal to the Carbideplant.

9.3.1 Storage at the depots.

Once the charcoal is bagged, the bags must be carried down to the depots along the forest or main road and, again depending the climatic conditions, covered with whatever coverage, be it a sheet of polyethylene or tarpaulins, but also improvised covers like bamboomats, flattened drums, broad leaves etc. will do.

9.3.2 Packing.

As far as the packing is concerned: it was observed that -as already mentioned in a memorandum to BCCL, dated 27.6.1988 (see: Appendix V, paragraph 6.0 Interim Report 5.7.1988)- the major part of the jutebags is wet even soaked.
Not only the charcoal will be contaminated resulting in a higher moisture content, but also the packing itself will suffer from this condition and will rot in a short time.

It was advised to start drying the packing as soon as climatic conditions permit such. Delivered in bundles at the sites the crews should untie these bundles and expose the bags to sun and wind whereever possible.
Once the packing is acceptably dry it should be stored immediately under cover.

The technical staff of the Carbideplant is invited to look for means and methods - possibly using the heat of the limestone furnace - to dry the wet charcoal bags.

In the mean time the Charcoal Division, recognizing this problem, has ordered several hundreds of polyethylene

bags, which are stronger and less vulnerable to moisture.

9.3.3 Transport.

Whenever a load of 200 bags is stored at the depot or will be within a few days, the contractor should order for a lorrie to transport the charcoal without delay to the Carbideplant.

Following the consultants' advice the Charcoal Division already ordered that the maximum carload should not exceed 240 bags of each 20 - 22 kg.

By doing this it will be avoided that the charcoal in the bags at the bottom of the load will be crushed during the transport, causing a higher amount of fines. It must be mentioned that transportation from remote sites to the Carbideplant often takes many hours, in some cases even several days.

During transport the load must be sufficiently covered, not only to protect the charcoal against rainfall but also to secure the load itself. So the use of tarpaulins should be compulsory for all charcoal transportation no matter what weather condition.

9.3.4 Storage of charcoal at the Carbideplant.

As alreacy stated in a memorandum - Appendix VI of the Interim Report - the storage of charcoal at the Carbideplant should be improved.

For safety reasons the bulk charcoal must be partitioned by concrete or masonry walls, creating sectors of 100 m3 in volume.
In case of a fire it can be expected that only a minor part of the charcoal will be destroyed and the bulk be saved.

If stored in bags - to construct temporary partitioning walls - the bags should be piled not higher than 8 bags on top of eachother to prevent an increase of fines in the bags at the bottom. Such walls must be replaced every now and then.

Truckdriving on top of the stored charcoal for reasons of easier unloading i.e. emptying the bags, must be strictly prohibited.

When storage of packed charcoal in the open is inevitable the piles of charcoalbags should be covered adequately with tarpaulins. It is strongly recommended to remove c.q. to use this charcoal at earliest convenience.

CHAPTER X

10.0 Appraisal productioncapacity.

10.1 Present requirements.

As mentioned in Chapter II, paragraph 2.3, contractors committed themselves to supply almost 9,500 tons of charcoal to the Carbideplant at Pasakha.
Whether or not this quantity really will be supplied may seem irrelevant as the requirements of the factory are calculated at only 5,500 tons for the first operational year, so from May 1988 till May 1989.

On the other hand the production of carbide was about 1,500 tpm since the commissioning of the plant in May 1988, so consuming about 750 tons of charcoal per month and totalling 9,000 metric tons per annum.

It is believed that the management of BCCL will seize any opportunity to boost carbide production as much as possible because the export of this product will contribute largely to the governmental target of self-reliance.
Considering this continuous high consumption of charcoal it is advisable to prepare for an equally high production of charcoal.

10.2 Future requirements.

It is calculated that, starting with the 5th operational year, annual consumption of charcoal by the Carbideplant will be slightly over 14,000 tons.
Viewing however the present data and considering the total carbideproduction capacity of the factory as well as a forthcoming realisation of existing plans to expand the range of chemical products, it would be wise to foresee an annual consumption of charcoal up to 20,000 tons, say in ten years from now.

10.3 Appraisal present and future capacity.

Both the Charcoal Division and the consultant agreed that concluding supply-contracts does not necessarily guarantee the supply itself. In other words: from the 9,500 tons committed in suppliercontracts about 6,000 tons are expected to be delivered between 1.10.1988 and 1.10.1989. As this quantity is still almost twice as much as supplied in the previous period, achieving this target can be considered as a major success.

In the opinion of the consultant it is however doubtful if an annual increase in the second and following years can be realised without taking exceptional measures.

Of course, improved kilning techniques, a better use of the productioncapacity per carbonization crew, charring

exclusively with dry fuelwood etc. will account for a considerably higher yield, perhaps to cover the requirements in the second year.

From then on the bulk of a futher increase of charcoal supply must come from medium- and even large scale production units, such as the Chimakhoti Charcoal Plant and the Reafforestation Project in Bangthar.

CHAPTER XI

11.0 The Chimakhoti Charcoal Plant (CCP).

11.1 Present situation.

Only a little bit of information was given in Chapter II, par. 2.2, stating that this non-destructive distillationplant actually was meant to serve as a demonstration project.

After having produced occasionally batches of pinewood-charcoal the activities were ceased for several reasons, among them the impossibility to cbtain sufficient supply of fuelwood for carbonization. Since the summer of 1988 the plant has been abandoned and the condition of the equipemt is worsening rapidly.

11.2 The equipment.

At the start of the production CCP was equipped with two stationary circular kilns, each with a length of 6.25 m and a diameter of 1.50 m. Thickness of the steel is 1,5 cm.
For sprinkler-cooling also two stationary cylindrical retorts sizing same length, diameter and thickness were available, several dozens of trolleys and a total of 100 m of narrow-gauge line including turntables.

The carbonization retorts are situated in a spaceous building which also houses two distillation condensers and two combustion chambers.

Before the trolleys were loaded the fuelwood was cut by a simple bandsaw at the required lengths and widths, which enabled also a slight decrease of the moisture content.

The latest productiondata obtained (September 1988) when the remaining fuelwood on the compound was carbonised, indicated 800 kg per 24 hours.

One of the coolingretorts has been removed to elsewhere.

11.3 Rehabilitation.

Discussions sofar were focussed on two options:

11.3.1 Training- and testplant.

The management of CCP, being Tashi Commercial Group is strongly in favour of a study to make further use of the plant for testing the charring potentials of a range of wood species growing in Bhutan.
It can be expected that though the plant cannot rely on regular and continuous supply of fuelwood, sufficient

quantities of fuelwood can be obtained to execute testprogrammes.

Sofar it is not indicated which testprogrammes should be implemented nor at what they should be aimed at.

Consultant believes that a limited use of the plant does not contribute to BCCL's requirements nor could execution of testprogrammes be of major value to a charcoalproduction in Bhutan at the moment, mainly because of the great difference between factorized production and small scale earthmoundproduction.

Keeping the personal request of BCCL's Managing-Director to him in mind the consultant strongly recommends to use the plant as an ..

11.3.2 Industrial scale production unit.

Accepting this option would mean a complete dismantling of the plant and its transfer to a site, where, especially in years to come, abundant quantities of fuelwood will become available.

The dismantling itself would not involve major difficulties as the construction of the shed and the carbonization parts is relatively simple.

Because the building is constructed from wooden poles with a roofcover of asbestos cement it will be of great value at a future location.

The transportation of the cylindrical kilns will be a challenge to any transport company. Yet as they have been transported from India or assembled partly at Chimakhoti, it must be possible to arrange the reverse way.

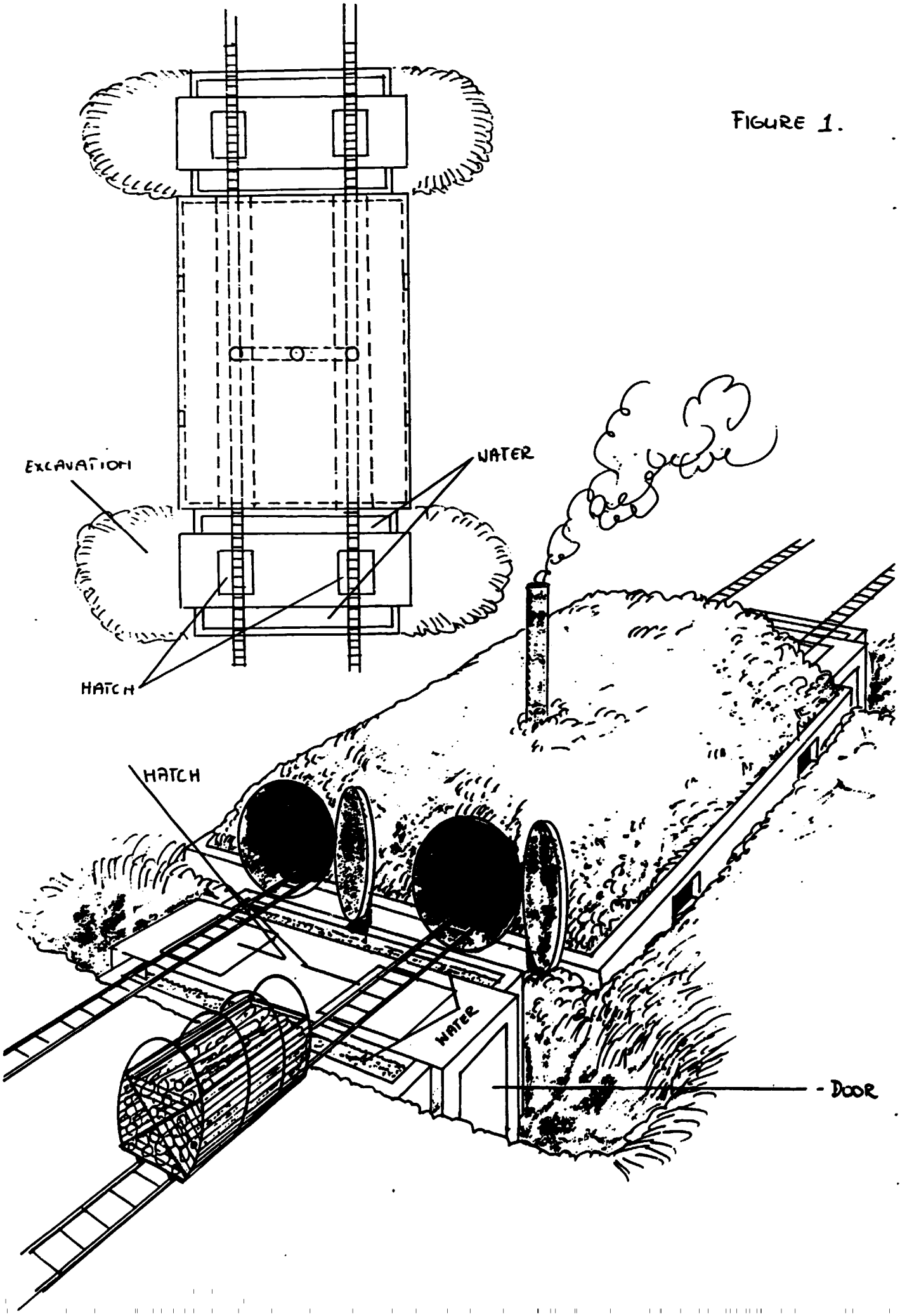
Thorough calculation shows than when operated in continuous batches a production capacity of 2,500 tons per year is attainable. For this it will be necessary to arrange a number of modifications in order to make the best use of the installation.

11.4 Design.

From an artists impression (fig. 1) of the new plant it can be learned that both carbonizationretorts have been placed on concrete fourdations and have been covered with sand to create an optimal insulation.
Underneath each retort a large combustionchamer is constructed where bark, waste wood and sawdust will be burned to start the spontaneous endotherm process inside the retort.

On both ends of the retort the charcoal can be unloaded from modified trolleys into a bunker, constructed from

FIGURE 1.



thin but strong metal sheets.
These bunkers are placed in a concrete tank through which a continuous flow of water is led to cool down the charcoal inside the bunker.

While the unloading of the charcoal takes place ont the one end of the retort, trolleys loaded with fuelwood are shifted inside the retort at the other end, thus profiting by the still high temperature inside the retort.

As a third retort is available, a second exactly identical unit, consisting of two retorts - one of them to be purchased - is recommended. This 4 retort factory could achieve a maximum productioncapacity of 2 x 2,500 tpy = 5,000 tpy.

Additionally a small powerplant will be necessary and a study is recommended to use either a charcoal- or a wastewood gasification unit for this purpose.

The carbonization per unit must be organised in a continuous operation, if feasible in 3 shifts per 24 hrs.

The best suitable location for this design is the site of the Reafforestation Project at Bangthar in Samdrupjongkhar, southeast Bhutan.

CHAPTER XII

12.0 Bangthar Reafforestation Project.

12.1 General Information.

The Forestry Department of the Royal Government of Bhutan allowed the Charcoal Division of Bhutan Carbide & Chemicals Ltd. to start a reafforestation project near Bangthar in Samdrupjongkhar.
This project is financed by a World Bank loan and is aimed at a medium scale charcoalproduction as well as at the reafforestation with fast growing species.

The area to cope with is about 1,000 ha and clearing of the annual batch of 100 ha started in the season 1986/-87. In the then following season 1987/88 75 ha were replanted with legumesi, a fast growing fuelwood species. It is intended to clear another 100 ha in the season 1988/89 with simultaneous replanting of 125 ha, so catching up with the initial planning.

Up to 15.4.1988 a total of 121 tons of charcoal was produced, the carbonization being started in November 1987.

The Reafforestation Project, directed by Mr. N. Wangchuck, a keen forester from the Forestry Department, is mainly dealing with the landclearing and the replanting, leaving the carbonization to two contractors.
Charring is carried out in pitkilns or earthmounds under strict supervision of the manager of the project.

The rainy season in 1988 was used to prepare the fuelwood for carbonization by crosscutting it in lengths between 1.00 and 1.30 m and stacking it under cover to protect against heavy rainfall.
At the start of the new charring season a total quantity of 25.000 m3 will be available.

The contractors are committed to supply 800 tons of charcoal to the Carbideplant from 1.10.1988 - 1.10.1989.

12.2 Availability of fuelwood.

The average yield on fuelwood from logging waste per 100 ha is 10 - 12.000 m3. In 1987 a quantity of 5.000m3 was yielded for charring, in 1988 20.000 m3.
Total logging comprises 70-80.000 m3 per 100 ha, so the annual yield on waste wood from tops and lops is ca. 15%.
Assuming that the specific weight of the fuelwood is 500 kg/m3 total annual availability will be 5 - 6.000 tons.
The carbonization capacity of the dual retorts can easily deal with this quantity.

12.3 Increased production capacity.

Further study must show whether or not a second unit of two retorts will be necessary in the near future. Some consequences, negative and positive, are already obvious.

12.3.1 it will be necessary to double the land clearing to yield twice as much fuelwood for charring

12.3.2 more manpower will be required to cope with this new situation

12.3.3 probably less timber of 2nd or 3rd quality will become available as it will be needed for carbonization.

12.3.4 speed of the replanted species will not catch up with the speed of the landclearing

12.3.5 a considerable part (25 - 35%) of BCCL's requirements on charcoal can be covered from only one source, employing a limited number of manpower.

12.3.6 invaluable experience will be gained by operating this industrial scale carbonization.

12.4 Second Reafforestation Project.

It is estimated that BCCL will require possibly between 15.000 and 20.000 tons of charcoal in the 5th and following years of carbideproduction.

Recent information learnt that BCCL is negotiating with the Forestry Department to set up a second Reafforestation Project. This project comprises an area of 10.000 ha and all available wood will be carbonised, not only tops and lops. It will be situated in the southern region of Bhutan, probably between Kalikhola and Phuntsholing.

Supplied with hunderd thousands of m3 of raw material per annum carbonization obviously will be highly profitable when implemented in continuous processing.
In this case one or two retorts of the S.I.F.I.C. type are capable to cope with the annual production of fuelwood, producing up to 10.000 tons of charcoal of excellent quality per year.

The total investmentcosts are estimated at US $ 5,- million including arrangements for infrastructure in the projectarea.

CHAPTER XIII

13.0 Transfer of production sites.

Hitherto the production of charcoal in Bhutan is widely spreas though with the majority of the sites in the triangle Paro-Phuntsholing-Wangdi. A considerable part of the charcoal produced int his area is charcoal from pinewood, so a softwood charcoal.

BCCL demands however a charcoal quality with a high fixed carbon content, which only can be achieved from hardwood charcoal.

It therefor can be expected that a gradual transfer of the charcoalproduction must take place from the northern zone to the mid- and/or southbelt, where hardwood species are available.

The establishment of an production unit on industrial scale at Bangthar (maximum capacity ca. 5,000 tons of charcoal) and one unit at a second reafforestation project as described in the previous chapter (counting for 10.000 tons of charcoal) will fit exactly in such a scheme.

Thus from a total demand resp. production of an estimated 15 - 20,000 tons of charcoal for the carbide-plant about two third will be procured from industrialized production and one third from small scale charring operations.

13.1 Advantages.

Engaging such a diversified production would certainly have a number of significant advantages.

- supplylines from productionareas to the plant will be shortened considerably or can benefit by easier communications through Indian border territories
- factorized production has not necessarily to be suspended during the rainy season as the actual production is implemented under protecting roof
- charcoalquality will be more consistent when produced in industrial operated units.
- the yield per metric ton raw material will be higher than when produced in earthmounds
- charcoalquality will be the best attainable considering the specifications of the fuelwood and will meet the chemical analysis of BCCL
- less (non-national) manpower will be involved in a factorized production

- possibility to extract wood chemicals which can be used for further development of BCCL-sidelines

- potential export of a surplus of charcoal to neighbouring countries as India and Bangladesh for domestic or industrial usage.

CHAPTER XIV

14.0 Overall strategy for charcoalproduction in Bhutan.

The ultimate target to be achieved in 1993 must be:

- charcoalproduction in Bhutan will meet totally the demands of the Bhutan Carbide & Chemicals limited
- a stock of charcoal for 3 months carbideproduction must be present at the carbideplant in Pasakha
- the quality of the charcoal supplied must meet the chemical specifications set by BCCL
- charcoalproduction will be organized for 2/3 in two or three industrial operated productioncentres; for 1/3 in small scale productionunits.

14.1 Phases.

1988/89
- establishment of a stock for 1 month carbideproduction
- boosting individual small scale carcoalproduction
- improvement of charcoal quality
- transfer of 2 retorts plus additional equipment to Bangthar Reafforestation Project
- start feasibility study factorized production in planned second Reafforestation Project

1989/90
- augmentation stock to 2 months carbideproduction
- boosting individual small scale charcoal production
- start gradual transfer small scale production to the midbelt
- improvement of charcoal quality
- if approved: start building industrial scale production unit in 2nd Reafforestation Project

1990/91
- finalizing transfer small scale charcoal production to the midbelt
- quality as required
- finalizing construction industrial scale production unit in 2nd Reafforestation Project
- small scale production at peak level.

1991/92
- industrial scale production fully operational
- augmentation stock to 2 1/2 month carbideproduction
- slow decrease decentralized small scale production
- charcoal quality as required

CHAPTER XV

15.0 Computerization of filing system.

Referring to Chapter III, paragraph 3.4 "Administrative support", it was mentioned that the administrative support of the charcoal production is based on all kind of documentation in over 120 files by now.

It can be expected that the planned increase of the production will result in even more paperwork as the number of contractors, sites, packing, quantities, transport etc. will rise simultaneously.

Early in 1989 the Bhutan Carbide & Chemicals Ltd. will install a computersystem.
On consultants' advise the Charcoal Division will also benefit by this automation and has already set up a extensive data base, comprising all available information thusfar recorded in the manual filing sytem.

Using this data base properly all wood preparing and charring operations can be anticipated and once followed closely, be steered, controlled etc. whenever necessary.

A tentative database has been composed in the mean time as shown in Appendix III.

CHAPTER XVI

16.0 Transfer of charring technology.

Referring to Chapter VII, "Manpower" as well as to Chapter IX, paragraph 9.2.2 "Charring Technology", it is felt necessary to look for a simple but efficient method to pass the charring technology from the management of the Charcoal Division through supervisors and contractors on to the individual carbonizers.

This can be implemented by introduction and distribution of a manual for carbonization.
Far from being written in a sophisticated way it should visualize in simple drawings all stages of the carbonizationprocess step by step, starting with the preparation of the fuelwood till the loading of the lorrie at the depot.

In 15 to 20 drawings the process can be explained to these generally illiterate labourers. The booklet, eventually designed by the consultant, as shown in an example in Appendix IV, will also have an explaining text in English, Bhutanese and Hindi.
Translation in Bhutanese and Hindi language as well as the printing on special, non-destructable paper, can be executed in Bhutan.

16.1 Training courses.

As stated in Appendix II of the Interim Report from July 5th 1988 the Charcoal Division was ordered to establish a training- and testcentre for charcoalmanufacture at the plants' compound at Pasakha.

This centre was completed in October 1988 and training of contractors and supervisors is scheduled to commence in January 1989.

Training will be focussed on:

- preparation of the fuelwood
- the pyrolysis process
- improvement of charcoal quality
- handling and storage of bagged charcoal
- kilning techniques
- charring with a) earth mound
  b) pit kiln
  c) TPI portable steel kiln
  d) brick kiln
- experiments with various species of fuelwood

CHAPTER XVII

17.0 Consultancy.

This consultancy comprised actually two stages:

1st mission: reconnaissance and ad hoc recommendations
2nd mission: thorough investigation of all aspects of the entire organization for charcoal manufacture; short term and long term recommendations

17.1 1st Mission. 30.5.1988 - 9.7.1988.

As recorded briefly in the Interim Report the first mission was dealing mainly with a provisional inventory of the situation,

A number of field visits, though in several cases to only more or less easily accessible sites, were executed and a limited on the job training conducted.
Charring activities were few at that time except for the coniferous zone in the Paro-,Ha- and Thimphu area where climatic condiitons still permitted carbonization.
For the record:

1.	Jolela Road	4/6	Paro area *
2.	Chalela Road	4/6	do*
3.	Kanana	5/6	Ha area
4.	Pasakha	7/6	Ph/ling area
5.	Gedu Wood Proc.	9/6	Gedu area
6.	Chimakhoti	10/6	Chimakh. area*
7.	Geylegphu	16/17/6	Geylegphu area *
8.	Bumthang	20/6	Jakar area
9.	Chamagoan	22/6	Thimphu area*
10.	Yusipon	23/6	do
11.	Chonkaphu	24/6	do
12.	Pasakha testcentre	25/6 - 4/7	Ph/ling area*

* charring activities in progress

At Pasakha the establishment of a training- and testcenter started and after partial completion a few demonstration runs were conducted notwithstanding the unfavourable wheather conditions and poor wood quality.

It was emphasized over and over again that to obtain an optimal yield of charcoal with an acceptable quality carbonization should be implemented with dry wood only, i.e. wood with less than 30% moisture content, preferably even less than 20%.

Also a programme of activities for the 2nd mission was scheduled, as mentioned in Chapter VI of the Interim Report.

To assist in the start of a wood preparation programme, equipment as chainsaws, splitting axes, moisture testers were selected, ordered and purchased.

Especially the moisture tester proved of extremely great value during the field visits in the second phase.

17.2 2nd Mission. 22.9.1988 - 5.11.1988.

The second mission was concentrated, for the major part, on inspection of the carbonization sites, actually for a number of reasons, among them:

a) to observe whether or not the instructions left behind at the end of the 1st mission, were imple mented.
b) to correct wrong or incomplete charring techniques on the spot
c) to record various data concerning the decentralized carbonization
d) to study the rehabilitation of the Chimakhoti Char coal
e) on the job training

From the 32 sites mentioned on the map "Carbonization sites in Bhutan" 16, with 92 mounds, were visited, which in most cases, was only possible by some physical effort in these rather rugged areas.

At site nr. 18 activities were concluded for the time being, at nrs. 9, 19 (driftwood), 21, 25 and 30 carbonization should commence within a few weeks, depending on the availability of manpower.
Unfortunately the sites Samdrupjonkhar, nrs. 27 - 30, could not be inspected, due to a few dozens of landslides in that area. These sites were only accesible through Indian (restricted) border territories, for which no transit permit was released.

As for a) and b) consultants instructions were still not implemented completely; in almost all cases still wet fuelwood with a moisture content more than 30% was tried to carbonize, except at site nr. 11. Nor, in most cases. the fuelwood was crosscut or split (except at site nr. 26)
Crosscutting and splitting was also carried out at the sites in Samdrupjongkhar according to the information obtained from the Reafforestation manager.

Mound construction showed very good progress, at some sites excellent built earthmounds, easy to control and operate, were observed.

Contractors, supervisors and crews were ordered to implement the kilning techniques as instructed.

As for c) a number of data was recorded, using the Site Inspection Form, and afterwards discussed with all parties involved.

As for c) may be referred to Chapter XI.

CHAPTER XVIII

CONCLUSIONS.

* However up to 1987 no charcoal production whatsoever existed in Bhutan, the completion of a large calcium carbideplant in mid 1988 forced the management of Bhutan Carbide & Chemicals Ltd. to get off the ground an extensive production organization.

* It is significant for the attitude of the officials of BCCL, headed by the Managing Director personally, that in a remarkable short time a solid foundation was laid for a charcoalproduction which could at least meet partially the requirements of the carbideplant.

* due to - but al ; thanks to - a balanced forest policy executed by the Forestry Department of the Royal Government of Bhutan charcoal production is bound to follow the official logging operations or can profit by available wastewood elsewhere, so deforestation will be avoided.

* charcoalproduction is as a consequence inevitably widely spread, decentralized and only small scale, yielding here a few dozen there a couple of hundred bags of charcoal.

* the production is assigned to contractors, who are employing relatively cheap non-national labourers in most cases.

* the widespread production at over 30 sites requires numerous labourers

* shortage of manpower will block rapid increase of the production

* increase of yield must be found in better preparation of the raw material, improvement of kilning techniques and more care for the finished product

* studies are necessary on: a) transfer of production to hardwood areas
  b) introduction of medium- and large scale production

* to guide and assist in present production as well as in future production, both small scale and industrial scale, assistance of UNIDO-consultancy is indispensable.

CHAPTER IXX

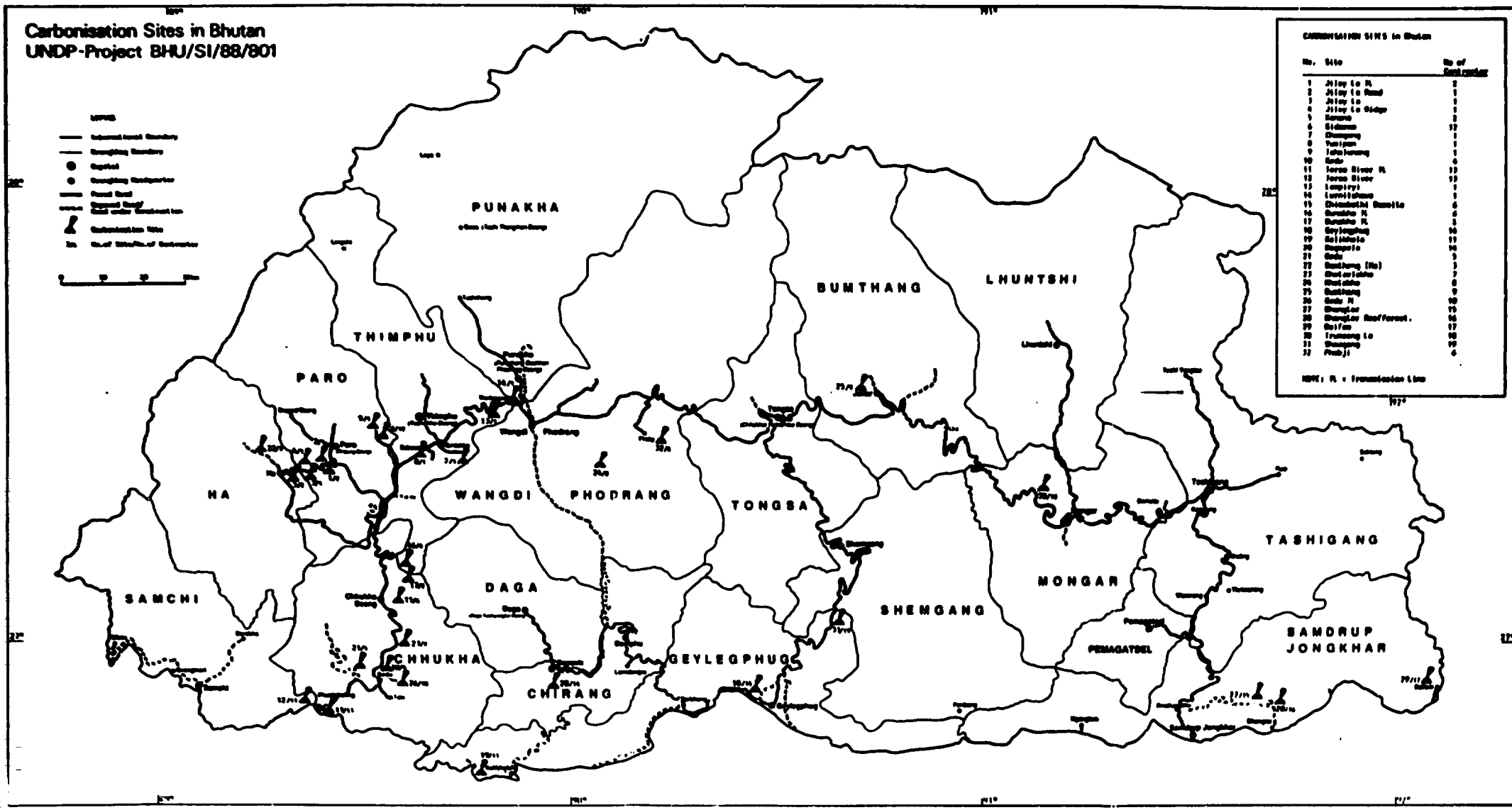
RECOMMENDATIONS.

For the Charcoal Division of Bhutan Carbide & Chemicals Ltd.

* procurement of sufficient wood-handling tools (chain-saws, crosscut saws, splitting axes, hammers, wedges, moisture testers etc.) to equip 30 to 40 fuelwood preparation teams
* systemize and co-ordinate wood preparation in all allotted areas
* no release of prepared wood to contractors/charring crews unless moisture content is below 25%
* execution of regular and frequent control of carboniza-tion and forest treatment
* establishment of training courses - twice a year - at Pasakha
* study on gradual transfer of charcoal production to hardwood areas
* negotiations with the Ministry of Home Affairs for extension of stay for trained charcoalburners

For UNIDO/UNDP.

* assist in procurement of wood-handling tools
* design a 4 - 5 year planning to assist in build-up of charring organization
* research on industrial scale charcoalproduction using S.I.F.I.C.-retorts
* design, print and distribution of a manual for car-bonization, visualized in simple drawings
* assist in proposed transfer of the charcoalproduction from softwood to hardwood areas
* provide funds for training of staffmembers of the Charcoal Division of BCCL in view of future industrial scale production
* provide annual consultancy for assistance, inspection and transfer of know-how


Carbonisation Sites in Bhutan
UNDP-Project BHU/SI/88/801
PUNAKHA
THIMPHU
PARO
HA
WANGDI
PHODRANG
BUMTHANG
LHUNTSHI
TONGSA
SAMCHI
DAGA
CHHUKHA
CHIRANG
GEYLEGPHUG
SHEMGANG
MONGAR
TASHIGANG
PEMAGATSEL
SAMDRUP
JONGKHAR

APPENDIX I

LIST OF CHARCOAL CONTRACTORS WHO HAVE ALREADY EXECUTED CONTRACT AGREEMENT UNDER REVISED RATES.

No.	Name of Contractor	A R E A S	Annual target	Rate/M.T.
1.	M/s Karma Timber & Charcoal Contractor	Ha, Paro, Gemina, Chankhaphu, Lumichawa	3,000 M/T	2,200,--
2.	Mr. Lhap Tshering	Kanaphu Logging area Coupe no. 11	500 -	2,200,--
3.	Mr. Appey Tshering	Balumna, Chanona, Damthang & Drugyel Dzong	240 -	2,200,--
4.	Mr. Chakey Dukpa	Biri & Bongo area	170 -	1,900,--
5.	Mr. J.B. Tamang	Gedu, Biri, Bongo, Chungeykha & Transmission Line from Gangalakha to Chasilakha	1,000 -	1,900,--
6.	Mr. B. Lepcha	Chukha River Bank to Chapcha under Transmission Line, Phubjikha	1,010 -	1,900,--
7.	Mr. D. Tshering	Chasilakha to Chukhachu under Transmission Line	100 -	1,900,--
8.	Mr. Tharchung	Khotokha (Thimphu)	600 -	2,200,--
9.	Mr. Namsa Dorji	Hurchu (Bumthang)	500 -	2,400,--
10.	Mr. Kishore Mahat	Ganglkha to Gedu under Transmission Line	1,000 -	1,900,--
11.	Mr. Sonam Tshering Dukpa	Kalikhola, collected driftwood from Sunkosh & Raidak River and other junkwood	100 -	1,800,--
12.	Mr. R.B. Sherpa	Gidakom	100 -	
13.	Mr. Gatey Chien	Tursa River and Transmission Line	200 -	
14.	Mr. Kamal Nepal	Geylegphu, Dagapela	40 -	
15.	Mr. Samling Dorji	Bangthar Reafforestation	600 -	
16.	Mr. K.P. Sharma	Bangthar Reafforestation	200 -	
17.	Mr. Gyeltshen	Daifam	50 -	
18.	Mr. Sonam Wangdi	Thrungsingla	50 -	
19.	Mr. K. Dorji	Shemgang	50 -	
		TOTAL	9,510 M/T	

APPENDIX II

SITE INSPECTION FORM

Organization : UNIDO
Consultant : Albert Zorge

Site :
Contractor :
Date of visit :

WOOD PREPARATION	data	yes	no	remarks
moisture content				
crosscut				
split				
piled				
covered				
CARBONIZATION				
data: commenced				
finished				
opened				
sizes				
air inlet: size				
number				
markings				
air outlet: size				
number				
cover				
PACKING				
condition				
storage				
CHARCOAL				
condition				
storage				
OIL FOREST TREATMENT				
number of labourers				
forest control				
fuelwood control				
kilning techniques				

Specifications for DATA BASE computerprogramme CHARCOAL

CHAPTERS:

01 contractors
02 productionsites
03 manpower
04 deliveries
05 chemical analysis
06 raw material
07 packing
08 site inspection
09 forest control
10
11
12

01 CONTRACTORS:

001 name
002 adress
003 quantity committed
004 period
005 operating sites
006 kilning methods
007 packing
008 quality analysis
009 manpower
010 deliveries
011
012

02 PRODUCTIONSITES

021 etc. see site inpection form except BCCL paragraph
022 climatic conditions
023
024

03 MANPOWER:

031 totals on: supervisors
do nationals
do non-nationals
do employed since ..
do employed at site ..
do employed by (contractors name)

04 DELIVERIES:

041 running period
042 target contractorwise
043 deliveries contractorwise
044 balance

05 CHEMICAL ANALYSIS:

051 use of laboratory-reports
per lorrie
do contractor
do month
do year
do moisture content
do ash content
do volatile matters
do fixed carbon

06 RAW MATERIALS:

061 logging waste			
062 sawmill waste	coniferous		
063 junkwood	hardwood		dry
064 driftwood	mixed wood		wet
065 pollarding			
066 thinning			

07 PACKING:

071 incoming bags
072 outgoing bags
073 specification per site
074 specification per contractor
075 new bags - jute
076 polyethylene bags

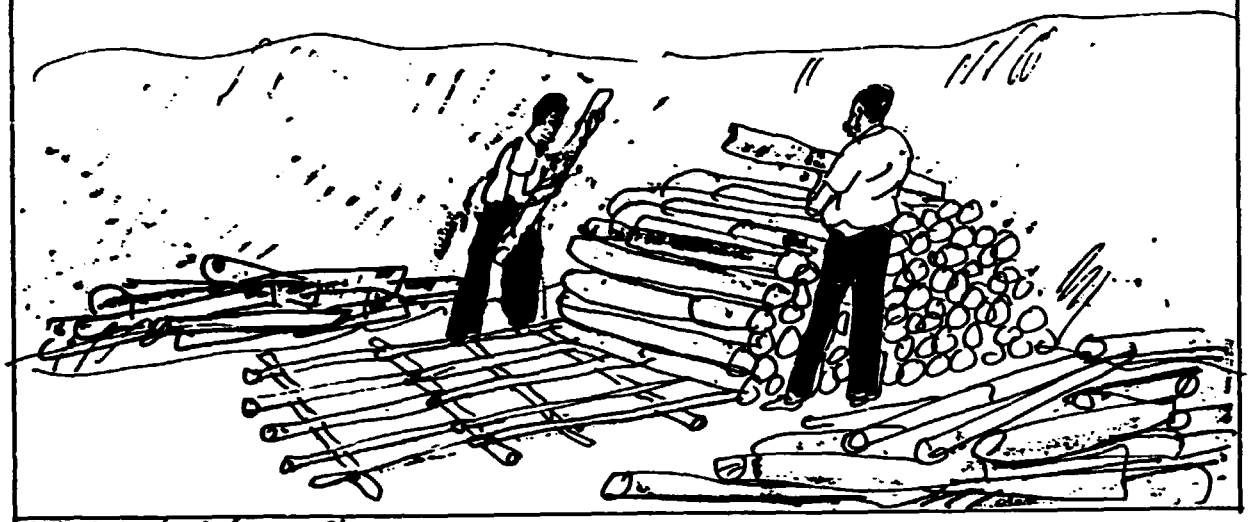
08 FOREST CONTROL:

081 forest treatment contractorwise

Phuntsholing, 14th October 1988.

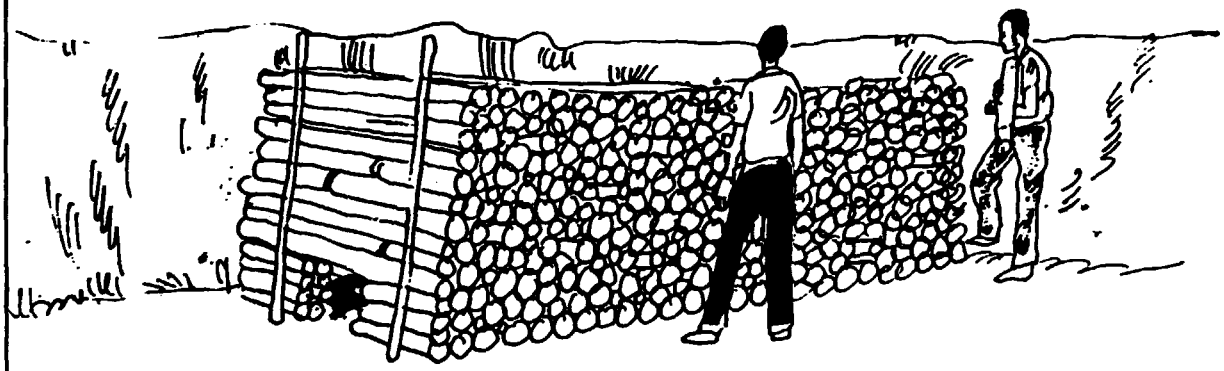
Albert Lorge
Charcoal Consultant for UNIDO

STACKING THE PILE ON A GRID.



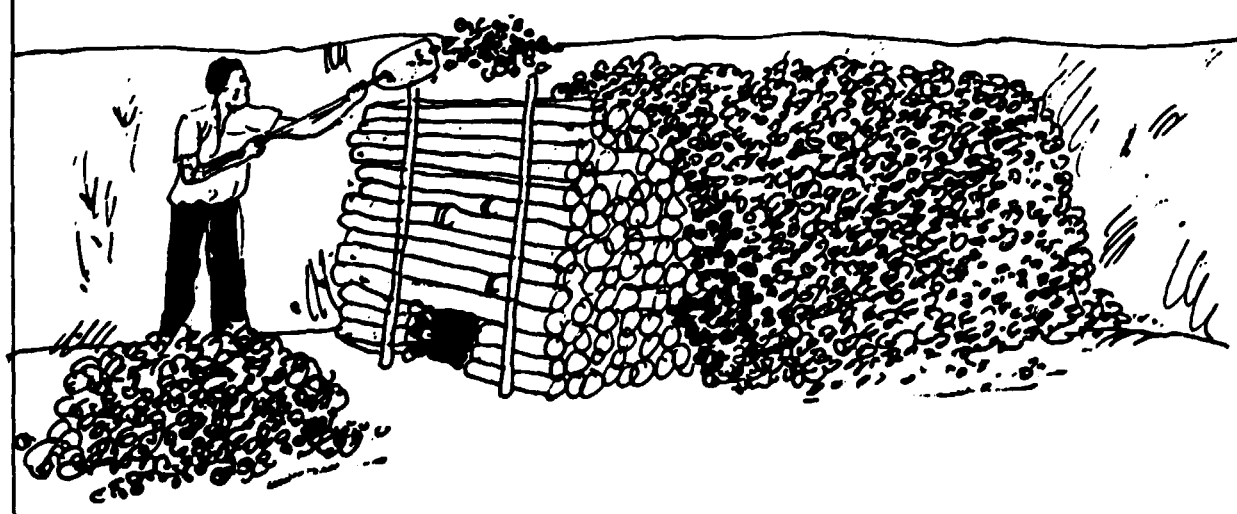
1 Hout stapelen tegen een wal

STACKING COMPLETED; NOTE FIRING POINT IN FRONT



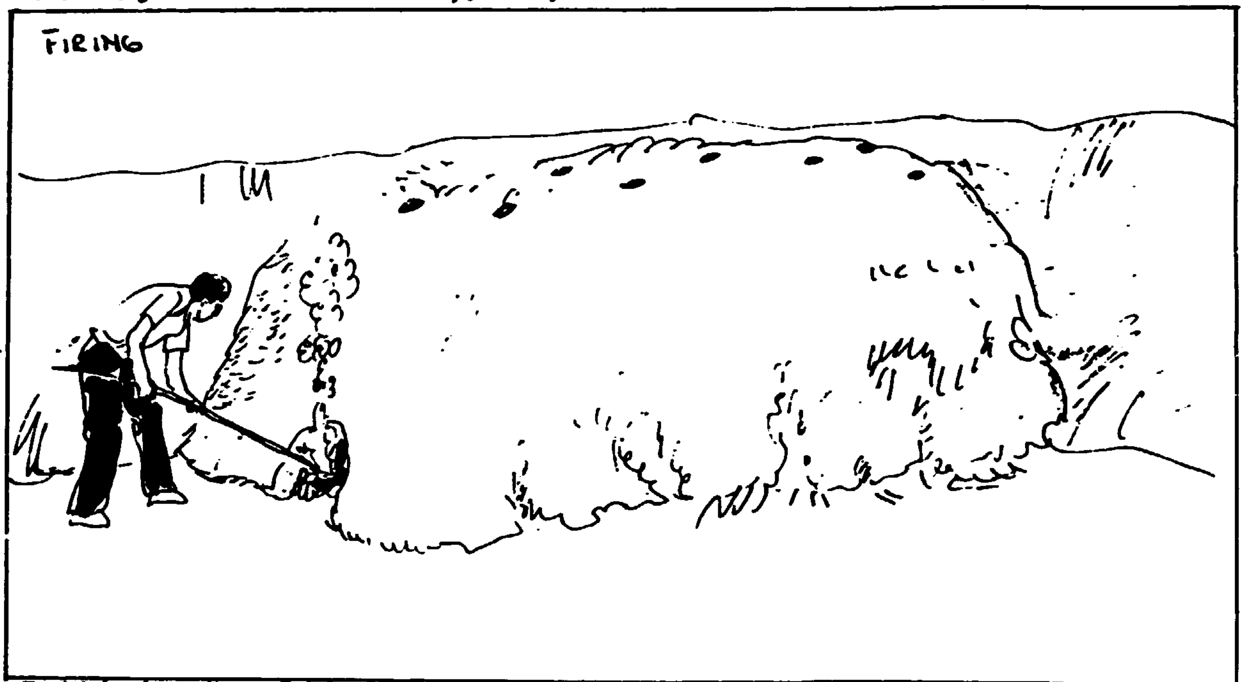
2 Hout stapelen gereed. Opening voor brandgat

COVERING WITH GRASS OR LEAVES

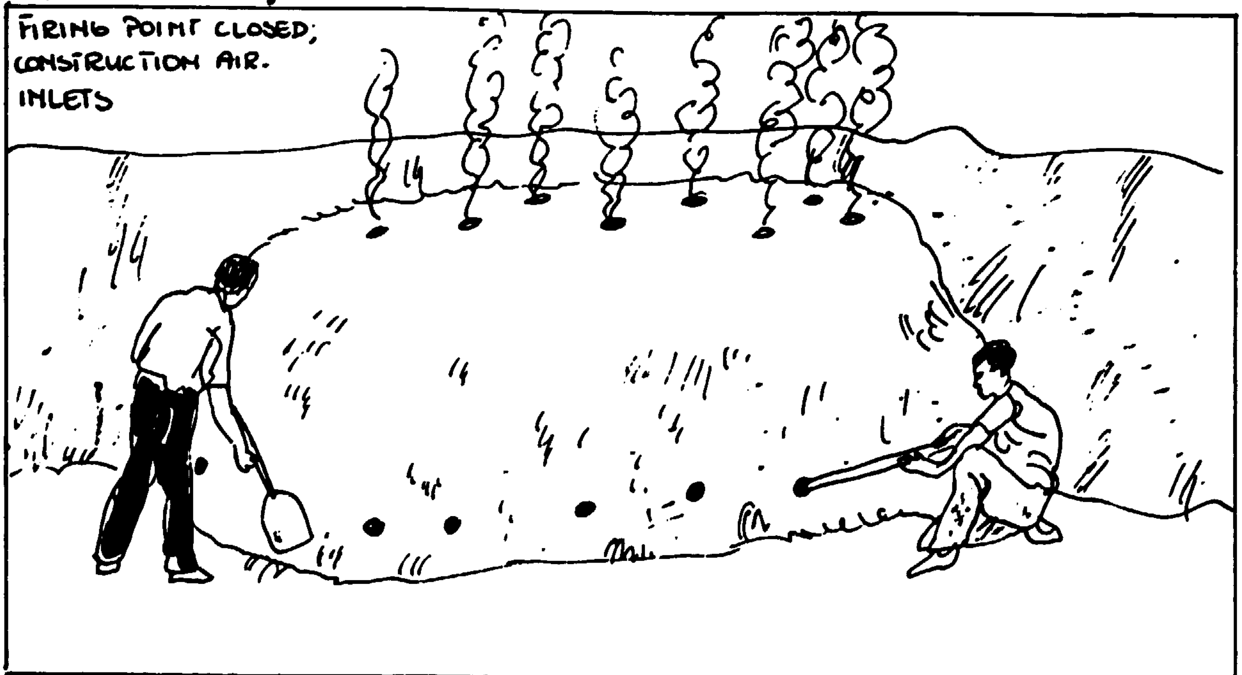


3 Bladeren + gras worden over het hout gelegd

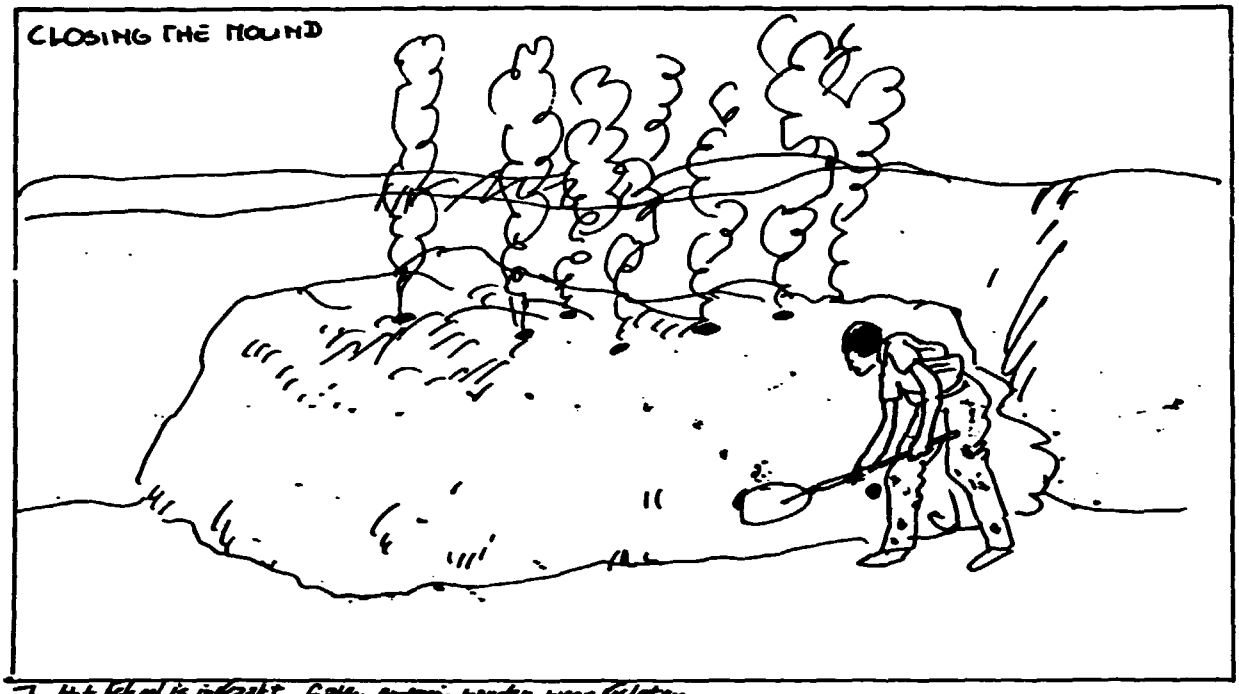
4 Een laag zand wordt over de bladeren/gras aangebracht. Gaten voor rookafvoer bovenop.



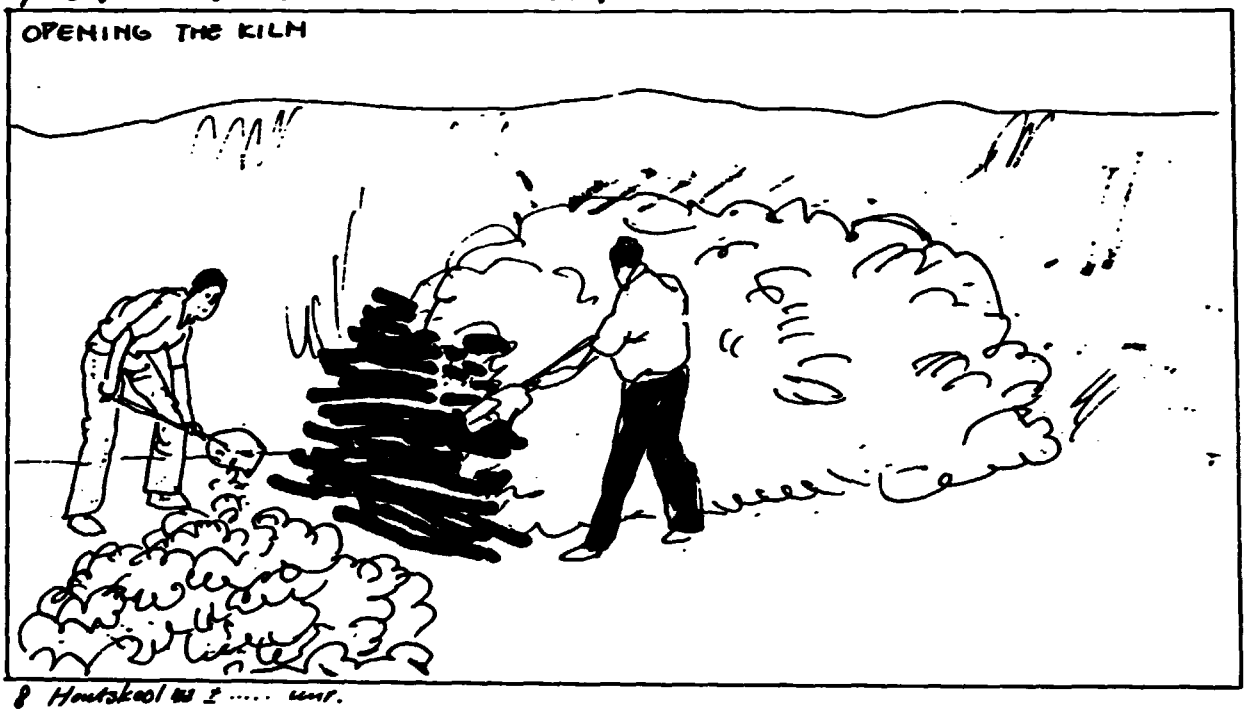
5 Het hout wordt aangestoken



6 Brandgat wordt gesloten. Onderin worden gaten aangebracht.



7 Het fakkel is ingezakt. Gaten worden weer gesloten



8 Houtskool uit de ..... oven.