THE PEOPLE'S REPUBLIC OF

BANGLADESH

SMALL SCALE METAL WORKING AND LIGHT ENGINEERING INDUSTRY

ITS PRODUCTS AND TECHNOLOGIES

SEPTEMBER 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

THE PEOPLE'S REPUBLIC OF

BANGLADESH

SMALL SCALE METAL WORKING AND LIGHT ENGINEERING INDUSTRY

ITS PRODUCTS AND TECHNOLOGIES

SEPTEMBER 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

This is an excerpt from a report entitled "The Study on Development Plan of Small Scale Industries in the People's Republic of Bangladesh" presented to the Government of Bangladesh in September 1980 by the Japan International Cooperation Agency (JICA).

The purpose of preparing this small booklet is to present the JICA Survey Team's diagnostic view as to the present status of products and technology of the small scale metal working and light engineering industry in Bangladesh, one of the most important subsectors of the small scale industry for the rural development.

It is hoped that the views and opinions presented herein are beneficial to both the Government officials concerned and the private industrialists who try to improve and develop this subsector.

The contents of this excerpt consist of two parts, namely identification of products (or industries) for priority promotion, and diagnoses of production technology and product quality of the subsector.

Tan Hashida
Team Leader
JICA Survey Team

CONTENTS

1. Identification of Industries for Priority Promotion

(1) Criteria for Screening Industries

Each of products or industries listed in the foregoing section has its own business prospects and the importance to the national economy in general and to the industrialization in particular. All of them may deserve attention of agencies concerned with industrial development of the Country. It would, however, be worthwhile to have a shorter list of industries so that promotion activities could efficiently achieve the purpose.

Considering the economic situation of Bangladesh and the national aspirations for the development stated in various documents, following criteria have been adopted as a conceptual framework for further screening of the industries listed in the preceeding section. These criteria are:

- National project supporting criterion
- Welfare criterion
- Resource utilization criterion
- Foreign exchange saving criterion
- Employment generation criterion
- Industrial dispersal criterion
- Industrial linkage criterion
- Specific technology criterion
- Technology application criterion

The national project supporting criterion is to select industries promotion of which is vital for supporting important programmes and projects set forth under the new Five Year Plan. The programmes and projects are such as the Food Production Doubling Programme and the programme to uplift the living standard of people in the villages.

The welfare criterion aims at identifying industries which will contribute to the welfare of the general populace through supplying devices for water supply and

other essential services, improving means of transportation in towns and villages, supporting directly or indirectly the supply of daily necessities (foods, cloths, home appliances etc.), and others.

The resource utilization criterion is intended to choose industries which will contribute to the fuller utilization of resources currently under-utilized. This type of industries include manufacturing of spare parts for other industries whose capacity lies idle due to the difficulties in obtaining necessary spare and manufacturing of improved sugar milling machine and oil milling machinery for existing small mills so that the sugar and oil content wasted by the existing processes can be extracted further.

The foreign exchange saving criterion is to select industries which will save foreign exchange through import substitution. Export potentials in the future are also to be taken into account.

The employment generation criterion is to choose industries for which labour intensive technologies are applicable.

The industrial dispersal criterion aims at identifying industries where many small production units can be viably established in many places of the Country. If it is not economically justifiable to do so, the divisibility of the production process is to be examined whether some portion of the production process, the production of some components or assembly operation, can be separately undertaken.

The industrial linkage criterion is to select industries which will have a higher degree of linkages with other industries.

The specific technology criterion is intended to choose a set of industries through promotion of which a set of specific technologies can be upgraded so that a sound technology base for the future development of the metal working and light engineering (MW/LE) industries will be created. It is also envisaged that units which are specialized in one of these specific technologies or another will be promoted in due course of time. The specific technologies mentioned above are;

- machining

- casting
- forging
- sheet metal working
- welding
- heat treatment
- surface treatment

The technology application criterion aims at identifying industrial technologies involved which have the possibility to proceed to the production of more technologically sophisticated products. One example is the production of sickles and other hand operated cutleries. The technology for industrial production of these products has the possibility to proceed to the production of cutleries for industrial use such as blades of wood working planers and sugar cane shredders.

(2) Further Screening of the Long List

In the following paragraphs the metal working and light engineering products listed in Table 3.2.2 will be further screened in the light of the criteria mentioned above. Firstly, let us consider the following 4 criteria:

- National project supporting criterion
- Welfare criterion
- Resource utilization criterion
- Foreign exchange saving criterion

For the standpoints of these four criteria a number of products in the long list (Table 3.2.2) can be regrouped into several categories which are receiving the keenest attention. These categories are;

- agricultural tools and implements,
- irrigation and water supply equipment,
- agro-processing machinery,

- low cost rural transportation equipment, and
- spare parts for various machinery.

Now let us examine products which are regrouped in these categories and which could possibly be manufactured by small-scale metal working and light engineering industries.

a) Agricultural Tools and Implements

Although the production of agricultural tools and machinery is statistically classified as the activity of the manufacturing sector, the development planning of this sub-sector is primarily the task of agencies concerned with the agricultural development. That is, selection and development of agricultural tools and machinery to be produced by the sub-sector belong to the jurisdiction of the agencies responsible for agricultural development. In this study, therefore, extensive interviews were conducted with administrative and extension officers at the central and the district government levels, agricultural scientists and engineers of BARI, BARRI, CERDI and universities, etc. Following discussion is based on the findings of these interview and the Team's observation on existing production capacity of the sub-sector.

Table 3.3.1 summarizes the agricultural tools and implements commonly used in Bangladesh at present. In the paragraphs which follow, the present status of the use and production of agricultural tools and implements shown in Table 3.3.1 will be briefly described and the role expected to be played by the small scale metal working and light engineering industries will be discussed. In case of some products in the table, it can be assumed that there is more or less established design of products and the Team is mainly concerned with upgrading the quality of products. These are sickles, weeders and dryers. In case of other products, the improved design of the products will be worked out by agricultural research instituties and the Team is concerned with building up the capacity of the sub-sector to produce those of improved design. These products are spades, hoes and other hand tools and animal-drawn ploughs.

Table 3.3.1 Agricultural Tools and Implements Currently Used in Bangladesh

Farming Operation	Tools and Implements commonly used	Suggested improvement
Land preparation	- Hand tools such as 'Koddal' (Alenhoe)	- Design improvement and deversification
	- Animal-drawn implements (plough etc.)	- Design improvement
		- (Introduction of power tillers and tractors)
Planting and Transplanting	- Manual operation with no special equipment	- (Introduction of manually operated seed drills)
Weeding	- Hand tools such as 'Nirani'	- Introduction of hand-pushed weeder
Crop protection	- Not performed	- Introduction of knap sack type sprayer
Harvesting	- Sickles	- Quality up-grading
Threshing	- Hand beating or treading with cattle	- Introduction of pedal thresher
Drying	- Sun-drying with no special equipment	- Introduction of mechanical dryer

Source: Compiled by JICA Team

Note: Different opinions are heard among persons concerned with agricultural development of the Country as to whether immediate actions should be taken toward the suggested improvements shown in parenthesis in the above.

— Land Preparation

Virtually all land preparation operations are carried out with bullock-drawn or manual implements and tools. Experts concerned with the Country's agricultural development are of the opinion that there is a good prospect for increasing agricultural productivity by improving the design of the local implements. A special attention has been given to the possible improvement of bullock-drawn ploughs in order to attain reversing as well as deeper tillage.

Another area for attention is diversification of hand tools. Farmers in Bangladesh typically have only one kind of tools, namely 'Koddal' or Alen hoe, which is used for almost any farming operation. It is pointed out that if farmers use more adequate hand tools according to the nature of farming operations and local conditions of soil etc., farming could be substantially intensified.

Certain number of power tillers and tractors have been introduced but different opinions are heard whether the use should be expanded progressively. Those who favour the use of such equipment argue that, although Bangladesh has not reached the stage to resort to mechanization for manpower saving, the day will come soon when the introduction of power tillers and tractors becomes economically justifiable in order to complete necessary farming operations at right timing.

Most of the animal-drawn and manual equipment used for land preparation is produced by local artisans. Some of the equipment such as spades are also manufactured by medium/large-scale industries which employ more capital intensive technology.

The economic and social situation of Bangladesh would dictates that production activities of such equipment should be left to the artisans (the cottage industries) as much as possible. It can be argued, however, small-scale industries with some simple, mechanized production facilities should be promoted. This point will be further discussed in 3.3.1 - (3).

— Planting and Transplanting

Planting and transplanting are almost exclusively performed by hand. Certain types of manually operated seed drills are manufactured locally on an experimental basis. Opinion among experts concerned with agricultural development does not seem to have well established as to whether use of such equipment should be encouraged in the immediate future or not.

— Weeding

Weeding is performed mostly with traditional hand tools such as "Nirani". A rotary, hand-pushed weeder of Japanese origin has been manufactured by the Comilla Cooperative Karkhana Ltd. The firm has produced some 8,000 such weeders in the past three years and sold to farmers in the nearby areas. According to the firm the sales are expanding to other areas such as Sylhet and Mymensingh. A few other firms have started production of similar weeders. The quality of the weeders presently produced is not satisfactory (see 4.1.1). Since the use of such weeders is believed to increase the paddy yield significantly, promoting small-scale industries to manufacture weeders of better quality will be very necessary.

— Crop Protection

A limited number of knap sack type pesticide sprayers have been in use. A trial production of such sprayers has been commenced. Since demand for this equipment is expected to increase as more HYV rice is planted, needs will arise to promote small scale industries to undertake production of such sprayers.

— Havesting and Threshing

Harvesting of paddy and other major crops is done almost exclusively with sickles. Threshing is performed by traditional way of hand beating or treading by cattle. Pedal threshers of Japanese model have been introduced and the use of such threshers are getting popular.

Production of the traditional saw sickles is undertaken by blacksmiths. Products in various qualities are found in the market depending on the skill of

the producer and the nature of material used (see 4.1.1). A question similar to the case of spades and other hand tools arises as to the role to be played by modern small scale metal working and light engineering industries. This question will be taken up later in 3.3.1-(3).

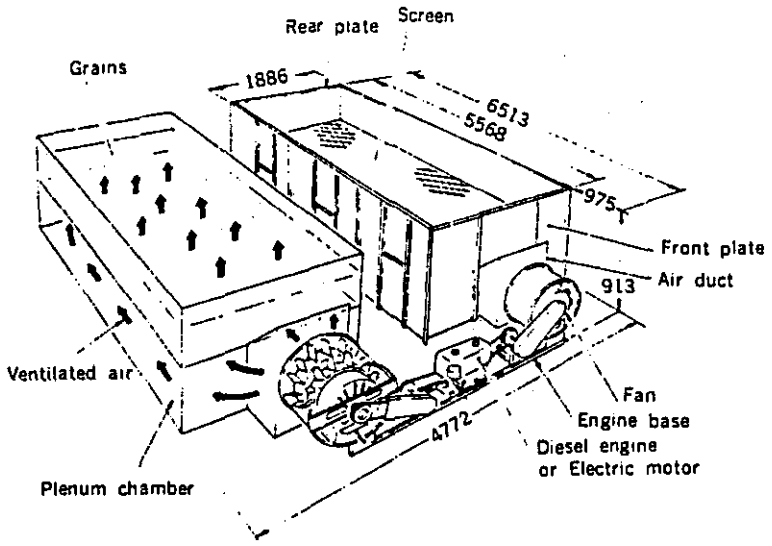
The pedal threshers are fabricated by the Comilla Cooperative Karkhana Ltd. and also by a few other workshops. In order to reduce post-harvesting losses the government is going to take several steps for promulgating the use of the pedal threshers. The quality of the pedal threshers being produced at present is, however, very unsatisfactory (see 4.1.1). Up-grading the quality of the products is required urgently. This is one of the areas which calls for intensive promotion of small scale metal working and light engineering industries.

— Drying

Cereal grains as well as other agricultural products are sun-dried spreading them on metalled roads or other surfaced open space. With this method of drying, the rate of drying cannot be adequately controlled. Losses due to bird attack is not negligible and the quality of the commodity is debased due to mixing of foreign materials. Even during the rainy season sun-drying is practiced intermittently since mechanical drying equipment is almost nonexistent.

This is a keen interest in developing the mechanized drying capability in order to decrease post-harvest losses in view of increasing production of the Boro and Aus crops which are harvested during the wet season. Production of such drying equipment is also an area where small scale metal working and light engineering industries can find a good prospect. An exemplified design of a grain dryer is shown in Fig. 3.3.1.

Figure 3.3.1 Flat-Type Twin Grain Dryer



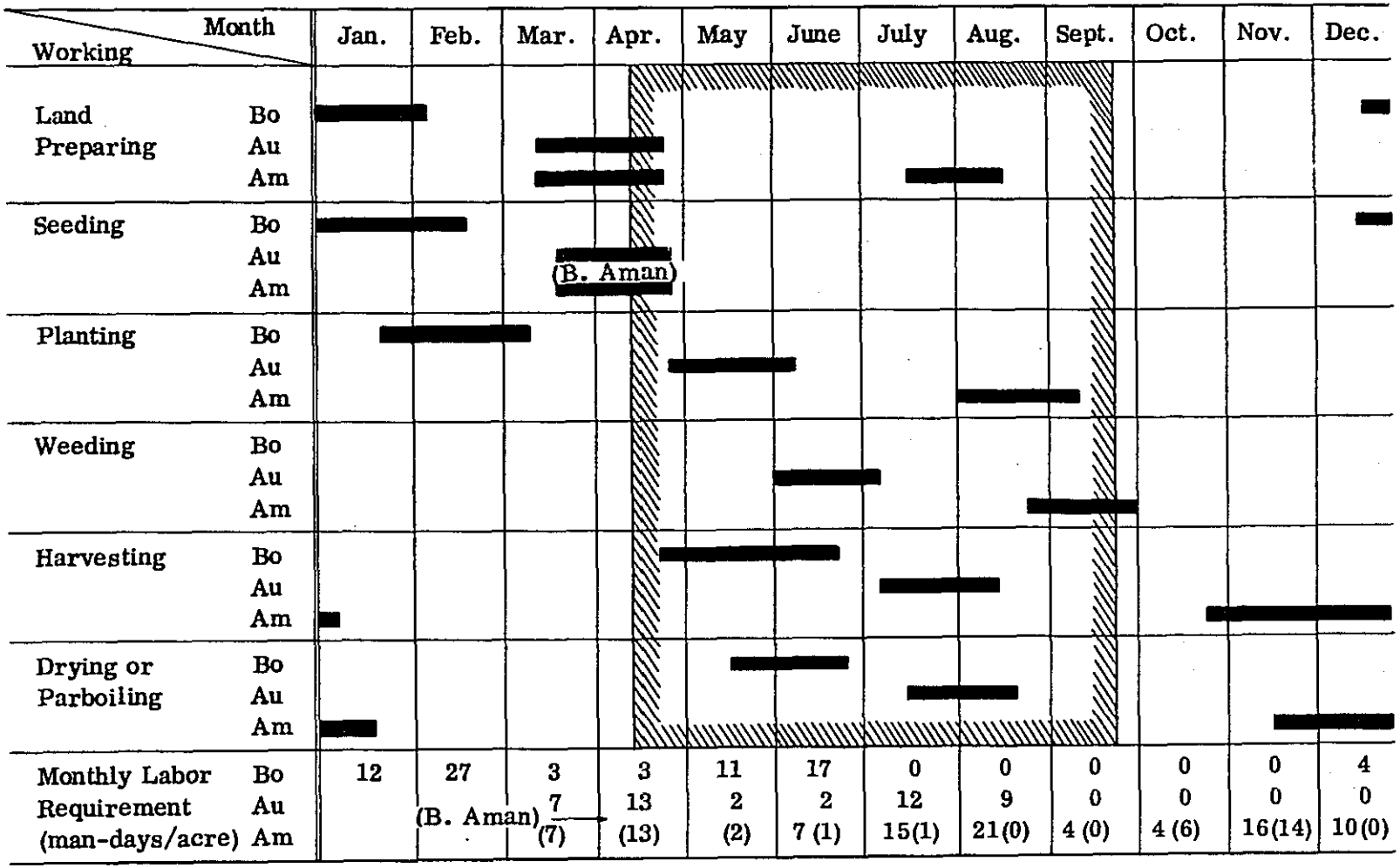
The Table 3.3.2 summarizes the principal seasonal farm working pattern in Bangladesh based on the three types of paddy cropping.

b) Irrigation and Water Supply Equipment

Irrigation has been the area which has received much of the government's efforts in agricultural development. It is estimated that approximately 11,000 deep tubewells (DTWs), 20,000 or so shallow tubewells (STWs) and over 50,000 low lift pumps (LLPs) have been installed in the Country. These power-driven pumps altogether irrigate about 8,500 km^2 or nearly one tenth of the total cultivated land.

Besides, 90,000 hand pumps, known as MOSTIs (manually operated shallow tubewells for irrigation), have been installed for irrigating some 200 km^2. The same hand pumps are extensively used for supplying drinking water. Under the Rural Water Supply Programme sponsored by UNICEF, 250,000 hand pumps have been installed so far for this purpose.

Table 3.3.2 Diagram of Principal Paddy Farm Working in Bangladesh



Source: JICA Team

Note: Bo: Boro, H.Y.V., Au: Aus, Am: Aman, H.Y.V.
Variety total: Bo. 77; Au. 45; Am. 77

Rainy Season

Centrifugal pumps are manufactured locally. Table 3.3.3 gives a list of the manufacturers. Centrifugal pumps produced by them are mostly of 1/2-2 cusec capacity. The total production is 24,000 units per year according to BKB.

Table 3.3.3 Manufacturers of Centrifugal Pumps

Name of Manufacturer	Annual Production Capacity
Bangladesh Machine Tools Factory	5,000
KSB Pump (BD)	5,000
Farmland Engineering	5,000
Prantic Engineering	3,000
General Electric Co. (BD)	2,500
Ittefaq Industrial Corp.	1,000
Balaka Engineering Co. (BD)	1,000
Auto Equipment	500
Krishikol	500
Rupali Engineering	500
Total	24,000

Source: BKB

Hand pumps are also fabricated by local firms. At present UNICEF procures 5,000 hand pumps annually from 8 foundries, 4 in Dacca and one each in Chittagong, Comilla and Khulna. There are a number of other hand pump manufacturers.

Prime movers for irrigation pumps are produced by local firms, mostly on a knock-down basis. The total production capacity of these firms is 5,100 diesel engines of 2 to 18 HP and 35,000 electric motors of up to 30 HP, according to BKB.

Steel tubes for STW and LLP are also manufactured locally by the Bangladesh National Tubes Ltd., an enterprise of Bangladesh Steel and Engineering

Corporation. The company is supplying almost all the requirements of the Country for the steel tubes.

There will be an increasing demand for irrigation and water supply equipment in the coming years. The new Five Year Development envisages to introduce additional 100,000 STWs and 20,000 LLPs during the plan period. There are programmes to install some 500,000 units of new hand pumps under the sponsoreship of UNICEF and USAID. Besides, there will be sizable replacement requirements for existing pumps.

Manufacturing of centrifugal pumps and hand pumps is an area where small scale metal working and light engineering industries can find an opportunity for expanding their business.

c) Agro-processing Machinery

— Rice Milling

There is an estimate that over 80% of paddy produced in the Country is processed by traditional method of husking with 'dekhi', a foot operated mortar and wood pestle and the rest is processed by powered rice mills. According to the Census of Small Industries, 1978/79, there are 12,242 small scale rice mill units in the Country. Altogether employing 59,484 workers, the industry is the most important branch of small scale industries in terms of the number of units and employment. Rice mills of medium/large scale are found in urban areas.

Although there are a number of local small firms which produce components and complete sets of mill equipment for rice as well as other grains, many imported machines, mostly from India and Pakistan, are still being used. Mill equipment commonly used is small 'Engerberg' husking machines of approximately 1/4 ton per hour capacity (larger mills install a number of such machines).

Serious shortcomings of this Engerberg machines are pointed out; the rate of milling losses is high and bran cannot be separated from husk. There is a keen interest in finding machines of more suitable type with a view to reduce the losses and extracting oil from bran. The task does not seem to be simple, however. An alternative fuel may have to be found for parboiling in which a

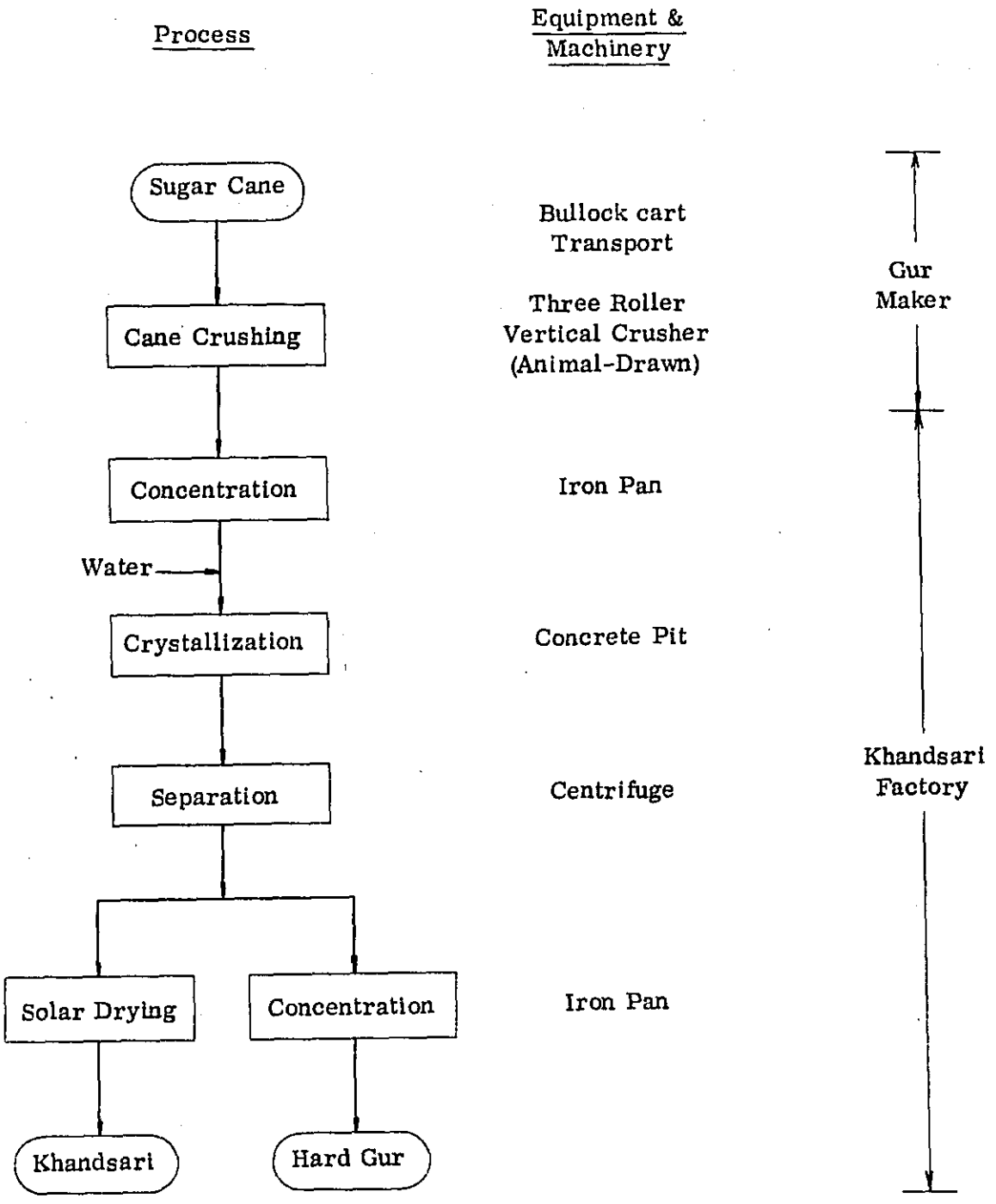
mixture of husk and bran is currently used. A rice bran oil mill requires a good system of collecting bran from a number of small rice mills. Thus improved rice mill equipment cannot be introduced without successful changes in the entire system involving harvesting, parboilding, and collection and distribution. If these questions are solved, the modernization of rice mills will offer another prospective market for small scale metal working and light engineering industries.

— Cane Sugar Production

The sugar industry in Bangladesh consists of the modern and traditional sectors. The modern sector refers to modern sugar mills operated under the Bangladesh Sugar and Food Industries Corporation (BSFIC). The corporation has 15 mills in operation and another one under construction. The total sugar cane crushing capacity of the existing 15 mills is 1,968,000 tons in the 1978-79 crop year and the total sugar production capacity 164,000 tons. The traditional sector produces 'Gur' (concentrated sugar cane juice as traditional sweetening agent) and 'Khandsari' (raw sugar) utilizing simple technology (see Fig. 3.3.2). There are establishments which undertake only the Gur making (hereafter refered to as Gur making units) and other establishments which perform the further processing of Gur and produce Khandsari (hereafter Khandsari factories).

Most of the Gur making units are sugar cane growers themselves. They crush cane with a bullock-driven three roller vertical crusher. The cane juice thus obtained is purified by removing cane dust and other foreign articles manually. The juice is then concentrated by heating in an open pan for several hours. The concentrated juice, is poured in earthen pots for delivery. Gur is marketed as it is for domestic consumption or it is sold to Khandsari factories. The entire production processes described above are typically performed in farming field by 4 or 5 workers. Cane waste and rice straw are used as fuel for heating and boiling the juice. According to the Survey of Cottage Industries 1962 there were 17,881 Gur making units in Bangladesh, in which a total of 63,665 persons were engaged. Characterized as cottage industries, about 3/4 of the work force was family members (more recent statistics are not available).

Figure 3.3.2 Traditional Production Process of Cane Sugar



Source: JICA Team

Khandsari factories buy Gur as raw material and process it further. Gur is diluted with water and stilled to get crystallized, and then fed to a centrifuge for separation. The product raw sugar crystals are sun-dried in an open space and is rolled by a ground-leveler to ensure the uniformity of the grain size. After this process the product, raw sugar, is ready for delivery. Molasses, the by-product of centrifuging, is concentrated by boiling so that it will become solid when it gets coller. The concentrated molasses, 'hard Gur', is sold in the market for use similar to the unprocessed Gur. Khandsari factories are much smaller in number and larger in scale than the Gur making units. As compared to Gur making units they are characterized by factory-type operation and resort to mechanical motive power.

The rate of recovery of sugar content in the cane is 55 - 60% by the traditional method and 90 - 94% by the modern process. There is some possibility to increase the efficiency of the traditional sugar making by slightly modifying the process without investing so much. One such modification is to add a cutting or shredding operation prior to the crushing. The operation is to cut the cane into small pieces in order to facilitate extraction of juice in the crushing operation which follows. It is expected that this modification alone would improve the efficiency of the overall system substantially as evidenced by improved efficiency by about 10% in Japan. In order to introduce the cutting or shredding operation the crusher is also to be altered to a horizontal type. There still exist in Japan sugar mills which are almost identical to the traditional sugar mills found in Bangladesh except that they have a sugar cane cutting or shredding device before crushing. There may be some other improvements which could possibly increase the efficiency of the traditional sugar making industry.

Manufacturing of sugar cane cutting machines or shredding machines for use by the traditional mills can be carried out by small scale metal working and light engineering industries. Production facility for manufacturing the sugar cane cutting and shredding machines can be further utilized for producing paper and wood cutting machines. Thus establishing such small scale industries will open up the road for production of cutleries for industrial uses.

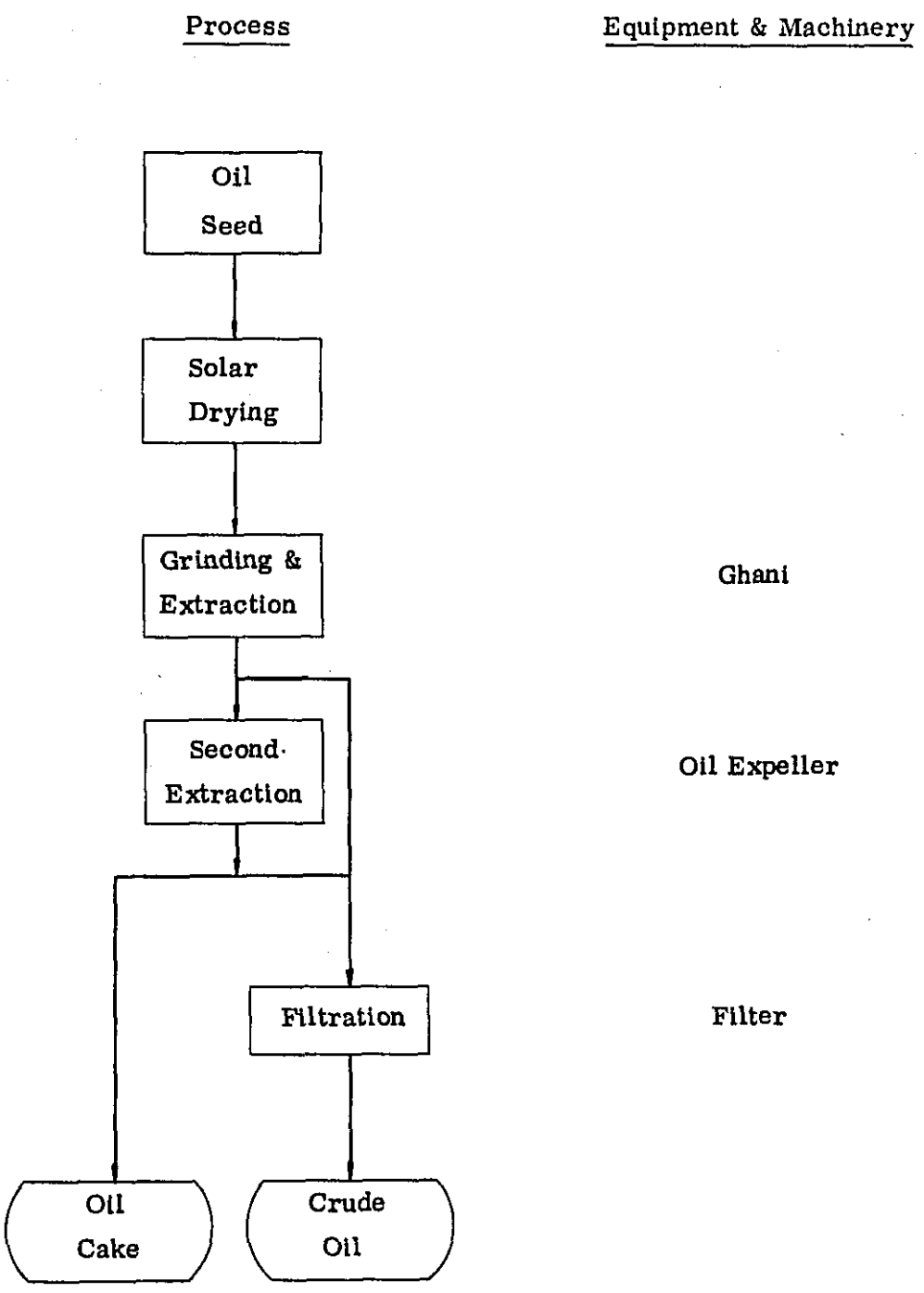
BSFIC considers that a good prospect exist to increase sugar cane production by utilizing land suitable for growing no crops but sugar cane such as a portion of river bed free from water in the dry season. Such land plots exist sporadically and constructing modern sugar mills of the conventional size, say, 1,000 ton per day crushing capacity, is not economically feasible due to high transportation cost of sugar cane collection. Construction of mini modern sugar mills may be an answer. A number of very small mills having crushing capacity of 50 - 250 ton per day exist in several places in the world. Construction of such mills may become economically feasible also in Bangladesh. Equipment of such a mill will cost more than US$1 million, if vacuum distillation process is resorted to, and is beyond the scope of small scale industry (and thus out of the scope of this study). Establishing more traditional sugar mills may also be an answer to cope with the expected increase of cane growing areas.

— Oil Milling

The edible oil milling industry occupies an important position in the cottage and small scale industries of Bangladesh. The Census of Small Industries, 1978/79 has revealed that there are 577 small scale oil mills altogether employing 4,561 persons. According to the Survey of Cottage Industries, 1962 the number of oil mills classified as cottage industries was 25,060 in which 65,280 persons were engaged. The industry was the most important cottage industry of the country after the handloom industry in terms of the number of units (more recent statistics are not available).

Most important oilseed crops grown in Bangladesh are rape and mustard seed. Apart from a few exceptional cases mechanical extraction process in utilized. Production process of conventional oil mills is illustrated in Fig. 3.3.3. After being sun-dried in an open space, oil seed is fed into a machine called 'Ghani'. The Ghani grinds seed with mortar and pestle driven either mechanically or by animal. Oil cake left in the Ghani is then fed to an expeller. The cake is passed through it twice. Some of the factories had a filtering machine by which oil is cleaned.

Figure 3.3.3 Production Process of Conventional Oil Mill



Source: JICA Team

One of the oil mills visited by the Team has 32 ghanis, one expeller and one mechanical filtre. The milling capacity of the factory is 4,800 lb a day on a 3 shift basis, producing 18,000 lb of oil and 3,000 lb of oil cake. Other factories had similar set-up. Most of the machines used by these factories are imported ones but a number of local manufacturers exist which produce components and complete sets of such equipment.

The efficiency of oil extraction of these conventional oil mills can possibly be improved substantially by making inexpensive modifications to the existing process. One possible modification is to introduce a pre-heater in place of sun-drying. Another is to introduce cooking process between the crusher and the expeller. The structure of the crusher could also be modified. Improved production system envisaged here is illustrated in Fig. 3.3.4.

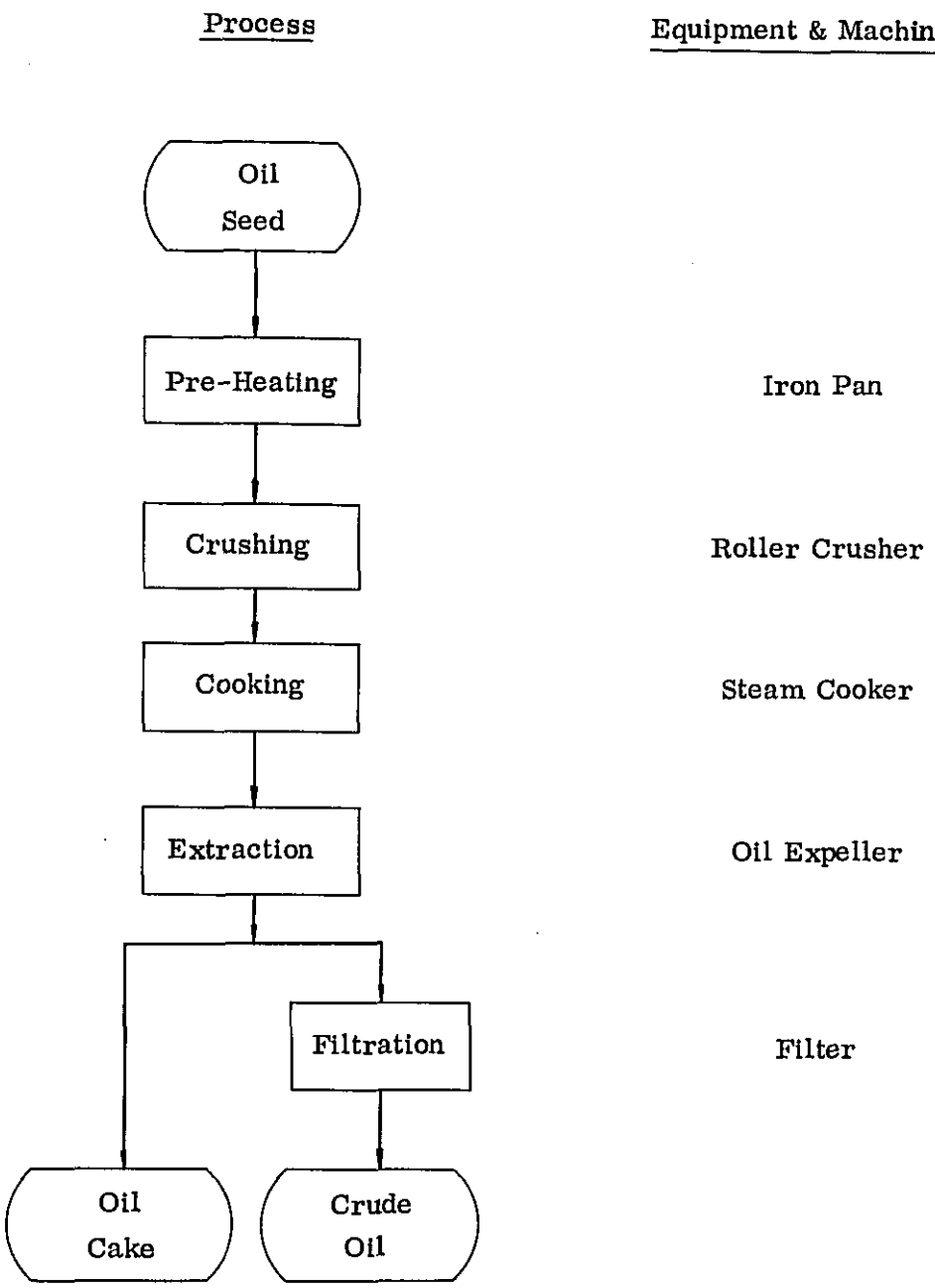
In the simplest form, the pre-heater can be one like a large frying pan, the crusher can be a slightly modified Ghani and the cooker can be one like a large rice steamer.

Crusher, pre-heater and cooker proposed for improving the efficiency of conventional oil mills can be manufactured by small scale metal working and light engineering industries, if appropriate design and production technology could be developed. Commercial production of these machines and equipment by local small scale workshops would have to wait until such development work will be completed by research institutes such as the Sugar Industry Research Laboratory and BSCIR. A few oil mills still exist in Japan which can be a model for such development.

d) Low Cost Transport Equipment.

Transport modes for carrying goods and materials used in Bangladesh are summarized in Table 3.3.4 by source of power and by distance of trip. Traditional means of transportation as those shown in the tables are still extensively used in Bangladesh. Particularly in rural areas, the predominant method of short distance movement of goods and materials is head loading or shoulder loading with a carrying pole. Bicycles, bullock carts and row boats are also common.

Figure 3.3.4 Improved Production Process of Small Oil Mill



Source: JICA Team

Table 3.3.4 Transportation Modes for Carrying Goods and Materials Currently Used in Bangladesh

Source of Power	- Short Distance < 10 km	- Medium Distance 10-50 km	- Long Distance > 50 km
Human Power	- Head loading - Shoulder loading with a carrying pole - Handcart - Bicycle - Rickshaw - Row boat	- Rickshaw - Bicycle - Row boat	
Animal Power	- Bullock-cart - Horse-cart	- Bullock-cart - Horse-cart	
Wind Force		- Sailing boat	- Sailing boat
Mechanical Force	- Motorized rickshaw - Pick-up - Passenger car* - Motor cycle - Boat with outboard engine	- Motorized rickshaw - Pick-up - Passenger car* - Motor cycle - Bus* - Truck - River barge	- Pick-up - Truck - Bus* - Train - River barge - Cargo boat

Source: JICA Team

Note* : These vehicles are often heavily loaded with goods and materials.

Developing appropriate means of rural transportation is very important in this Country since the provision of such transportation facilities constitutes an essential infrastructure pre-requisite for rural economic development. With increased emphasis placed by the government on economic and social development of rural areas, the movement of goods and materials within, to and from rural areas is likely to increase significantly in the near future. Unless appropriate means of transportation are provided, such development may be severely affected.

It is pointed out that in areas where a flood control and irrigation scheme has been implemented, river boat as traditional means of transportation have to be substituted by other appropriate transport equipment.

In view of the production capability of the small scale metal working and light engineering industries and considering conditions prevailing in the rural areas of the Country where roads are narrow and rough, if they exist at all, and very low income level of the population, following discussion will be limited to overland transportation equipment for short distance, to carry light and medium load of up to about 200 kg and driven by muscle power.

As seen in Table 3.3.4, transportation equipment presently used in Bangladesh for above-mentioned purpose ranges from head and shoulder loading to handcarts and rickshaws.

— Bicycles

Bicycles have become fairly popular in towns and villages of the Country and the demand for them seem to be increasing steadily. It is estimated that about 80,000 units of bicycles are sold in Bangladesh annually. There are a number of local firms which manufacture components and assemble complete sets of bicycles. The domestic production can, however, meet only one half of the demand at best and the balance is dependent on imports. Imported bicycles are acknowledged by consumers for higher quality at lower prices. Even for those fabricated locally, supply of certain components such as rims and lugs are dependent on foreign products.

A keen interest is shown by public and private sectors in increasing the production capacity of the local industry to cope with the increasing demand. Needs are felt to improve the quality and to decrease the price of bicycles domestically produced (see 4.1.4). Production of components is also to be promoted.

— Rickshaws

Rickshaws commonly seen in Bangladesh are designed for carrying passengers. While rickshaws are very often used to carry goods and materials in

their passenger seats, there are also varieties of rickshaws designed for load carrying, although the number of such rickshaws is much smaller than that of human-carrying rickshaws. These rickshaws carry load of upto 250 kg or so.

Needs are felt to improve the design of wheels and other parts of the load carrying rickshaws as well as that of the overall structure (see 4.1.4). These rickshaws are fabricated predominantly by the cottage industry sector. While the assembly process will continue to be left in the hand of the cottage industries, small scale industry is expected to supply various components to these assemblers. Most of such components will be common to bicycles.

- Handcarts

Several types of handcarts or pushcarts are found in Bangladesh. Some have wooden wheels and a wooden shaft. Some others utilize rear wheels of a rickshaw. Yet some others make use of wheels and a shaft of a dismantled motorcar. Chasis are usually made of wood and those made of steel are rare. While bullock-drawn carts are also used for human traction, carts designed for human drawing as well as for drawing by bicycles are not common. Wooden components of these carts are, in general, robustly constructed at the expence of excessive dead weight.

It is worthy of attention to develop adequate design of handcarts for use in rural areas. A possible model for such improvement is bicycle trailers extensively used in several countries. By attaching to bicycle frame, they can substitute for the carriage of goods and materials offered by rickshaws. They can also be used for manual operation independent of bicycles and will replace the role traditionally played by head and shoulder loading and conventional handcarts.

Wheelbarrows may find more widespread use in rural areas, if they are designed for reasonably comfortable use in muddy places. It is recommended that public research institutes undertake design develoment of such handcarts and wheelbarrows and promote small scale industries to manufacture them.

e) Spare Parts for Various Machinery

A considerably large amount of foreign exchange is spent annually for importing spare parts and other components of various industrial production facilities in the Country. The amount is estimated to exceed Tk 30 million counting only those imported by the public corporations such as Jute Mills Corporation, Textile Mills Corporation and Sugar and Food Industries Corporation.

As pointed elsewhere, the difficulty of obtaining spare parts in desired quantity and at right timing is one of the main reasons for the low level of capacity utilization of existing production facilities.

Thus, promoting the production of the spare parts and components by local industries is receiving keen attention of agencies concerned with industrial development. If it can be promoted successfully, its economic significance could be substantial through foreign exchange saving, resource mobilization of existing production facilities and constructing a sound linkage among industrial subsectors.

BSCIC is going to take steps to encourage public enterprises to procure spare parts and components from local industries on one hand and encourage small scale industries to embark on manufacturing of such spare parts on the other hand.

Much difficulties are however anticipated in achieving such development. The procuring industries will demand the quality and the price of the spare parts to be comparable to imported ones. They need to be assured the spare parts are supplied in desired quantity at right timing. On the other hand, commercial benefits have to be assured to the manufacturers of the spare parts. Considerable promotional efforts will, therefore, become necessary.

(3) Further Examinations

Discussion in the foregoing paragraphs has concerned with the four of the nine criteria for screening industries. Although remaining five criteria have also been considered through various stages from that of preparing the Table 3.2.2 (long list of industries), there are several questions worthy to make further examinations.

Almost all of the industries so far named have possibilities to satisfy the employment generation criterion and the industrial dispersal criterion. That is, those industries could possibly be established by adopting more labour intensive technology and in a way to disperse a number of establishments to various places of the country. Certain government measures would, however, be necessary so as to induce industries to be established in such a manner.

Most of the industries discussed in the previous paragraphs have industrial and technical linkages only with agriculture and rural sectors. They do, however, have future prospects for enlarging their business to products for use by other industries.

Within the small scale industry sector, several industrial units each specialized in one or two specific technologies could be established independently so that they altogether manufacture some of the products discussed in this section (see Table 3.3.5). In this way, these industries can satisfy the criterion.

Table 3.3.5 shows specific technologies contained in each of the industries discussed in the above. Typical products of the industries which employ forging and heat treatment as major technological components are animal-drawn and manual agricultural implements which have traditionally been produced by local artisans. One would argue that, under the economic and social conditions of the Country, such production activities should be left in the hands of artisans. It can be argued also that modern small scale industries should be promoted in this area. The latter argument has following grounds.

As the economy progresses the demand for products will increase which cannot be easily produced by local blacksmiths, components and implements of power tillers and tractors for an example. Introduction of simple mechanized forging technology is a logical process of technological development. It is also expected that if the products supplied by local artisans at present were produced by the modern industry with improved design and equality but in limited quantity it will stimulate farmers to demand such improved products and artisans to upgrade their products.

Table 3.3.5 Major Technological Components Contained in Production of Selected Products

	Forging	Casting	Sheet metal work and welding	Press work	Machining	Heat treatment	Surface treatment
Hand tools[1/]	o					o	
Hand-pushed weeder			o	o	o		o
Pesticide sprayer			o	o	o		o
Pedal thresher			o	0		o	
Grain dryer			o	o			o
Hand pump		o			o		
Centrifugal pump		o			o		
Sugar mill equipment[2/]		o			o		
Oil mill equipment[3/]		0	o		0		o
Handcart (Pushcart)			o				o
Wheelbarrow			o				o
Bicycle parts		o		o	o	o	o

Source : JICA Team

Notes : Only metal working technologies are dealt with in this Table (Some products need wood working and other technologies).

1/--- Hand and animal-drawn agricultural tools and implements such as spade, hoe, plough and sickle.

2/--- Cane cutter, shredder and crusher.

3/--- Pre-heater, cooker and tank.

Thus it is proposed here that small scale forging industries with some mechanized hammers are promoted which manufacture animal-drawn and manual agricultural tools and equipment. Their production should, however, be limited in quantity so as not to disturb the business of the blacksmith and they should be guided to embark on manufacturing of non-traditional products as soon as possible, such as tractor implements and sugar cane cutters.

The modern forging industry could also manufacture carpentry tools such as saws and planes, industrial hand tools such as screw drivers, wrenches and files.

The iron foundry seems to have a good business prospect as the government places increasing emphasis on installation of more hand pumps and centrifugal pumps. As seen in Table 3.3.5, other products will require some casting components. The industry could also embark on malleable iron casting to produce pipe filting etc. which are imported at present.

These products offer a good business prospects to machining workshops since most of iron casting products require their services. Such independent machining workshops would better be promoted as industrial units separate from foundries because the dusty environment of foundries is not favourable to machining operations.

Industry which contain sheet metal work and welding as the main technological components may deserve special attention. In a more industrially developed society, sheet metal work/welding technology compete with forging and casting as an alternative production method for a certain range of products. In Bangladesh, however, this technology has been somewhat behind of others. Starting from the use of thin plate, say less than 2 mm in thickness, the industry could proceed to products which require thicker plate such as gas cylinders, pressure vessels and chemical reaction tanks.

Press work tends to be regarded as a labour saving technology. But it is indispensable for certain products in order to ensure the accuracy and the uniformity of vital dimensions and its use will increase gradually. For the sound development of this technology, the industrial community should be equipped with the die making capability. Public institutions such as BITAC and BMTF are expected to play the role of supplying dies to small scale industries in the initial stage.

Heat treatment is performed to only a limited extent, except that blacksmiths perform quenching and tempering on most of their products, often with unsatisfactory results. Development of this capability is very important for some of the products discussed in the above.

Surface treatment other than hand painting is also rarely exercised. Other surface treatment technologies such as electro-plating should be developed gradually. It is recommended that surface treatment shops would be promoted not as constituent workshops of large factories but as independent industrial units specialized in the operation. Adequate care should, however, be taken to protect the environment from possible water contaminations by this industry.

(4) Short List of Priority Industries

Table 3.3.6 shows the list of industries which have been selected through the screening processes described above. It is to be noted that the list is a tentative one at this stage, although their economic viability has been examined by making a rough estimation of investment requirements, production costs and the marketability of the products. It is also to be noted that the industries listed in the table are classified by product to be produced and the actual small scale industry units to be established will not necessarily be classified in this way.

Table 3.3.6 Selected Industries for Priority Production

For immediate production	Possible future production
- Spade, hoe, plough etc.	- Screw driver, wrench and file
- Sickle	- Saw and plane (for carpentry)
- Hand-pushed weeder, pedal thresher and grain dryer	- Cane cutter/shredder
- Hand pump and centrifugal pump	- Blades for wood working machinery
- Handcart and wheelbarrow	- Insecticide sprayer
- Pipe fittings	- Oil mill equipment (pre-heater, cooker, tank etc.)
- Spare parts of jute and textile machinery	- Rice mill equipment
- Bicycle components	

Source : JICA Team

2. Technology

(1) General Remarks

One who has had an opportunity to glance at a factory of small-scale metal working and light engineering (MW/LE) industries in Bangladesh would be amazed by the ingenuity of those who are engaged in the business. It is indeed astonishing to see a number of very small metal working and light engineering industries jointly manufacture such relatively sophisticated industrial products as lathes and centrifugal pumps with limited range of production facilities and raw materials. Individually, the smallest of them can be a machine shop which has only one lathe and few ancillary equipment and is manned by the proprietor himself with one or two assistants, a foundry equipped with a small crucible furnace, etc.

Their products and components thereof may appear almost indentical to those produced in more industrially developed countries. A closer look at them would, however, detects fatal shortcomings. The level of the quality of these products will be dealt with later in 4.1.2.

Such shortcomings are widely observed, even in less sophisticated products and even in those manufactured by larger industries. They should not be attributed only to poor production facilities and the difficulties in obtaining proper raw materials. There is a room for rectifying some of the shortcomings by slightly modifying the production facilities and shop floor practices. Problems of specific technologies are dealt with in the sections which follows. In this section problems of general nature will be discussed.

Firstly, the importance of engineering design should be emphasized. Many products of the existing metal working and light engineering industries are dead-copies from similar products of foreign origins and are engineered without conforming to proper technical specifications. In fact, the use of technical drawings is very rare among the metal working and light engineering industries (not only small-scale metal working and light engineering units). When drawings are used they do not specify the tolerance of the measurements, the surface roughness and other important elements.

The practice to use drawings (and the ability to read them) is essential to ensuring the uniformity of products and it is a prerequisite to the promotion of sub-contracting and other forms of linkages between industrial units. It is to be emphasized here that technical drawings and specifications should be adequately prepared so as to ensure that the product is manufactured to serve its purpose within a reasonable range of performance and durability at the minimum possible production cost.

Secondly, much more attention should be given to the importance of production technology. The quality of products and the efficiency of production operations cannot be achieved by a mere combination of adequate production facilities, proper raw materials, the skill of workers, and good technical drawings.

There are many other important elements which are broadly refered to as production technology or know-how. Dynamic balancing of impellers of centrifugal pumps is an example. The need for it may be taught by a text book but the text book does not tell when, how and to what degree it should be done. This comprises an important element of production know-how in manufacturing centrifugal pumps. Any industrial product has such vital points in the production process which, if not managed properly, will result in the poor quality of the product and the low efficiency of production operations.

Many literatures are available which tell about elements of production technologies but their treatment of the subjects is usually too general to put into action at the floor level. For the production of a specific product a literature is not readily available. Foreign collabolation either in the form of direct investment or technical cooperation arrangement is often a quick answer, since such technologies are usually embodied in individual firms. But such an arrangement is difficult to envisage in cases of small-scale industries. Certain involvement at the governmental level is called for.

Thirdly, there is a need for promoting quality consciousness on the side of the parties who purchase the products of small scale MW/LE industries. To refer to an extreme case, the Team have witnessed an instance that agricultural imple-

ments such as hand-pushed weeders and pedal threshers are manufactured by a medium-sized factory in Dacca according to an order from a public agency. The quality of the products is such that they would serve the purpose, at best, for a very short period. The products are purchased by the agency to distribute them to farmers with an aim to promote agricultural production by introducing improved farming technology. Whether the products are given to the users as an outright grant or at a subsidised price they would only discourage the users from adoption of intended improvements.

Forthly, a need for promotion of industrial specialization deserves attention. At present as in many other developing countries, there is a tendency that manufacturing units tend to be self-contained, that is, they tend to undertake all the production processes to produce a final product without resorting to farming out some jobs to outside. As acknowledged, and emphasized elsewhere this tendency would be hampering the upgrading production techniques of small-scale industries and hindering efficient utilization of capital equipment from the standpoint of the individual firm concerned as well as from that of the national economy.

(2) Machining

There exist machine shops of varying sizes in the Country, from very small ones equipped with a lathe together with a bench drilling machine and a bench grinder and employing only few workers to considerably larger ones which employ some hundred workers. If several exceptional cases such as BMTF and BITAC are excluded, these machine shops are not essentially different from each other in terms of sophistication of machinery installed and the nature of products they produce. Larger establishments have more lathes but not many of them have milling machines and other more sophisticated machinery.

There are cases where even very small machine shops operated by proprietors by themselves with a few assistants are manufacturing lathes (by letting out some jobs to other machine shops equipped with a milling machine etc.). Most of small ones, however, are typically undertaking jobbing works to supply others with relatively simple spare parts needed for repairing machines such as rice and other grain mills, oil mills, bicycles, rickshaws etc. Larger establishments tend to

have, beside a machine shop, a carpentry shop, a foundry, a sheet metal work shop etc. and produce finished products such as centrifugal pumps of 0.5 - 1.5 cubic feet per second capacity, hand-pushed weeders, pedal threshers and other simple agricultural tools, or spare parts for various machinery such as those for jute and textile mills.

Technical problems of these machine shops, whether they are large or small in size, arise from lack of quality consciousness and lack of fundamental knowledge of machine shop operation rather than from inadequacy of machinery they have. Fundamental knowledge of machine shop operation mentioned above are as follows, all of which are neglected by most of machine shops:

- use of blue prints as the basis of shop operations and the ability to read them
- use of measuring instruments such as vernier calipers (many machine shops do not have any)
- use of jigs and fixtures to ensure operation of machinery at the required accuracy
- proper choice of tools and materials (although this is often difficult to achieve under prevailing market conditions)
- use of cutting fluid
- installing machine tools on right foundation (many machines are installed on the floor without any ground making)
- lubricating, cleaning and other indispensable works to maintain the accuracy of the machinery and equipment.

A prominent shortcoming of most machine shops is that components of products are not made accurate so as to ensure the interchangeability. That is, components are not machined within a required range of tolerance and surface roughness. Failure in any aspect of machine shop practice pointed above would cause such a shortcoming and very often all these aspects are almost completely neglected. By acquiring such fundamental knowledge and taking adequate care, products of more acceptable quality and durability could be produced with minimum

additional investment.

(3) Casting

The number of foundries existing in the Country is estimated to be around 400. Almost all of grey iron casting foundries fall in either or two categories described below. Rare exceptions are such as those of BITAC and BMTF where up-to-date foundry technology is utilized.

- Foundries equipped with cupolas of 1-3 ton per hour capacity and employing 20-100 persons.
- Very small foundries using 100-200 lb crucibles and employing ten persons at most.

Typical products of these foundries are components of centrifugal pumps of 0.5 - 1.5 cubic feet per second capacity, grain milling machines, vegetable oil milling machines, weighing scales as well as cooking pans, weights for fishing nets, manhole covers, sanitary cisterns and fittings etc. Properties of the products are not substantially different between the two categories of foundries. There are a number of non-ferrous metal casting foundries also, producing small machine components such as roller bearing holders of bicycles as well as many kinds of ornamental goods.

This section deals mainly with grey iron casting foundries of the two categories mentioned above with limited reference to the other types of foundries. Salient features of technologies utilized by these foundries are described below with regard to major stages of casting operation.

a) Moulding Sand and Sand Preparation

In Dacca, foundry grade sand is available from two sources of supply in the suburbs of the city. The sand is not classified by the merchants as such but experienced moulders can identify sand good enough for casting. Sand from a place called Kaliakair has grain size of 100 mesh and sand from Gaffargaon 60 mesh. In the two kinds of sand mentioned above, the grain size is fairly uniform and grain shape is sub-angular. Both are river bed sand but are

naturally clay-covered such that additional binding clay is not required for the first two or three burnings. The SiO_2 content is in the range of 85 - 90% and its refractoriness is fairly satisfactory for use as core sand as well as facing sand.

In most of the other parts of the country, sand of similar quality can be found although it may not be readily available from the markets. Thus the quality of locally available sand should not cause any major trouble in most of iron casting operations. Moulding practice in most of foundries, however, does not match the quality of the sand and slight modifications in moulding practice could significantly improve the quality of castings.

Many foundries add coal dust not only in the facing sand mixture but also in the backing sand. Interviews with managers and foremen of the foundries gave an impression that the coal dust content in the moulding sand mixture is not controlled properly. It was observed in a number of foundries that the moisture of the sand was excessively high due to adding too much water. In almost all the foundries many castings were being mended at the cast surface by filling blow holes and short runs by welding, perhaps suggesting that improper sand mixture causes such troubles.

To old sand local clay is also added. Coal dust and binding clay are usually ground by 'dhekki', a traditional foot operated rice husking device. Mechanical kneading is rarely practiced.

b) Moulding

Moulding method is a typical bedding-in method using one moulding box. Patterns made of cast aluminium are extensively used. Moulding bed is usually not insulated from the ground. Under the climatic conditions in Bangladesh where the relative atmospheric humidity is usually above 80% in the May to October period, such a moulding bed structure makes it impossible to control the moisture of moulding sand within the acceptable level.

In addition, moulding bed of most foundries is not properly protected from the rain. Often the buildings in which the moulding bed is located do not have

proper walls and roof is made of corrugated iron sheets without adequate rain shielding. Thus, it is not surprising to hear a remark of a resident foundry engineer that the reject rate of castings can be almost 100% in the rainy season (casting operation is continued even under such conditions of the rainy season extensively resorting to mending by welding).

In designing moulds, it is pointed out that more adequate considerations should be paid to such aspects as direction of solidification and venting air and moisture in order to ensure better cast surface.

In preparing core sands addition of molasses is extensively used. Some foundries of larger size have core drying ovens of brick structure which are fired by either fire wood or natural gas.

In the sand mixture for non-ferrous metal casting molasses is believed to be the best binder, volumetric ratio of molasses being 15 - 20% of the mixture. For small non-ferrous metal casings which require extra smooth surface, a sand mixture using engine oil as a binder has been developed by BITAC (the technology is known as the Mobil Oil Sand System in Bangladesh). Finishing of castings by this method is almost comparable to die-casting.

c) Melting

As mentioned earlier, existing foundries are equipped with either cupola or crucible furnaces. Other melting furnaces such as electric induction melting system have not yet been installed in the industry. In some foundries a cupola is so constructed that pipeline natural gas can be burnt together with coke in the cupola in order to minimize the cost of fuel.

Design and installation methods of cupolas in most of existing foundries are not satisfactory. The height of the furnace relative to its inner diameter could be increased so as to improve the heat efficiency. The number of tuyeres would better be increased and the size of the wind box could be made larger in order to ensure more uniform flow of air blown into the cupola. It is strongly recommended that in designing cupolas standard specifications already established in industrialized countries be followed. For reference, the standard specifica-

tions layed down in Japan are given in Table 4.1.1.

Most of existing cupolas are of local made. Fire bricks are produced in the Country including the Mirpur factory although their properties are inferior to those made in more industrialized countries. Fire bricks in singly lined cupolas can hold heat only for about five hours and those in doubly lined cupolas for about 15 hours.

In small foundries crucible furnaces are used even for iron melting (suggesting perhaps the difficulties for small machine shops to obtain castings from larger foundries). Crucible furnaces are fired with either coke or furnace oil.

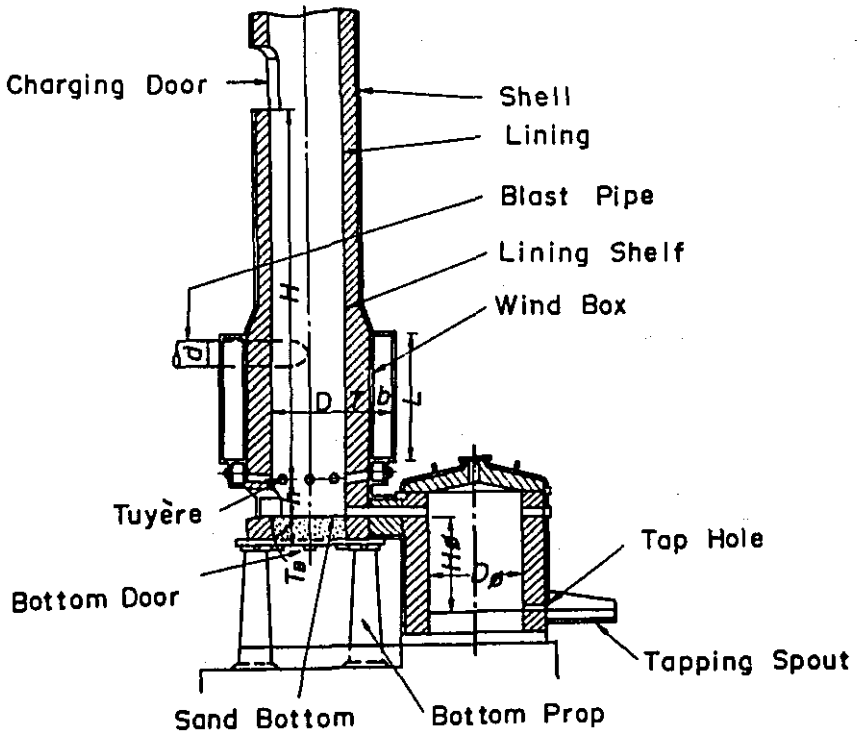
Cake is imported from abroad, very often from India and the Eastern Europe. Import of coke is centrally controlled by the Coal Comptroller. Complaints are head that the Coal Comptroller does not pay the attention to the quality of coke it imports. It is reported that coke for other use, which had very high sulphur and ash content, was imported in the past and used at causing serious troubles in casting operation.

Table 4.1.1 Standard Specifications of Japanese Cupola Furnaces*

Type of cupola	D (mm)	A (m^2)	A/S	H (mm)	H/D	h (mm) Without fore-furnace	h (mm) With fore-furnace	d (mm)	b (mm)	L (mm)	H_F=D_F (mm)	T (mm)	T_B (mm)	'Velocity of dissolution (V/A-121-140) (t/hr.)
1	300	0.071	4 - 9	1,500	5.0	350	-	120	120	480	-	80	80	0.3
2	350	0.096	4 - 9	1,750	5.0	400	-	130	130	520	-	100	90	0.4
3	400	0.126	4 - 9	2,000	5.0	450	-	140	140	560	-	120	100	0.6
4	450	0.159	4 - 9	2,250	5.0	500	350	150	150	600	580	120	130	0.8
5	500	0.196	4 - 9	2,500	5.0	550	350	160	160	640	630	120	160	1.1
6	550	0.238	4 - 9	2,750	5.0	600	350	180	180	720	680	190	180	1.4
7	600	0.283	4 - 9	3,000	5.0	630	375	200	200	800	730	190	200	1.8
8	650	0.332	5 - 10	3,250	5.0	660	375	215	215	860	780	190	200	2.2
9	700	0.385	5 - 10	3,500	5.0	680	375	230	230	920	830	240	220	2.7
10	750	0.442	5 - 10	3,750	5.0	700	400	250	250	1,000	880	240	220	3.2

*: For details of size designation see Figure 4.1.1.

Figure 4.4.1 Specifications of Cupola in Japan



d) Metal Materials

Pig iron is imported from a number of countries. Import is monopolised by TCB with exceptions of import by UNICEF and few others which have special import license. It is reported that the quality of pig iron is satisfactory for the time being with its composition roughly as follows:

- Carbon 4.2%
- Silicon 4%
- Manganese 0.5%
- Sulphur ..... below 0.1%
- Phosphorus ..... 0.1 - 0.15%

(Pig iron imported by UNICEF contains slightly more phosphorus, 0.15 - 0.2%, so as to ensure freer flow of molten iron in castings of thin walls of hand pumps.)

Complaints are heard among foundry engineers that pig iron classified according to different compositions is not made available in the markets. It is also reported that foundries have bitter experience in the past when pig iron of very bad quality was imported and foundry managers are not assured that such cases will not be repeated in the future.

Scrap cast iron is available from markets, classified into two categories, sanitary ware scrap and machinery scrap. It is possible to buy scrap of required composition selectively if a buyer has experties to identify it. Ratio of pig iron and scrap in the charge is usually adjusted, in most cases, on a trial and error basis by machining test pieces. Technique of using scrap steel to adjust the composition of silicon is not practiced. It is reported that many foundries use only pig iron (without adding any iron scrap) when pig iron is cheaper than iron scrap.

Lack of metallurgical knowledge, coupled with undesirable practices in various stages of casting operations as described throughout this section, results in sub-standard castings. Additives such as ferro-silicon and ferro-manganese are not used (in fact they are not available in the market but this is rather not the cause but the result of foundries not demanding such materials).

e) Pouring

Pouring operation is undertaken solely by hand carried ladles, even at larger foundries having cupolas of larger capacity, say 3 ton per hour. Since they do not resort to machine molding (reasonable choice under prevailing price of labour), their moulding bed tends to be very large. In extreme cases molten metal is hand carried to moulds about 100 yards away from the cupola. Decrease of temperature during such transportation can cause defective casting.

Not much safety precausions are taken in the foundries. Workers wearing goggles are never sighted. Ladles containing molten metal are carried by bare-footed workers.

f) Post-casting Operations

Castings after being knocked out of the sand are cleaned, at best, by a wire brush to a minimum extent. Surface appearance of castings seems to be of little concern to most of foundries and their customers. Use of surface cleaning technique such as shot blasting are very rare.

Annealing to relief casting stress is not undertaken. As a matter of fact, most of products of the existing foundries may not require annealing. Some products do need it, for an example lathe beds, and they are seasoned instead in some foundries. One foundry under construction has installed an annealing furnace aiming at producing malleable iron castings such as pipe fittings.

(4) Forging

Forging operations are predominantly performed by blacksmiths. Although some factories have forging facilities beside turning and other metal working facilities, most of them employ hand forging only. According to the TECHNONET/ JICA survey which covered 315 firms, 22 employ forging process and the number of firms which employ forging as their main production process is only one. Of the 22 firms employing the forging technology only 6 equipped with powered press/ hammer. Among these 6 firms only one had the facility with the maximum capacity above 2 tons.

It is envisaged that the demand for products which require power forging operations will increase as the economy progresses. In Japan and U.S.A., some of blacksmiths have developed themselves to modern engineering industries based on their traditional technology. Some of blacksmiths in Bangladesh have high level technology as will be described below and are worthy of attention as modern forging industries in embryo.

According to an estimate there are about 8,000 blacksmithy units in Bangladesh. Almost all of the blacksmiths are members of Karmakar and Boshtomi, hindi castes. Their main products are sickles, spades and other agricultural tools; 'boti' (a traditional kitchen cutlery) and other household utenciles; hammers and other carpentry tools; nails, hinges and other building hardwares; etc.

The entire production process is performed manually. Materials are cut to a size with a hammer and a chisel, and heated and hammered repeatedly until the final shape is obtained. Air blow to the hearth is operated by hand. Water quenching is exclusively used. For finishing only a file is used. Most of the tools and equipment they use are made by themselves.

Materials are mostly scrap iron or steel of various origins such as rail, machine parts and concrete reinforcement bar. Fuel for the forging hearth is either charcoal (often burnt fire wood collected from kitchens) or coal (burnt or rejected coal from locomotives and brick factories). Some blacksmiths use a mixture of both.

Among a number of blacksmiths visited the Team came across with very skillful blacksmiths in Bogra. They are Mr. Shamal Chandra Mohonta and Mr. Babul Chandra Mohonta. The two are brothers and each of them has a workshop of his own. Although they produce a variety of products, they are specially good at making sickles. One of them whose workshop is located in Malati-nagar Bakshihatkhola is 26 years old and has been practicing this trade for 12 years. He employes a young boy as his assistant. The production process of a sickle made from a combination of mild steel and medium-carbon steel is described below (he also makes sickles solely from medium carbon steel).

The production technique using two pieces of steel of different metallurgical properties is known as forgeweld. Mild steel forms the structural part of a sickle and high-carbon steel forms the blade. The beauty of the technique lies in that the mild steel being less brittle stands the impact given to the sickle when it cuts while the hard steel blade gives extra sharpness in cutting operations.

First, a piece of concrete reinforcement bar is heated and flattened. A slit is cut on it and a small thin piece of medium-carbon steel is inserted therein. The resulting workpiece is heated and hammered repeatedly until the final shape of the sickle is obtained. Small saw teeth are cut along the edge of the blade of the sickle with the aid of a file. The sickle covered with finely ground salt is heated and them quenched into water. The hardness of the blade is tested by filing it. If satisfactory, tempering operation follows.

The whole process described above takes about one hour. Mr. Mohonta says that if sickles are produced on a batch basis he can make about 30 sickles a day. Due perhaps to the low level of demand for their sickles coupled with a shortage of working capital, he makes sickles according to individual orders of farmers. Thus the production efficiency is much lower than that could be achieved if sickles are produced by the batch system.

Metal materials are obtained at market in the town. Reinforcement bar costs Tk. 8 per seer (one seer is about 0.93 Kg) and pieces of broken stopper blade of a rice milling machine (medium carbon steel) Tk. 10 per seer. Coke and charcoal are brought by his unemployed neighbors and Mr. Mohonta pays Tk. 12 for a half gallon tin of coke and Tk. 3 per tin for charcoal. The piece of his sickle is Tk. 6 per piece without a handle, which he buys from a nearby carpenter one Taka a piece, if so requested by the customer.

The quality of his sickles has been revealed to be very high by a metallurgical test as shown in Table 4.1.2, but the amount of orders he receives is small. Many farmers of the nearby villages buy cheaper but inferior sickles available in the market. Such sickles cost only Tk. 3 or Tk. 4 but wear out quickly.

Table 4.1.2 Metallurgical Properties of Sickles Made by Blacksmiths

Test Piece No.	Manufacturer	Carbon Content of Steel	Hardness of the Blade
1	Mr. Mohonta of Bogra	0.6% in blade 0.27% in other part 1/	Hv780-800
2	Mr. Mohonta of Bogra	0.46%	Hv544-560
3	Blacksmith of Joydebpur	0.2 - 0.25%	Hv188-196

Source : JICA Team

Note : 1/ --- The forgeweld technique was employed.

(5) Sheet Metal Work/Welding

Quite many firms employ sheet metal work/welding technology. The TECHNONET/JICA survey shows that 129 out of 315 firms surveyed employ this technology, of which 42 firms as their main production process. Products fabricated primarily by this technology include components of bicycles and rickshaws, truck frames for irrigation pump sets, hand-pushed weeders, seed drills, seed treaters, steel furnitures and cabinets, grilles for gates and windows, hinges etc., to name those observed by the Team.

Production facilities commonly utilized by these firms are simple employing manually operated presses, shearing, blanking and bending machines. Power-operated machines are not very common. For welding, only manually-operated electric arc welders are widely used. Welders of other types such as oxy-accetylene welders and spot welders are rare.

Exceptional cases are found in some medium/large-scale firms. These include wire drawing with multipul-stage dies, production of bicycle mud guard with a roll forming machine, automatic production of welded tubes from steel strip, rebuilding of automobile crank shafts with a sub-merged arc welder, etc.

(6) Press Work

The production precesses which employ power presses in more industrialized countries are still predominantly undertaken by manual operations in Bangladesh. According to the TECHNONET/JICA survey, there are 9 firms which have screw press, 20 firms which have crank press and 5 firms which have penumatic/hydraulic press among 315 firms surveyed. The maximum capacity of these power presses is mostly below 100 tons. Blanking dies used are mostly simple ones and the use of compound dies and progressive dies is rare. The Team observed many of dies are not designed and manufactured properly.

Although resorting to manual operations in place of power press work is logical choice under the economic and social conditions of Bangladesh, the demand for products which require the use of power press work is expected to increase. For the sound development of this technology, however, the problem in obtaining

appropriate materials should be solved and the die making technology should be introduced.

(7) Heat Treatment and Surface Treatment

Heat treatment of iron and steel is not widely performed except by blacksmiths, although the quality of some products could be improved by quenching and some others by stress relief annealing. The situation seems to be due to the lack of the quality consciousness of the manufacturers as well as of the consumers, coupled with the difficulty in obtaining proper materials which have good heat treatment characteristics.

3. Quality of Products

(1) Hand and Animal-drawn Agricultural Tools and Implements

Products classified under this heading are hand hoe, spade, plough, sickle etc.. The important function of these products is cutting capability similar to that of cutlery. As sickles are used for cutting herbaceous plants, hand hoe, and spade plough are used for 'cutting' clods of earth. The products currently used in the Country are, however, not designed and produced properly for these purposes.

Prerequisites for a good cutlery are;

i) it cuts clean,

ii) the sharpness of the blade lasts long,

iii) it is designed for use under certain given conditions (the nature of farming operation to be used for, the nature of soil to work with, etc.) and

iv) it has long service life.

The prerequisites iii) and iv) in the above are the questions of designing more appropriate tools and implements and the agricultural research institutions are expected to develop improved design (see 3.3.1). The prerequisites i) and ii) are the questions of production technology and the quality of the products produced in the Country is evaluated inferior from these standpoints.

To cut clean, the blade should be sharpened. But hardly no whetting operation is performed by the manufacturers of these products, whether by blacksmiths or by machine equipped factories. In fact, most of them do not have whetstones. If blades of these products are sharpened by a whetstone, they will cut much more cleaner. Whether such cutting quality lasts long is another question, the prerequisite ii) in the above.

One way of knowing the quality in the light of the prerequisite ii) is to examine the metallurgical property of the blade. The Team asked a metallurgical testing laboratory in Japan to conduct a test on sickles made in Bangladesh. The results of the tests are shown in Table 4.1.2. One sickle made by a blacksmith in Bogra, the test piece No.1, is concluded to be of the highest quality which can possibly be

attained with the material usually available to local blacksmiths. Another sickle made by a blacksmith in Joydebpur, the test piece No.3, is much inferior and cannot be regarded as cutlery.

Although the number of test pieces is very small the test seems to have identified sickles of the highest and the lowest quality available in the Country. Perhaps the quality of sickles made by other blacksmiths falls between these two extremes although the production process may be seemingly similar to that of the test piece No.1.

The quality of spades made by modern factories will not be comparable to sickles of higher quality described above since the material is steel of low carbon content and heat treatment is not performed.

Technological conditions to be met in order to manufacture blades of good cutlery are as follows;

- the use of right materials (the use of materials of uncertain origins should be avoided),
- employing appropriate forging process according to the specifications of the product and the quality of the material,
- applying proper heat treatment according to the quality of the material and the purpose of final use of the product, and
- sharpening the edge of the blade to the right angle and dimensions.

The difficulty in obtaining desired materials is one of the most serious problems industries in Bangladesh are faced with and will be discussed later in 4.2. The forgeweld technique described in 4.4.1 is worthy of attention in this respect since it can economize the use of high quality steel as well as it ensures the extra robustness of the product.

(2) Simple Agricultural Machinery

The following paragraphs deal with the quality of hand-pushed weeders and pedal threshers. Although the Team observed these products of very unsatisfactory quality produced by a factory in Dacca, there are a number of other factories whose

products are of better quality. But there is much room for improvement in those products in order to ensure reasonable performance and durability.

Sliding plates of the weeders can be modified in size and shape so that they can be more easily operated in the paddy field in Bangladesh. It has been observed that the sliding plate tends to go too deep in the mud to such an extent that two persons are needed to operate a weeder, one pushing and the other pulling with a rope. Adjustment mechanism of the sliding plate should also be modified.

In order to stand the excessive force imposed on the cultivator sweep due to such tough use, the cultivator sweeps are made of extra thick steel plate and do not fit closely to the hexagonal bar. They are joined to the shaft by welding but since the hexagonal bar is made of cast iron, a material of low weldability, they come off quite easily. Rivetting of the sweeps are not properly made and cannot stand the force imposed on them. Wood for the handle is not dried sufficiently causing deformation of the handle.

Shortcomings of the pedal threshers are as follows:

- Threshing teeth are drived into the tooth holder by hand loosely. Thus they come off easily.
- The threshing tooth holders and the threshing drum side plate are assembled loosely. Again the durability cannot be guaranteed.
- The threshing drum is not balanced and vibrates excessively when it rotates.
- The shaft of the threshing drum and ball bearings are not fit properly. Thus the smooth rotation and durability cannot be guaranteed.
- Surface of gears is rough and causes unstable rotation.
- Since a return spring is not installed to the foot pedal, kicking action of the foot pedal could hurt the operator.
- As the threshing drum is not covered by outer shield, grains scatter away.

(3) Hand Pumps and Centrifugal Pumps

Major components of hand pumps and centrifugal pumps are made of cast iron. Due to the inferior casting technology described earlier in 4.1.1, these components are of the sub-standard quality. Besides, following shortcomings are pointed out.

Water discharge of hand pumps is not in proportion to long and heavy strokes of the handle. This indicates that the mechanical efficiency of the pump is low. The efficiency could be substantially raised by making appropriate improvements in the quality of cast iron, surface roughness and tolerance of the piston and cylinder, design of mechanical links, prevention of leakage and assembly operations.

With regard to the quality of centrifugal pumps following are major shortcomings:

- The surface of components are very rough due to improper casting operations and little finishing work. Thus the efficiency and discharge capacity of the pump would be much lower than those engineered properly.
- No care is taken at all to ensure that the impeller is dynamically balanced. Thus the durability of the pump can not be guaranteed.
- Each unit of the pump is assembled by making some adjustments to components individually. Thus the inter-changeability of components is lost making the repair and maintenance difficult, if not impossible.

(4) Bicycle, Rickshaw and Carts

From the standpoint of the safety of passengers, the design and specifications of various components of bicycle and rickshaws need modifications. Particular care should be taken in the design and specifications of hub-body, hub-spindle, rim and spoke for rear wheel. At present, these components are made according to same specifications whether the bicycle is used for carrying light or heavy loads. And the strength and the rigidity of the body frame and wheel are not high enough to guarantee the safety of traffic when used for rickshaws which sometimes carry more than 200 Kg.

The quality of many components should be improved so as to compete with imported bicycles. Production system is also to be streamlined in order to decrease the price. Specialization of firms in certain line of components is to be

encouraged for this purpose.

A variety of hand- and animal-drawn carts is found in Bangladesh. While there is a keen interest in developing new transport equipment to replace these and other conventional means of transportation, there is an ample room for improvement in the carts of conventional model. Those made of wood tend to be built robustly at the expence of excessive dead weight. They could be made lighter in weight (thus saving material used and power needed for moving) by reinforcing certain important parts, such as use of metal wheel and rubber tire, use of metal bearing on the shaft, use of metal reinforcements on joints of various components, etc.