introduce push type hand weeders and in some areas, this type of weeder is being used during cultivation.

To exterminate harmful insects, the Government in the past rented power sprayers to the farmers, but due to mechanical maintenance and repair problems, hand sprayers are being rented out at the present time. However, they are currently not very widely used.

(4) Future Trends in Farm Machinery

It is believed that the demand for tillers and for sprayers will increase in the future.

Interest among farmers in tillers stems not only from livestock losses due to floods but also from the annually spiralling cost of feed for draft animals.

If the present domestically produced tillers can be improved to meet the needs of the farmers, there is a good possibility for increase in demand for those machines, as they can be comparatively effectively used in the narrow fields of the country. This would also make possible the effective utilization of idle engines which are now lying unused in warehouses.

The import of medium and large size tractors for soil improvement and deep tillage may be considered, but to use these tractors effectively, it is necessary first to improve farm roads and recontour fields. Consequently the dissemination of such tractors will require considerable more time.

3.3.3 Post-Harvest Processing Facilities

To improve post-harvest processing is equally as effective as increasing rice production, as it reduces post-harvest losses. One characteristic of Bangladesh post-harvest processing is the parboiling of 80 per cent of all paddy harvested. As there are 7,000 to 8,000 small, privately owned parboil and rice-milling plants in the country being operated on a commercial basis, mechanization of parboiling and rice-milling equipment is quite advanced.

(1) Harvesting, Threshing, Drying and Transportation

Harvesting of rice is done by hand sickle. As in Japan, the rice stalks are cut short to the ground. After the rice is harvested, it is field dried or dried in piles, then transported to open yards, to be threshed by hand or by having cattle tread on the paddy. At Comilla, foot operated threshers are being manufactured, but they are not popular as yet among farmers in general. Rice is usually transported manually, with row boats utilized when rice must be transported across rivers to threshing grounds.

After threshing, the paddy is sun-dried in the drying yard, or sometimes passed directly into the distribution system. The quality of the paddy harvested during the rainy season drops because of poor drying, and this contributes to considerable production loss. This particularly applies to the harvest of Boro and Aus which coincides with the rainy season. The loss in paddy between the harvesting and the drying stages using the present methods is comparatively great.

The paddy reaches the consumer through various distribution routes as may be seen in Fig.3-9, and boats and trucks are among the modes of transportation used.

(2) Parboiling Processing

Parboiling is a method of husk processing widely practiced on the Indian subcontinent. Parboiling includes several methods, ranging from the traditional one using bottles, to the continuous steaming method used in the United States, a modern method which is completely automated. The process followed in Bangladesh is intermediate between these two. After soaking, the paddy is steamed in an open steam tank. The heat source is husk, which produces the steam in a simple boiler. Following steaming, the paddy is sun-dried in the drying area.

By parboiling, the incidence of broken rice is diminished, thereby raising the milling recovery. The nutritional value and preservative qualities are also enhanced.

(3) Milling and Storage Facilities

Parboil processing and rice milling facilities are included in the same plant. In Bangladesh, the Engelberg-type rice mill plant is widely used. At the producer level, rice polishing machines using engines for pumps are in evidence in various parts of the country. However, the milling recovery of 50% or 60% of the Engelberg-type of husking and milling machine is quite low. The rubber roll type, which combines the abrasive and friction types of rice milling, raises the ratio from 65% to 70%.

The construction of large-scale rice mills, warehouses and silos is being pushed by private and government organizations. However, large-scale rice mills tend to over-dry and operational efficiency is low. As of January 1983, there were 186 large-scale rice mills in the country with a daily milling capacity of 3,731 tons (8 hour day).

Nos. of Major Rice Mill		Storage Capacity (t)		Processing Capacity (ton/8hrs·day)	
Feb 1982	Jan 1983	Jan 1980	Feb 1982	Feb 1982	Jan 1983
182	183	133,108	142,066	3,731	3,731

Source: Directorate of Procurement, Ministry of Food

Grain storages are properly supervised and managed by the Ministry of Food.

According to the report from the Directorates of Food, the storage capacity of the government silos is aproximately 1,850,000 tons (Feb 1985). Data regarding storage capacities and the amount of grains in stock are shown in the table below.

LSD Capacity (ton)		CSD Capacity (ton)		Silo Capacity (ton)		Total (ton)	
Jan 1984	June 1984	Sept. 1983	June 1984	1983	June 1984	1983	June 1984
1,094,920	1,102,970	438,800	466,230	225,000	227,302	1,758,720	1,846,500

LSD: Local Supply Deposit
CSD: Central Supply Deposit
Source: Directorate of Procurement, Ministry of Food

Data (1985)	Amount in Stock at the End of the Month (1,000t)	Storage Capacity (1,000t)	Storage Utilization Ratio (%)
June	1,049	1,920	55
Aug.	1,020	1,925	53
Sept.	1,064	1,928	55
Oct.	1,010	1,928	55
Nov.	888	1,928	46
Dec.	861	1,928	44
Jan.	798	1,928	41
Feb.	692	1,928	36

Source: Ministry of Food

The amounts of wheat procured by the Ministry of Food are listed hereunder.

PROCUREMENT OF WHEAT BY MINISTRY OF FOOD

FY	Total Production (1,000t)	Amount Procured (1,000t)1/	Procurement Ratio (%)
1977/78	349	11	3.2
1978/79	486	54	11.1
1979/80	810	125	15.4
1980/81	1,075	179	16.7
1981/82	950	13	1.4
1982/83	1,076	24	2.2
1983/84	1,200	122	10.2

Source: Ministry of Food
1/: Include impored wheat

Grain quality is controlled by the Ministry of Food under standards during procurement and storage. The standard specifications shown in Tables 3-31 and 32 apply to grains, rice, and parboiled rice.

(4) Future Trends of Post-Harvest Processing Facilities

The portion of harvest procured by the Ministry of Food is well managed. However, machinery improvement at the private level such as introduction of rice mills to increase milling recovery, and reduction of grain damage and improvement of product quality by using driers heated by the parboiling process could be considered. In addition, application of irrigation engines towards motorization of threshing operations can also be devised to reduce grain loss and improve product quality during threshing.

CHAPTER IV

POST-EVALUATION OF THE PREVIOUS PROGRAM

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POST-EVALUATION OF THE PREVIOUS PROGRAM

Total assistance provided to Bangladesh from 1977 to 1984 under the Program amounted to about ¥19 billion as summarized in the following table.

TOTAL ASSISTANCE PROVIDED UNDER THE AID PLAN 1977-84

Year	Item	Cost (¥million)
1977	Fertilizer, Agricultural Machinery	700
1978	Fertilizer	1,000
1979	Agricultural machinery	2,300
1980	Fertilizer, Agricultural Machinery	2,900
1981	Fertilizer, Agricultural Machinery	2,900
1982	Agricultural Materials/Equipment	3,200
1983	Agro-chemicals, Agricultural Machinery	3,300
1984	Fertilizer, Agricultural Machinery, Agro-chemicals	2,728
Total		19,028

BADC has been receiving commodities under the Program since its inception while the Plant Protection Wing, Ministry of Agriculture and the Directorate of Food, Ministry of Food have only been included in recent years.

Fertilizer and agricultural machinery are the main commodities provided to BADC and these have been used to achieve the high priority goal of increased food production. Commodities provided to the Plant Protection Wing and the Directorate of Food consist of various types of agro-chemicals. Agro-chemicals contributed to the Plant Protection Wing are used for gratuitous pest control services offered to rice farmers, while the planned use of those contributed to the Directorate of Food is controlling pests in the godowns.

4.1 Fertilizer

4.1.1 Supply Record

The amount of fertilizer contributed by Japan to Bangladesh is shown in the following table.

Year	Fertilizer	Quantity (t)
1978	Urea	32,926.75
1979	Urea TSP	5,038.02 4,332.00
1980	TSP	16,908.21
1981	Urea TSP	9,859.154 8,805.031
1984	Urea	23,500.00

Amount for each type of fertilizer is 71,324t of Urea and 30,045t of TSP at total cost of ¥6,255 million.

The percentage of fertilizer consumption in Bangladesh which the above amounts comprise is illustrated in the following table.

Year	Domestic Consumption (t)		Amount Provided by Japanese Assistance (t)		Ratio (%)	
	UREA	TSP	UREA	TSP	UREA	TSP
1978	468,990	174,270	32,926	-	7.0	-
1979	533,315	205,322	5,038	4,332	0.9	2.1
1980	559,765	215,061	-	16,908		7.9
1981	518,775	208,478	9,859	8,805	1.9	4.2
1982	629,058	205,999	-	-	-	-
1983	708,070	260,730	-	-	-	-
1984	831,801	345,675	23,500	-	2.8	-

Fertilizers contributed under the Program are handled by BADC, Ministry of Agriculture and are distributed via the NMS (Fig. 3-2) under BADC jurisdiction. However, as a record is not kept of the type and place of manufacture of imported fertilizers when they are sold to the dealers, it is very difficult to identify the distribution route of fertilizers contributed by Japan. It is assumed that as fertilizers received from BADC are sold by the dealer to the farmers, fertilizers contributed under the Increased Food Production Program are likewise sold and used within Bangladesh.

4.1.2 Effect

As mentioned above, the distribution route for fertilizer contributed by the Program is not identified. It is possible, however, to estimate the effect of fertilizer contributed by Japan from analysis of fertilizer consumption for each crop in Bangaldesh. Application effectiveness (ratio of yield increase to application) for each type of crop is shown in Table 4-1.

On the basis of the said table and assuming that fertilizer (urea 71,324t, TSP 30,045t) contributed under the Program is only used for rice cultivation, fertilizer contributed by Japan is estimated to result in an increased yield of about 560,000t. Moreover, the Benefit/Cost (B/C) ratio of income derived from increased yield and expenditure for fertilizer (CIF price in Bangladesh) in 1981 and 1984 is 2.73 and 4.34, respectively. If the BADC standard selling price of fertilizer in Bangladesh is used, the B/C ratio is 5.49 and 6.19 respectively.

Comparison of the separate B/C ratio of urea and TSP however, reveals that the B/C ratio of urea is much higher than that of TSP. The B/C ratio for urea alone was 3.27 in 1981 and 4.34 in 1984 at CIF standard price and 5.84 and 6.19 at domestic sale price, while that for TSP was only 2.20 in 1981 at CIF standard price and 5.05 at domestic sale price. This fact indicates that sale of fertilizer contributed under the Aid Plan is fairly heavily subsidized. At the same time, it is also estimated to have a substantial effect on increasing crop yield (Table 4-2).

The types of fertilizer selected under the Program are considered appropriate for Bangladesh as the Government is actively promoting extension of urea and TSP application. At the same time, the Government is also endeavoring to protect domestic fertilizer production by limiting imports of NPK Complex Fertilizer and other fertilizers.

4.1.3 Price

The Government of Japan contributed 23,500t of urea to Bangladesh in 1984 under the Program . As the price of TSP fertilizer for that year was too high, the Government of Bangladesh withdrew their request for TSP. Consequently, the funds allocated for TSP remained unused. Table 4-3 shows the price of urea and TSP fertilizer contributed by main donners and also compares the import price, the subsidization rate and the domestic sale price of fertilizers in Bangladesh.

The subsidization rate for average subsidy of urea contributed from Japan was 125 which is slightly high. In contrast, the subsidization ratio for TSP contributed by Japan on the other hand, was much higher than 200. In terms of CIF price, comparing with the average price of TK5,041.97/t, the price of TSP fertilizer contributed from Japan is as high as about 1.4 times of that of the other donners. BADC is required to raise the counterpart fund equivalent to the same amount of CIF price of contributed fertilizer under ERD regulation. Therefore the reservation of the counterpart fund constitutes a greater burden for BADC in the use of TSP from Japan because of a higher CIF price than that of other countries assisting under the Program. It is assumed that the Government of Bangladesh withdrew their request for TSP on the basis of this price differential.

Although some decrease in the yen base price of Japanese fertilizer is anticipated due to cheaper import price for raw materials, it is still projected that Japanese fertilizer will remain somewhat more expensive on a dollar base than the same product from other countries.

4.2 Agro-Chemicals

4.2.1 Supply Record

Provision of agro-chemicals under the Program was begun in 1983, and consequently, such provision has been made only twice so far. A total of about 100t was contributed to the Plant Protection Wing of the Ministry of Agriculture in 1983 at a total price of ¥130 million, and another 100t to the Plant Protection Wing and 10t to the Directorate of Food, Ministry of Food in 1984 for a total price of ¥140 million. As shown in Table 4-4, agro-chemicals contribuled from Japan were all pesticides and were 60 tons of ULV pesticides for areal spraying for 1983 and 1984.

4.2.2 Utilization of Agro-Chemicals Granted

(1) Plant Protection Wing

1) Usage Record

Data concerning utilization of agro-chemicals received by the Plant Protection Wing in 1984 are not yet available. Utilization of those contributed in 1983 however, is as described hereunder.

utilization of agro-chemicals are divided into to methods. One is grand spraying and the other is arial spraying. Agro-chemicals contributed under the Program are applied free of charge to the farmers. DDVP 100EC and Phenthoate 92 ULVC were not utilized; however, more than 70% of the other chemicals provided were utilized. Total utilization amounted to 56% of the chemicals received. (refer to Table 4-5).

The Plant Protection Wing requested various types of agro-chemicals from the Government of Japan in order to control rice pests such as the Rice Hispa, Green Leaf Hopper, Stemborer, Rice Ear-cutting Caterpillar and Brown Plant Hopper. The characteristics and application of each chemical are delineated below.

MIPC: Carbamate insecticide

Use: Control of Leafhoppers and Planthoppers of rice plants; long lasting effect; systematic insecticide. As permeation into the rice plant is good, application to the water surface is effective. Has minimal effect on spiders which are natural preditors of rice pests.

Application rate: 2.13kg/ha for 75WP

Diazinon: Organophosphorus insecticide

Use: Control of rice stemborers, leaf miners and cutworms of rice plants as well as many other pests. Can be applied to the stem, soil or water surface.

Application rate: 1.68kg/ha for 60EC

Fenitrothion: Organophosphorus insecticide

Use: Control of rice stemborers, fruit crop and vegetable pests.

Application rate: 1.12kg/ha for 50EC

Phenthoate: Organophosphorus insecticide

Use: Control of rice stemborers, green leafhoppers, planthoppers and rice bugs. Although can permeate, it is mainly used as direct contact insecticide. Fast acting but not long lasting.

Application rate: 2.4kg/ha for 50EC

DDVP: Organophosphorus insecticide

Use: Control of rice ear-cutting caterpillar, aphids and mites. Short term effect; can be used almost until harvest. Due to short term effect, should be applied where outbreak occurs, and if any insects survive should be re-applied about 5 days later.

Application rate: 0.56kg/ha for 100EC

Based on the above application data and unit area application rate, the benefit area of each agro-chemical is 4,272ha for Diazinon 60EC, 3,158ha for Phenthoate, 13,393ha for Fenitrothion 50EC and 45,614ha for Fenitrothion 98ULV for a total benefit area of 66,437ha (Table 4-6).

About 44% of agro-chemicals contributed in 1983 are still in storage as of March 1986; however, as the storage limit for agro-chemicals is generally 3 years, disposal of warehouse stock is not considered urgent. The reason for the large amount of agro-chemical stock for aerial-spray is the availability of only one airplane for spraying.

Therefore agro-chemicals for aerial-spray should not be supplied until this limiting factor is eliminated. On the other hand, agro-chemical stock for ground spray are being used at a regular and steady pace.

2) Effect

The effect of agro-chemicals, which is usually counted a part of modern field husbandry together with fertilizer, irrigation and so on, is quite difficult to quantify independently. Nevertheless, a rough quantification could be made as follows:

In the case of Fenitrothion 50 EC, dosage is 1.12 lit/ha. Consequently, cost is 276 TK/ha. Boro yield is 2,410 kg/ha (1984/85), the average yield for all rice varieties is 1,420 kg/ha, and the price of paddy is 5.2 TK/kg. BRRI estimates the crop damage by insect pests to be 16~20%. Considering this, if 5% of rice yield is saved through the application of agro-chemicals, the benefits can be calculated as:

Boro: 2,410kg/ha × 0.05 × 5.2 TK/kg=626.6 TK/ha

Average for all
types of rice: 1,420kg × 0.05 × 5.2 TK/kg=369.2 TK/ha

The above benefits are greater than the 276 TK/ha investment for agro-chemicals. Although the above case study applies a crop loss prevention of 5%, it can be seen that even if prevention of a 2.2% crop loss in the case of Boro, or 3.8% in the case of the average for all types of rice is achieved, usage of Fenitrothion 50EC can then be considered effective.

The same applies for other agro-chemicals. As unit costs for agro-chemicals as shown in Table 4-6 are less than 5% of paddy yield, it may be concluded that the agro-chemicals granted are economically effective.

(2) Ministry of Food

Only Fenitrothion (10t) was contributed to the Ministry of Food in 1984 under the Program. Due to delays caused by various conditions in implemetation of the Program in 1984, the agro-chemicals had just been loaded onboard ship as of March 1986 and had not yet reached Bangladesh. Accordingly, in luck of actual results, only the utilization plan can be described.

Fenitrothion can be applied to control fruit and vegetable pests as well as for rice pests, however, the Ministry plans to use it to control pests which destroy stored rice in the godowns. In addition, the Ministry plans to make and distribute an application manual for insecticides including Fenitrothion to extend their utilization. The manual is summarized below.

1) Application of Contact Insecticides in Godowns

a) Effect:

Fenitrothion will prevent insect damage for 3-4 weeks after application to the surfaces of the ceiling, floor, walls, grain bags, etc. in the godown.

b) Application strength and method:

Dilute Fenitrothion 50EC with about 50 parts water. Spray inside the godown by a manual pump type or motorized knapsack sprayer. First spray the top of the piles of bags, the ceiling and the upper part of the walls. Next spray the sides of the bags, and finally spray the platform, the lower part of the walls, the floor, etc. The nozzle should be held about 30cm away from the object to be sprayed for the manual pump type and at least 1.5m in the case of the motorized knapsack sprayer.

c) Application interval:

Fenitrothion should be applied once every 3-4 weeks.

d) Other:

Sprayers should be thoroughly washed after use and then stored. The workers should also thoroughly wash their hands, face, feet, etc. Remaining chemical should be stored away from food stuffs in a cool dark place.

The Directorate of Food plans to utilize Fenitrothion for pest control based on the method described above. In 1985 the Directorate requested Methyl Bromide for use as insecticide.

2) <u>Study of the Fenitrothion Utilization Plan</u>

Once a month 500mg a.i./m^2 of Fenitrothion must be sprayed in all Dhaka type CSD crop godowns to protect stored rice. There are 12 Dhaka type godowns in the country with a total capacity of 450,000t. The specific gravity of bagged unhusked rice is 0.5 and the dimensions of one pile of bags are 3m(H)x10m(L)x20m(W). Insecticide must be applied to the top and sides for a total of 5 surfaces and thus the total area for application is 570,000m^2. Accordingly the amount of insecticide required per application is 570kg, or 6.84t annually.

Total capacity of LSD throughout the country is 1,000,000t. If insecticide is applied in the same way to all LSD, and grain is stored as in the Dhaka type godown, the required amount of insecticide is 15.2t/year. If the required amounts of insecticide for both the CSD and LSD are combined, the total required amount is 22.04t/year. The Ministry of Food utilized 13t/year of direct contact insecticide in 1985. From the above, it can be concluded that the 10t/year of Fenitrothion contributed in fiscal year 1984 of the Program, delivery of which was delayed, can still be effectively utilized.

The economical effect of Fenitrothion is studied below. The Fenitrothion dosage per CSD is 6,840kg and the cost is estimated at 1,683,385 Taka (6,840kg x Taka 246), and the total storage capacity of a CSD is 450,000t. The loss by insect pests in godowns of the Ministry of Food is estimated at 3.75% per year. Considering this, if the reduction of the grain loss (caused by insect pests) is estimated at 1%, namely 4,500,000kg or 23.4 million Taka, the resultant benefit is 14 times the Fenitrothion investment (1,683,385 TAKA). As a result it is concluded that the use of agro-chemicals is economically viable.

4.3 Agricultural Machinery

4.3.1 Actual State of Provision

Out of the total sum of ¥19 billion provided in the past under the Program, agricultural machinery accounted for ¥12.2 billion or 64%. As may be seen from Table 4-7, excluding ¥70 million in 1984 for spare parts for trucks, the rest was for pump engines, pipes for wells, engine repair and spare parts for irrigation equipment.

The Program consisted mainly of irrigation equipment. In particular irrigation engines and spare parts accounted for 96.6% of the total outlay. The sole receiver of the above increased food production assistance was the BADC. The pump engines imported by the BADC, BKB, and BWDB are shown in Table 4-8. Although data are partially incomplete, and precise figures are thus not available, the total number of engines imported beginning in 1978 to the present are compared with these imported specifically for the increased food production assistance in the table below.

(Unit: Number)

1978 - 1983	DTW		STW		LLP		Total	
	BADC	Total	BADC	Total	BADC	Total	BADC	Total
A. Actual Imports	356	356	118,994	136,452	10,127	10,922	129,477	147,730
B. Increased Food Production Program	50	50	84,372	84,372	3,450	3,450	87,872	87,872
B/A x 100 (%)	14.0	14.0	70.9	61.8	34.1	31.6	67.9	59.5

From the above, it may be seen that a little under 70% of all engines imported by BADC and a little under 60% of all imported engines were for increased food production assistance, and that the ratio accounted for by this activity is accordingly extremely high.

4.3.2 Status of Engine Use And Maintenance

(1) Status of Engine Use

All engines provided under the Program were received by the BADC. The BADC matches the engine with locally produced pumps and where necessary attaches them to a common or movable base and in the case of wells attaches the necessary pipes and strainer and sells them to farmers as a set.

The farmer sets up the pump and performs the well-digging, and pays the BADC for the engine in cash. A farmer who cannot pay in cash joins a users association with other users in order to raise a bank loan. The bank examines the loan request and pays the BADC the amount for the engine, even going as far as to install the pumps.

From 1 July 1975 to 31 March 1986, the number of shallow tubewell pumps sold and the method of sale are shown below. (BADC data)

Cash	553 units
Bank loan	595 units
BRDB loan	3 units
Total	1,151 units

The summary of sales value of various pumps for BADC under the Program are given below: (BADC data)

Low lift pump

Capacity 1 cusec (28.3ℓ/S) TK20,815 -- TK22,655
9 HP class engine

Capacity 2 cusec (56.6ℓ/S) TK26,680 -- TK28,750
18 HP class engine

Shallow tubewell pump

6 HP class engine

With pipes and strainer

Pipe length 18 m TK28,270 -- TK30,822

Pipe length 46 m TK34,547 -- TK37,099

2,200RPM shallow tubewell pump sold at discount as a 0.5 cusec (14ℓ/S) low lift pump	TK14,715
Second-hand low lift pump	TK7,100

Engines provided to BADC in the past and which are in stock are listed in Table 4-9, showing low lift pumps and in Table 4-10, showing shallow tubewell pumps. Shallow tubewell pumps were imported in quantity in the past and as sale thereof commenced from 1984, those in stock are not inventoried.

The actual sales of low lift pumps between 1 July 1985 and 31 March 1986 are as follows according to BADC data.

New units

1 cusec	661 units
2 cusec	1,390 units
Subtotal	2,051 units

Second-hand units

1 cusec	317 units
2 cusec	4,153 units
Subtotal	4,470 units

The number of low lift pumps in stock as of 31 March 1986 were new units 7,715, and used units 10,235. The used low lift pumps mentioned here were units the BADC rented to farmers who were unable to purchase pumps. However, this rental system was abolished on the recommendation of IBRD/IDA. Since 1981 low lift pumps have been sold to farmers under the Sale Programme. This program was to have concluded in 1985 but has been extended to include the Boro season for 1986.

The rental rates are as follows:

Boro season

1 cusec TK2,300/season + TK100 (Guarantee money)

2 cusec TK3,600/season + TK100 (Guarantee money)

Aman season

1 cusec TK1,100/season + TK100 (Guarantee money)

2 cusec TK2,300/season + TK100 (Guarantee money)

The low lift pumps in stock including both new and used ones totalled 17,950 units. This number achieves the goal for the Third Five Year Plan and at this point, all that would be required in the future would be to take care of new demand.

The number of shallow tubewell pumps sold between 1 July 1985 and 31 March 1986 was 1,151 units as previously noted. The number in stock as of 31 March 1986 was 58,945 units. Of this number, those of 2,200 RPM have experienced difficulties in various parts of the country due to the use of cheap, unsatisfactory lubricants and other maintenance problems. The use of these pumps has subsequently not received widespread support from farmers and they remain largely idle. BADC plans to drop the engine revolution from 2,200 RPM to 1,500 RPM and to sell the pumps as 0.5 cusec low lift pumps. But as there is now a glut of low lift pumps, this program is not progressing.

Table 4-11 shows the results of the analyses of diesel engine oil sold on the market in Bangladesh .

Besides the above, if the 24,800 units which were delivered under the 1983 Program are added, the total would come to more than 30,000 units in stock. These would probably be steadily sold under the Third Five Year Plan. However, although some 24,800 shallow tubewell pumps were supplied in comparatively recent times, present stocks of shallow tubewells account for almost 50% of all this type of pump imported by BADC since 1978. (Although it may be noted that some 24,800 units were received relatively recently.). As for low lift pumps, stocks 76% of new machines are currently idle (in stock). Consequently, it is hoped that BADC exercises careful judgement in the future import of engines and pumps.

Pump engines are effectively utilized by farmer. In particular, deep tubewell, shallow tubewell and low lift pumps were operating full time in April when the team concluded field survey in Bangladesh. In terms of construction and operating expense deep tubewell pumps are the most costly of the three types. Nevertheless, according to the BRRI annual report in 1983, deep tubewells exhibited sufficiently favorable benefit/cost ratio.

(3) Maintenance of Engines

Fig. 4-1 shows the national network of BADC Workshops. The Central Workshop indicated has not yet been established. The regional workshops supervises the Zonal orkshops and Upa-Zila Workshops.

Table 4-12 shows the personnel structure of the regional workshops and the Zonal Workshops. The Upa-Zilla Workshop generally consists 3 mechanics and contains mainly hand tools and is engaged in the repair and maintenance of farm machinery.

The BADC workshop system is comparatively well organized. Regional orkshops conduct staff workshops and short-term farmer training courses.

4.4 Counterpart Fund

In order to clarify the status of accumulation and utilization of counterpart funds, field survey was undertaken of organizations receiving assistance under the Program namely, the Ministry of Agriculture, the Ministry of Food, BADC, the External Resource Division responsible for co-ordinating the Program and the Bangladesh Bank at which the counterpart funds are deposited. At the same time offical requests for information and data were made to these organizations. As a result of this questionnaire, the following points have become clear.

4.4.1 Method of Banking Counterpart Fund

(1) Counterpart funds received from various organizations are deposited in Government Deposit Account No. IV of the Bangladesh Bank. In this account are deposited not only the counterpart funds for Japanese assistance, but counterpart funds for assistance from other countries and from international organizations as well.

(2) The amount which the Finance Division of the Ministry of Finance of the Government of Bangladesh has instructed the receiving agency to deposit as the counterpart fund is not two thirds of the FOB value, as spelled out in the exchange of official notes, but 100% of the CIF value.

(3) The receiving agency is obligated, prior to issuing its Authorization to Pay (A/P) at the time of procuring the capital equipment provided under the assistance programme, to file an undertaking to deposit counterpart funds at the bank designated to handle the A/P.

(4) The period in which each receiving agency must make their counterpart fund deposits is fixed at within two years of receipt of capital equipment.

The acutal state of the banking of counterpart funds is shown in the flowchart (Fig. 4-2).

The method used by the Government of Bangladesh for banking the counterpart funds is to put all these funds for assistance, including those from Japan, in one account with the Bangladesh Bank as stated above. This makes it difficult to specifically distinguish the counterpart funds for the Program from the rest of the deposits. The explanation given by the Government of Bangladesh was that if the Japanese counterpart funds are separated, the same will have to be done for the funds of other countries. Such an exercise would be beyond the capacity of the Government of Bangladesh, both physically and personnel-wise. Upon analysis of the data submitted by the Bangladesh Bank and by the ERD, first it appears that the value of the counterpart funds does not approach the two thirds of FOB value agreed upon in the Exchange of Notes. The criterion used by the Bangladesh side in determining the counterpart fund is not clear.

4.4.2 Utilization of Counterpart Fund

The counterpart funds deposited in Government Deposit Account No. IV of the Bangladesh Bank are used for the local currency component of the Annual Development Plan (ADP). The Annual Development Plan as shown in Table 4-13 is embracing all sectors included 760 main projects in 1985/86, of which 93 were technical assistance projects. Among these the sectors concerned with the Program are only two, namely Agriculture and Flood Control and Water Resources. The ratio of these two sectors against the total is 16%, or approximately 63 million Taka.

Consequently, once the counterpart funds are allocated in the budget of the ADP, it is impossible to determine on what specific project they are being used. If the Japanese Government were to designate beforehand projects for which the counterpart funds eminating from Japan are to be used, this would create difficulties in the execution of the ADP budget for the Government of Bangladesh.

For the two reasons cited above, the Government of Bangladesh requested that it not be obligated to report to the Japanese Government regarding utilization of counterpart funds.

CHAPTER V

BASIC DESIGN OF THE PROGRAM FOR 1985

CHAPTER V

BASIC DESIGN OF THE PROGRAM FOR 1985

5.1 Review on the Requested Items

5.1.1 The Requested Items

The Government of Bangladesh has submitted its request for the following commodities for the Program in FY 1985.

LIST OF COMMODITIES/EQUIPMENTS REQUIRED
UNDER THE PROGRAM IN FY 1985

Sl. No.	Items	Unit	Quantity
BADC			
1.	DTW Commissioning Material	Nos.	1000
2.	Spare parts for DTW, LLP and STW Engine	Lot	1
3.	Floating Pumps with Accessories	Unit	12
4.	Repair/Tug Boat	Unit	4
5.	Jeep	Unit	4
6.	Inspection Boat (40HP)	Unit	4
MOA, PPW			
7.	Pesticide	M/T	100
BWDB			
8.	Submersible DTW Pump	Now.	60
9.	Vibrating Pile Driving Hammer	Nos.	2
10.	Dragline	Nos.	2
11.	Bulldozer (200HP)	Nos.	4
12.	Wellpoint Pump and Accessories	Nos.	10
13.	Shearing Machine	No.	1
14.	Bending Machine	Nos.	2

Sl. No.	Items	Unit	Quantity
15.	Press Machine (300t)	No.	1
16.	Spare parts for Equipment	Lot	1
17.	Spare parts for Vehicle	Lot	1
18.	Sheet Pile	M/T	100
19.	Rail-mounted Tower Crane	No.	1
	Ministry of Food, Directorate of Food		
20.	Trucks, (7-8 Tons)	Nos.	40
21.	Moisture Meter	Nos.	500
22.	Paddy Dryer	Nos.	10
23.	Fumigant	Ton	100

The items requested for each respective agency in Bangladesh and their intended use are summarized hereunder.

BADC:

Floating pump and related equipment for exploitation of surface water for irrigation to increase productivity.

Engines for deep tubewells and spare parts to exploit groundwater for irrigation and thereby increase productivity.

BWDB:

Submersible pump for deep tubewell, construction material and equipment for the Kurigram Project and sheet piles to promote agricultural development in depressed areas, increase employment through intensive farming, and reduce poverty.

Plant Protection Wing:

Agro-chemicals for pest control to be provided free of charge to farmers.

Directorate of Food:

Agro-chemicals to reduce losses occuring during storage in the godowns after purchase.

The appropriateness, quantity and quality of the items requested, excluding floating pumps, were reviewed and the results are summarized in this chapter.

5.1.2 Agro-Chemicals

Agro-chemicals play an important role in preventing yield losses arising from pests and are particularly essential in Bangladesh where the climate fosters year-round propagation of insect pests and host plants. At present Bangladesh is entirely dependent upon imported agro-chemicals. In order to promote widespread use, the Government does not exact an import tax on agro-chemicals; however, the price is still too high for the average farmer and consequently, although the demand continues to increase, agro-chemicals can not be widely applied.

In view of the above situation, the Plant Protection Wing of the Ministry of Agriculture offers gratuitous pest control services wherever a major outbreak occurs. The Ministry of Agriculture first requested agro-chemicals for this purpose in the 1983 fiscal year of the Aid Plan. The request presently under review is their third such request.

The Ministry of Food submitted their first request for assistance under the Program in 1984 and the contents of the request consisted of contact insecticide for pest control in the godowns. The present request is their second and consists of fumigants for the same purpose.

(1) Plant Protection Wing

The Plant Protection Wing has requested 100t of insecticide for gratuitous pest control services offered to farmers. The type of insecticide however, has not yet been decided as the agency felt a thorough review of pest outbreak conditions and expenditures for agro-chemicals should be conducted before procurement.

1) Requested Quantity

With regards to the volume required, the demand for agro-chemicals from the perspective of distribution area is still quite high.

2) Agro-Chemicals for Aerial Spray and Ground Spray

The agro-chemicals required can be broken down into two types according to application method; namely, those for aerial spraying and those for ground spraying. Judging from utilization of agro-chemicals contributed in the past, the rate of consumption is higher for the ground sprayed type. A large quantity of previously contributed aerial sprayed agro-chemicals have not yet been utilized and it is thought that this is due to lack of airplanes and aerial spraying equipment. The area which can be covered by the existing number of airplanes was studied as discussed hereunder.

The Plant Protection Wing owns only one airplane for aerial spraying. Approximately 1.3ℓ/ha of ULV agro-chemical is applied by the plane and it can cover an estimated area of 400ha/day. If the amount of agro-chemical sprayed per day is 0.88MT and aerial spraying is conducted a maximum of 35 times a year, then maximum annual consumption of aerial sprayed agro-chemical is 30.8t with present equipment capacity.

Of the 100t of agro-chemicals contributed each year in 1983 and 1984, aerial sprayed agro-chemicals comprised 60t. As the spraying capacity is only 30t/year however, the remaining 30t should be exchanged for ground sprayed agro-chemicals. In consideration of the concentrations of aerial sprayed and ground sprayed agro-chemicals and the benefit area, 30t of aerial sprayed agro-chemical is equivalent to 60t of ground sprayed agro-chemical.

3) <u>Type of Agro-Chemicals</u>

Major rice pests in Bangladesh include the Rice Hispa, Green Leafhopper, Brown Planthopper, Rice Swarming Caterpillar, Rice Ear-cutting Caterpillar and Rice Stem Borer. Agro-chemicals contributed in 1983 and 1984, as well as those projected for 1985 are considered to be appropriate for control of the above insect pests. Based on these observations, the following conclusions were made.

a) Selection of types of agro-chemicals can be carried out in the same way as for previous years.

b) As there is only one airplane for aerial spraying, and more than 90t of agro-chemical still in stock, there is no need for supply of aerial sprayed agro-chemicals under the 1985 Program.

c) If only the ground sprayed agro-chemicals requested under the 1985 Program are provided, the benefit area will be considerably reduced. In order to cover the same benefit area as in previous years, provision of 160t of ground sprayed agro-chemicals will be required. In this case, however, provision of motorized backpack sprayers should also be considered.

4) Benefit of Agro-chemicals

Majority of rice farmers do not have enough capital to invest for the proper amount of agro-chemicals as discussed in Chapter II. Therefore, Plant Protection Wing, Ministry of Agriculture is utilizing the granted agro-chemicals under the Program for spray without fee to farmers. This policy of GOB meets well with the aim of the Program, namely to distribute agro-chemicals to as many farmers as possible. Furthermore if agro-chemical application reduces yield loss due to insect pests 5% of total Boro yield, their utilitation is considered economically viable.

(2) *Directorate of Food, Ministry of Food*

The Ministry of Food has requested 100t of Methyl Bromide for fumigating crop godowns under the 1985 Program. The quantity and effect of Methyl Bromide were studied as follows.

1) Methyl Bromide

All Dhaka type godowns must be fumigated once every four months for twenty-four hours with $24g/m^2$ of Methyl Bromide. There are 12 Dhaka type godowns throughout the country with a total capacity of 450,000t and a cubic volume of $1,942,200m^3$. Accordingly, 46.4t of Methyl Bromide is required per fumigation and thus about 140t is required per year. Actual usage is 1985 was 73.63t. From these two figures, the requested volume of 100t this time is considered appropriate.

2) Effects of Methyl Bromide

The following conditions were employed in estimation of the effects of Methyl Bromide.

a) Application volume: $24g/m^3$

b) Price: unit price = TK4.09/m^3

c) Rice storage capacity/ unit volume:

According to PWD type food storage standard specifications, dimensions for storage of 1,000t of rice are as follows:

L x W: 30.5x24.4m^2
Height: 5.8m

Accordingly, storage capacity is 4,316m^3 and rice storage capacity per unit volume is 232kg/m^3.

d) Rice price:

Average retail price of Aman, which comprises the greatest portion of total rice production, is TK5.2/kg.

e) Storage loss:

According to a survey by the Ministry of Food, annual rice storage loss is estimated at 3.75%. It is estimated that this loss can be reduced by half to 1.875% by fumigating 4 times a year. Accordingly, loss reduction per fumigation is 0.469%. Converted to monetary terms, loss is 232kg/m^3 x 0.00469 x TK5.2/kg = TK5.66/m^3.

f) B/C ratio:

Based on the above calculations, benefit is TK5.66/m^3, cost is TK4.09/m^3 and B/C ratio is 1.38.

From the results of 1) and 2) above, it was concluded that the 100t of Methyl Bromide requested by the Ministry of Food is appropriate. At present, however, Japanese manufactured Methyl Bromide is not yet approved for import, although registration procedures are being undertaken in Bangladesh. In order to provide the Methyl Bromide requested under the Program therefore, registration procedures must be completed as soon as possible.

5.1.3 Agricultural Machinery

The following equipment have been requested by the Government of Bangladesh.

For BADC

	Q'ty	Unit
DTW commissioning material	1000	Nos.
Spare parts for DTW, LLP, and STW Engine	1	Lot

Floating pump with accessories	12	Sets
Repair/tug boat	4	Unit
Jeep	4	Unit
Inspection boat (40 HP)	4	Unit

For BWDB

Submersible DTW pump	60	Nos.
Vibrating pile driving hammer	2	Nos.
Dragline	2	Nos.
Bulldozer	4	Nos.
Well-point pumps and accessories	10	Nos.
Shearing machine	1	Nos.
Bending machine (ϕ500mm)	2	Nos.
Bending machine (ϕ300mm)	1	Nos.
Press (300 ton)	1	Nos.
Spare parts for draglines and engine	1	Lot
Spare parts for vehicle	1	Lot
Sheet pile	100	Ton
Rail-mounted tower crane (5 ton)	1	Nos.

For Ministry of Food

Trucks (7 to 8 ton)	40	Nos
Moisture meter	500	Nos
Paddy dryer	10	Nos

Among the items listed above, floating pumps, tugboats, jeeps, and inspection boats are intended for the BADC Floating Pump Project and are discussed in Chapter 6 of this report. Other equipment and materials are discussed below on the basis of the respective agencies concerned.

(1) Regarding BADC

Items requested by BADC are DTW equipment and materials and spare parts for pump engines granted.

1) DTW Equipment and Materials

The Third Five Year Plan aims at increasing the number of DTW's from 17,000 in 1984 to 30,000 in 1989. This expected growth rate is the most marked among ground water irrigation projects. This is because a DTW maintains a constant volume of groundwater and is less susceptible to the fluctuation of groundwater stage between rainy and dry seasons. A STW, in contrast with a DTW, cannot be put in full operation in dry season especially in the area where there is a large number of STW's. However, the implementation cost of a DTW can be as much as three times that of STW. For this reason, DTW's should be implemented only in areas where groundwater is not enough for STW operations in dry seasons. 2,600 DTW's are required each year for the implementation of the Third Five Year Plan and DTW's imported by government agencies related in the past eight years have been introduced by BADC.

The ditching depth for DTW implementation in Bangladesh, according to ADB's Second Tubewell Project report, averages about 70 to 95 meters.

The total pump head is about 14 to 20 meters. On the average, a pump with a capacity of 2 cusec (56.6 lit/s) driven by a diesel engine and gearhead is used.

Calculation of power requirement for pumps under average conditions in Bangladesh is as follows.

Engine performance

Capacity	Q=2 cusec (3,400 lit/min)
Total head	H=20m
Pump revolutions	N=1,500 RPM
Engine revolutions	2,250 RPM
Gear ratio	1/1.5

Specific speed

$$Ns = \frac{N \cdot Q^{1/2}}{H^{3/4}} = 292\,(m \cdot m^3/min \cdot rpm)$$

Pump efficiency $\eta = 80\%$ (relation between Ns and efficiency)

Specific weight of water $\gamma = 1$

Engine power

$$P = \frac{\gamma QH}{75 \times 60 \times \eta} = \frac{3{,}400 \times 20}{75 \times 60 \times 0.8} \fallingdotseq 18.9\,(HP)$$

Necessary engine power

$$PN = \frac{P}{\eta t}(1 + \alpha) = \frac{18.9\,(1 + 0.2)}{0.95} \fallingdotseq 24\,HP$$

α: Diesel Engine
small engine 0.2 ~ 0.25
large engine 0.15 ~ 0.2

ηt: Transmission efficiency 0.94 ~ 0.96

Thus, the engine horse power required for an average DTW is approximately 24 HP.

However, where pump head is 30 m, necessary engine horsepower required is 36 HP. In the case of the subject request for assistance under the Program, pump head was assumed at 30m. Under assistance in 1984, 1,500 pump engines were provided of which 1,200 were of 36 HP. Considering annual pump engine demand at 2,600 units, another 1,100 units are necessary. If it is assumed that 1/2 of these are to be of the 36 HP type, then 500 units of 36 HP pump engine would be appropriate under the subject Program.

2) Spare Parts for PumpEngines

Spare parts for engines donated are indispensable to maintaining smooth engine operations. Depreciation life of a diesel engine is 10 years. Engines received from the Program are all younger than the depreciation life.

Estimation of the maximum costs of necessary spare parts is based on the following assumptions.

a) Annual repair cost is 5% of the machine price and 80% (totally 4%) of this amount is to be for spare parts.

b) 10% to 20% of the engine prices was included in the grant for engine purchasing. Thus a two-year portion of spare parts has already been provided and spare part grants for 1983 and 1984 are not required.

c) All engines for 2200 RPM STW's are in stock and other pumps are in full operation.

d) "Spare parts" are limited to those granted in the Program.

Spare parts cost

Year of Donation	Engine price (×¥1000) (90% of the amount granted)	Spare part cost in yen (4% of engine price × Nos. of years)
1978	26,505	5,301,000
1979	314,057.7	502,249,232
1981	269,892	21,591,360
1982	1,663,815.6	66,552,624
	Subtotal	143,694,216
1984 (Already granted)		-26,631,000
	Total	117,063,216 years

Definite contents of spare parts are yet to be requested by Government of Bangladesh.

(2) Regarding BWDB

All equipment requested by BWDB are to be fowarded to Kurigram Project. This project has the following description:

1) <u>Outline of BWDB Kurigam Project</u>

Name of Project	Kurigram Flood Control and Irrigation Project
Project area	Districts of Kurigam and Lalmonirhat
Project goals	a) Activation and intensification of agricultural activities to promote employment and alleviate poverty. b) To control flooding and drainage in 38,007 ha. c) Irrigation of 79,150 ha. d) Flood control to achieve self-sufficiency in food.
Project costs	Local currency TK 4,917,020,000 Foreign currency TK 819,750,000 Total TK 5,736,770,000

<u>Summary</u>

The project area is bounded on the North by the Teesta River, on the West by the Brahmaputra and Dudkuma Rivers, on the South by the Indian Border and the railway near Parteswari and on the East by the Kaunia-Mogolhat Railway. The area is divided into a South Unit and North Unit by the Dharla River, the former having an area of 63,765 ha. and the latter 41,903 ha. The project aims to surround the area with an embankment to prevent flooding, to build drainage facilities and to introduce irrigated agriculture. The project was started in 1972 and is expected to be completed in 1992.

Outline of facilities

Facilities and equipment of the project are listed below:

Project area	4,742	ha
Building	432	units
Canal	183	km
Resectioning of embankment of existing canal	108	km
Road constructed	36	km
Dharla barrage	1	location
Pumping station (Civil engineering work)	2	locations
Drainage canal	245	km
Drainage facility	33	locations
Irrigation canal	186	km
Irrigation facility	93	locations
Machinery and equipment	1	set
Vehicle	73	units
Transmission system	45	km
Pumps (500 cfs)	6	units

Capital equipment for the project are listed in detail below.

	Local Currency Q'ty	Local Currency Amount (mill. TK)	Foreign currency Q'ty	Foreign currency Amount (mill. TK)	Total Q'ty	Total Amount (mill. TK)
CAPITAL EQUIPMENT						
A Pump and Parts						
500 cfs	1	450.0			1	450.0
B Repair Shop Equipment						
1. Lathe unit	3	2.25			3	2.25
2. Drill unit	2				2	
3. Shaper unit	1				1	
4. Welding equipment unit	3				3	
5. Gas welding and cutting set	2				2	
6. Electrical tester unit			1	0.75	1	0.75
7. Electrical saw			3		3	
8. Tool set			6		6	
C. Office Equipment						
1. Ammonia printing machine unit	5	1.75			5	1.75
2. Duplicating machine	6				6	
3. Adding machine units	50				50	
4. Planimeter unit	9				9	
5. Antograph unit	4				4	
D. Surveying Equipment						
1. Theodolite unit	4	1.90			4	1.90
2. Levels unit	36				36	
3. Plane table unit	9				9	
4. Compass unit	36				36	

	Q'ty	Local Currency Amount (mill TK)	Q'ty	Foreign currency Amount (mill TK)	Total Q'ty	Total Amount (mill TK)
E. Construction Capital Equipment						
1. Flat bed truck	10	5.00			10	5.00
2. Water carrier	1	0.70			1	0.70
3. Oil tanker	1	0.70			1	0.70
4. Concrete vibrator	30	0.30			30	0.30
5. Concrete mixer	20	1.00			20	1.00
6. Dragline			2	6.40	2	6.40
7. Bulldozer			4	6.40	4	6.40
8. Payloader unit			4	---	4	---
9. Dump truck			16	12.80	16	12.80
10. Concrete batch plant (15 cu. yd.)			2	11.00	2	11.00
11. Generator 20 KVA		3	3.63	3		3.63
12. Wellpoint drainage equipment unit		10	2.00		10	2.00
13. Jet pump	3	0.60	3		0.60	
14. Vibrating-type pile hammer unit			2	2.40	2	2.40
15. Air compressor			2	0.30	2	0.30
16. Concrete breaker			2	0.03	2	0.03
17. Concrete driller			4	0.10	4	0.10
18. Drainage pump (1 cusec)			20	0.50	20	0.50
19. Sludge pump (0.75 cusec)			2	0.10	2	0.10
20. Concrete core sampler			2	0.10	2	0.10
21. Rod shearing machine			3	0.05	3	0.05
22. Rod bender		10	0.15	10		0.15
23. Concrete laborabory equipment			L.S.	2.00	L.S.	2.00
Strength testing equipment						
Reserve equipment						
	L.S.	0.40	L.S.	1.30	L.S.	1.70
Vehicles						
1. Sedan	1	0.28			1	0.28
2. Jeep 21	8.40		21			8.40
3. Truck	2	0.70			2	0.70
4. Pickup	2	0.35			2	0.35
5. Boat 2	0.20		2			0.20
6. Motorcycle	45	1.07			45	1.07
		25.00		500.61		525.61

2) <u>Progress of the Kurigram project</u>

The implementation progress of this project until June 1985 and the planning until 1982 are reported in Table 5-1. A progressive diagram is also presented in Fig. 5-1. According to these reports, over 85% of the embankment implementation and over 50% of the drainage canals and facilities have been completed. The full scale implementation of the ring-embankment will begin this year.

3) <u>Studies regarding the Program</u>

Kurigram project has a very strong potential to be an objective project to receive donation of equipment and facilities from the Program. This project is a part of the effort to attain self-supply level of food - by building substantial flood prevention and irrigation facilities equipped with pumping stations along the ring embankment. The B/C value for this project according to the feasibility study is 1.3. Equipment and materials requested are classified according to applications as follows:

- Supplementary irrigation machinery
  Submersible DTW pump(s)
- Machinery and materials for pump stations constructions
  Vibrating pile-driving hammer(s), Drag-line, Bulldozer(s), Well-point pump(s), Sheet piles.
- Workshop equipment
  Shearing machine(s), Bender (pipe dia. 500 and 300mm.), Press(es), Crane(s)
- Spare parts for dragline engine(s) and vehicle(s).

These items are to be studied with respect to their applications.

a) <u>Supplementary irrigation machinery</u>

It is planned that submersible deep tube wells (DTW) with a capacity of 3.4 m^3/min and total head of 33 meters will be used in the supplementary irrigation system. This supplementary system is to provide irrigation water to a net area of 2,000 hectares which are cut off from irrigation water by the Indian Enclave in the North Unit. The capacity of pumps requested is 2 cusec, the same as the capacity of pumps generally used for wells in Bangladesh. This is not included in the machinery and materials in the Project Proforma. A total head of 33 meters is comparatively deep. The pumps are to be driven by electric motors as the operation cost is approximately a half of the diesel engine-driven operation. However, although it is more advantageous and economical as far as operation cost and maintenance are concerned when driven by electric motors, it is also necessary to adjust the plan to electrification network of the area which is to be implemented from the fiscal year 1987.

According to the calculations regarding the machinery for DTWs in the previous section, the power requirement of the pump is 30 KW. The pump maximum diameter and the discharge pipe diameter for this specification according to manufacturers catalogs are approximately 240 and 150 mm, respectively.

With the estimation that 1 cusec of discharged water can irrigate 14 hectares of land, a 2-cusec pump can cover 24 hectares. A compromising number of 60 pumps has been proposed with a secondary estimation that this number will cover 1,680 hectores or 84% of the total area (2,000 ha). The remaining 16% of the total area is judged to be for residential and other purposes. However, the pumps will not be installed all at once but over a period of 2 to 3 years to ensure appropriate timing with local electrification.

b) <u>Equipment for pumping station construction</u>

The equipment are to be used mainly for the preparation work as embankment repair and access road to the project site in preparation for the full-scale construction which will begin in 1988.

i) Vibrating Pile Driving Hammer, Dragline, Sheetpile

This equipment mainly will be used for preparation work for pumping station construction. The pumping stations will be both at the North and South Unit.

Very large pumps with a capacity of 2,028 cusec ($57.4m^3/s$) will be installed at the North Unit and 1,430 cusec ($40.5m^3/s$) at the South Unit. The conditions used for the estimation of pump station size installed in the Megna Dhonagoda Irrigation Project are applied for the estimation of pump station sizes here. (The pump used in the Megna Dhonagoda Irrigation Project is $17.2m^3/s$, TH 3.81m). By this calculation the size of the North Unit pump Station is 40m x 50m with a height of 12m and that of the South Unit Station is 30m x 50m with a height of 12m.

Sheet Pile

Sheet piles for the pumping stations are to have margin allowance of 15m on either end. The total length of the sheet piles at the North Unit and South Unit will be 300m and 280m respectively. Type III sheets with width, thickness and height of 400mm, 13mm and 125~130mm are considered close to the requested dimensions of 400mm x 12.7mm x 12m (width x thickness x length). The sheet weighs 720 kg when its length is 12m. The sum of the total length of sheet piles for the North and South Unit is 580m and the number of sheets required is:

580/0.4 = 1,450 sheets

The total weight is:

1,450 x 0.72 = 1,044 tons

This amount of weight is over 10 times the requested weight of 100 tons and, therefore, it is judged that the requested weight of 100 tons is an error.

Sheet piles should be supplied all at once for a single project site.

Vibrating Pile Driving Hammer(s)

Vibrating pile driving hammers (also listed in the Project Proforma) will be used for the driving of sheet pile into the soil. As an accurate N-value of the site is not known, large Type III machine(s) with output over 40kW will used to ensure sufficient flexibility. In general, a vibrating pile driving machine consists of a body, tyre cable (s), pressure hose(s), and a controller. This does not include a power source. To maintain uninterrupted operation it is recommendable to supply the pumping station with a generator. It is required that this generator have an output of 40kW/100kVA.

Dragline

Draglines are also included in the machinery lists for the plan. They are to be used for excavations and as cranes for lifting pile-driving hammers. It is required that the bucket have a capacity of $1.91m^3$ and the basic length of the boom be 12m. If a dragline is to be used for lifting pile-driving hammers it must at least belong to the 40 ton class or with the bucket capacity of $1.91m^3$ it must at least belong to the 55 ton class. It is also necessary that the excavating operations be done during dry season. The amount of rainfall at Rangpur near Kurigram is as follows:

January	0.9mm	July	353.0mm
February	0.5mm	August	333.0mm
March	38.0mm	September	226.0mm
April	58.0mm	October	148.0mm
May	252.0mm	November	0.7mm
June	437.0mm	December	0.8mm

According to the data above, the period that the excavation is possible is between November and April (6 months). The capacity of the basket of a dragline is estimated by assuming that the net excavation time within the period of 6 months is 1 month, net operation time is 8 hrs/day, operation frequency is 12 times/hr, and the operation efficiency is 80%. Combined operations of draglines, bulldozers and pay-loaders are proposed; however, draglines are also assumed to substitute about 20% of operations that are difficult to be done by pay loaders. The excavation volume for the pumping station is determined at a depth of 5 meters to be:

$70m \times 80m \times 5m = 28{,}000m^3$

Thus the bucket capacity is,

$$\frac{28,000 \times 0.2}{30\ days \times 8\ hrs \times 12\ days \times 0.8} \doteqdot 2.43m^3$$

Accordingly, 2 draglines with a capacity of $1.2m^3$ are to be introduced. These machines can also handle 40 ton cranes. The booms of the draglines are to be 25 meters long to facilitate the driving of sheet piles.

ii) Bulldozer, pay-loader, truck

Bulldozer

Bulldozers are to be used as supplementary equipment for the excavations of the pumping stations, for the constructions of embankments, roads and other facilities, and also for facility maintenance. The hourly earth-moving capacity of the bulldozers is determined by assuming that half of the earth is moved 40m in one trip. This capacity is:

$$\frac{28,000}{30\ days \times 8\ hrs} \doteqdot 117m^3$$

The amount of work that can be undertaken by a bulldozer is proportionate to the horse power of the machine. For 40m of earth-moving operation, the amount of work that a bulldozer can handle is as follows:

40 HP	$35m^3/h$	120 HP	$150m^3/h$
60 HP	$50m^3/h$	160 HP	$200m^3/h$
90 HP	$60m^3/h$	200 HP	$250m^3/h$
		300 HP	$400m^3/h$

According to the data above, one bulldozer with horse power of 100 to 120 HP is required for the work at a pumping station. Another machine of the same class is also necessary for other operations. In addition, another two 200 HP machines are required for road construction.

Pay-loader

Using pay-loaders for pumping station construction work is to be studied.

Pay-loaders have higher efficiency than draglines but the operation require dump-trucks for soil transportation. The volume of soil-work per hour is determined as follows when 80% of the total volume is moved for 10m:

$$\frac{28{,}000 \times 0.8}{30\,days \times 8\,hrs} \doteqdot 93\,m^3/h$$

The amount of work handled with respect to horse power for 10m earth-moving and V-shape loading is as follows:

70 HP ($1.2m^3/h$)	$140m^3/h$	140 HP ($2.3m^3$)	$250m^3/h$
90 HP ($1.4m^3/h$)	$160m^3/h$	160 HP ($2.7m^3$)	$310m^3/h$
110 HP ($1.7m^3/h$)	$200m^3/h$	200 HP ($3.1m^3$)	$350m^3/h$

The value in the parenthesis is the capacity of the bucket.

One 70 HP pay-loader is required.

Dump truck

Dump trucks are to be used to transport soil from the pay loader. The size of a truck is to be 10 ton ($7m^3$). The travel distance is 1 km and it takes 12 minutes for round-trip travel. Including the treatment time of 3 minutes and the loading time of 4.2 minutes, the total time required for one round-trip operation is 20 minutes and 3 operations can be completed in 1 hour. The number of trucks necessary is,

$$\frac{200\,(m^3)}{14\,(m^3) \times 3} \doteqdot 5\ trucks$$

iii) Well-point pump

In Bangladesh and other countries where ground water level is high, it is necessary to lower the ground water level within the area surrounded by the sheet piles. Well-point pumps are to be used for this purpose.

Bangladesh has requested pumps with capacity between 3 to $4m^3/min$; however, the project sites have very high ground water level with large amount of water and is thus recommendable to use pumps with an approximate capacity of $6m^3/min$. Well-points are to be installed 50 meters apart outside the sheet piles of the pumping stations. The total number of pumps needed for the North and South Unit is approximately 12 pumps. However 10 pumps per site is recommended to allow for back up capacity. Pipes and other auxiliaries are also necessary in addition to the pumps and for a $6m^3/min$ pump, the diameter of the pipe applicable is 10 inches.

c) Workshop Equipment

Workshops are to be installed for the processing of materials at the equipment and materials receiving depots. It is scheduled that these workshops will be used mainly for the machinery maintenance work after the completion of material processings. However, in order to extract maximum output from the facilities, it is also desirable that these workshops handle repair and maintenance works of construction machines if any construction machines are introduced. In view of this secondary objective, the workshops materials currently requested would result in capacity required and have excessive material processing equipment with insufficient members of equipment to process and repair construction machinery. In addition, the workshop buildings are still in the planning stage.

It is thus desirable that outdoor/indoor dual-purpose equipment for material processings be introduced first with paralled planning to be conducted for construction of workshop buildings and installation of indoor equipment. Indoor-use equipment includes various types of machine tools (lathes, presses, drilling machines, etc) and equipment for repair and maintenance of construction machines.

Shearing machine

The capacity requested is 12mm x 3m. However, this machine will be used *only for construction of buildings and* the machine is not necessary if no buildings are to be constructed. Shearing machines that should be introduced are the rod shearing machines listed in the Project Proforma Two types of machines - one for rod shearing and the other one for pump pipe shearing - are required. For rod shearing a diameter of at most 32mm is required while for a diameter of at most 300mm is sufficient for shearing of pipes for well-point pumps *(maximum diameter of pipe is 250mm).*

Bending machine

For pipe bending, diameters of at most 300 and 500mm have been requested. As stated in the previous section, a diameter of at most 300mm is sufficient. In addition a 32mm rod bending machine is also considered necessary.

Press

Presses with a capacity of 300 tons have been requested. It is considered that the size requested is appropriate to the present scale of the project. The introduction of presses should be done after construction of buildings have begun.

Crane

Cranes with hoisting capacity of 5 tons with height and span of 12m and 30m have been requested. The cranes are to be of the out-door type for efficient lifting of materials at the equipment and material depots. The capacity and span of the cranes are considered acceptable as materials to be lifted include sheet piles which weigh 720 kg a piece. However, the Bangladesh side is to be responsible for the installations of crane rails and electrical works.

In addition to the machines and equipment above, introduction of gas cutting machine(s), electric welding machine(s) and manual tools are to considered at the same time.

Workshop buildings for these machine stations should also be planned as soon as possible.

d) Equipment for maintenance work

Spare parts for all types of vehicles and dragline engines previously introduced and currently being used in the Kurigram Project have been requested. The spare parts requested are necessary to maintain smooth progress of the implementation of the project; however, as the contents of the spare parts requirement depend on what is specified by the Bangladesh side in its request,detailed studies are not possible. Judgement to scope and content can be done only after definite details of the request are presented.

(3) Regarding the Ministry of Food

Ministry of Food is responsible for operations regarding the processing of post-harvest agricultural products. The operations include the processing, storaging and distribution (selling) of paddy rice, perboiled rice and wheat locally produced or imported. As the prevention of losses at processing, storage and distribution stages has the equivalent effectivencess as increasing yield itself, expansion of aid to these sectors is desirable. The following 3 items requested by the Ministry of Food are considered.

1) Truck

The Ministry of Food is increasing the procurement of locally produced rice from 1.2% to 6.0% (168,000 to 813,000 tons) and locally produced wheat from 1.4% to 16.7% (11,000 to 179,000 tons).

Wheat and rice are imported by the Ministry of Food. The amount imported in the last three years is as follows:

1983/84	1,089,000 ton
1984/85	2,201,000 ton
1985/86	596,000 ton

The percentage of rice and wheat grains handled by the Ministry of Food and which are locally produced is comparatively low. A maximum of 55% and a minimum of 36% of the storage space provided were used to store grains from July 1985 through February 1986. In other words, only half of the grain storages were utilized. The Ministry of Food has drafted a plan to promote procureement of domestically produced grains through improved yield quality and creative of substantial transportation networks and related facilities. This plan is being submitted to the Ministry of Planning.

Backgrounds of the plan proposed by the Ministry of Food are as follow:

Project Name: Rehabilitation of Food Transport Facilities (Phase-1)

Objectives:

1. To modernized the existing grain-storages in Dhaka, Chittagong, Raishahi, and Khulna
2. To procure appropriate maintenance and operation facilities for vehicles belonging to the Ministry of Food.
3. To develop public transportation networks *for effective grain storage and* management.
4. To stabilize grain supply by initiating efficient procurement, transportation, and distribution of grains.

Cost allocation:

Local	US$390,000
Foreign	US$190,000
Total	US$580,000

As a part of this plan, some new trucks are to be purchased. Transportation in Bangladesh refers to ocean freights, river freights, trains, trucks, bullock carts, etc. As a result of the recent improvement of highway networks, speedy highway transportations with less grain loss has made transportation by truck more advantageous. However, only a small number of trucks in poor condition are available at present. The Ministry of Food has perceived that an improvement measure for grain transportation and storage facilities should be included in this plan. Information regarding grain loss during transportation, is presented in the following table.

Loss During Transportation (paddy rice, wheat)		(%)
1. By Sea		1.0
2. By River		0.5
3. By Rail		1.0
4. By Trucks		0.25
5. Bullock carts	upto 16 km	0.5
	16 - 32 km	0.75
	over 32 km	1.0

Length of road and number of vehicles in Bangladesh are shown in Table 5-2.

The capacity of a truck should be as large as possible but not too large to be loaded on a ferry. Generally 10 ton trucks are favorable.

2) Moisture meter

As mentioned in the previous section the Ministry of Food is putting forth effort to improve grains qualities and has set the following specifications to determine the qualities of parboiled, polished, and paddy rice.

As a rule, the moisture content for all the three types of rices is to be 14%. This is because the safety limit of moisture content during storage is 14% and grain quality decreases when the moisture is over this value. According to the Ministry, the following factors affect the qualities of grains during storage:

1. Moisture content
2. Insect infestation
3. Rate of damaged grains
4. Pesticide treatments

The Ministry of Food has set the relative indexes below as standards to determine the number of months that grains can be stored without change in qualities.

Table 5-3 well illustrates how moisture content affects the grain qualities during storage. Especially when moisture content is over 17% grains cannot be stored even for one month. On the other hand, excessive drying not only causes cracked grains but also results in excessive decrease in weight that has negative effects on the income of farmers. The difference in weight at 14% and 13% of moisture content is determined as follows:

When 100 kg of paddy rice with moisture content of 14% is dried to the moisture content of 13% the weight of the rice at this moisture content is,

$100 \times (1 - 0.14)/(1 - 0.13) = 98.85$ kg

The weight difference per 100 kg is 1.1 kg.

Ministry of Food has planned to provided 2,000 moisture meters in the near future. Every inspector is to be carrying one moisture meter to check moisture contents of grains purchased.

There are four methods to measure moisture contents of grains. The first method is to dry the grains in an oven and measure the ratio of the weight before and after drying. This is a standard method. However, there are differences in the base standard values in some countries where the setting temperature of the oven is different. There are three setting temperatures used - 105 and 130°C. In Bangladesh the 130°C - 2 hours drying method is used but in Japan the drying method is 105°C - 5 hours drying method.

Another method to measure grain moisture content is to use infrared lamps. This method however requires long drying time and is not well suited for the intended purpose. The most practical moisture meters for on-site measurements are the electro-resistor and dielectric constant types moisture meters. Both moisture measurement claim merit and demerits, but it is the resistance type that is more compact convenient of the two. For both types, the standard moisture and its indicated value should be checked and measured annually. And, due to the fact that Japan and Bangladesh differ widely in the area of moisture standards for the resistance type and dielectric constant type moisture meter and that rice characteristics are somewhat different between the two countries, meters should be appropriately adjusted for conditions in Bangladesh.

3) Paddy Dryers

Although it was mentioned in the previous section that moisture control is the most effective way to prevent grain damage during storage, over stringent regulations will also discourage farmers from selling grains to the Ministry of Food and consequently sell the grains of high moisture content to private dealers. This is likely to bring grains with inferior quality into the market. Boro and Aus rice are specially likely to be damaged since it, sometimes rains during the harvest seasons. For this, introduction of dryers is being considered. However, the running costs of dryers are very high and very careful studies must be conducted before making any decision. At present there are some large rice-mills equipped with large dryers but these dryers are not being effectively used since farmers have no means to transport there grains to the mills. As an effort to solve this problem, the Ministry of Food has a plan to introduce a number of mobile dryers that can be moved to different areas when needed. The Ministry has requested for some of these mobile dryers as a pilot experiment to determine the effectiveness of the plan. The introduction of the experimental mobile dryers will also be used as a means to investigate the farmers' demand for dryers in each area. However, large-scale introduction of dryers are to be made only after there are confirmed demands and the running costs have dropped to a satisfying level.

One type of dryer thought to be simple and easily movable is the flat-type dryer. This dryer can be made mobile by mounting an engine on it and surveying of demand can also be done during mobile operations. This flat type dryer has the simplest structure, but feeding and discharging require manual labour and stirring is also necessary to prevent irregular drying. Drying irregularities and grain cracking are influenced by the blowing temperature. As a reference, cracking ratio, irregularity graph, and operation performance are shown in Fig. 5-2.

4.8 kg of Kerosene is required to dry 700 kg of paddy grains from a moisture content of 18% to a moisture content of 14%, and 12.6 kg of fuel is required when the initial moisture is 24%. This estimation is done based on the Japanese standard with blowing temperature of 15°C, and it is expected that the fuel consumption will be a little lower in Bangladesh.

The fuel consumption of a 1/4 PS engine for dryer is 0.055kg per hour. If the prices of kerosene and light-oil are the same, and the fuel price is TK10/lit, the fuel consumption and fuel cost per one drying operation are as follows:

			Consumption	Price
18%	→	14%	6.2 lit	TK62
28%	→	14%	16.1 lit	TK161

cf. Fuel price is TK10/lit

This fuel cost is equivalent to 1.8% (initial moisture 18%) and 6.4% (initial moisture 24%) of the paddy price when the loading capacities are 700kg and 550 kg respectively (paddy price = TK 5.2/kg).

It is desirable that the initial moisture content of paddy be reduced as much as possible before loading into dryers.

5.2 Basic Design

5.2.1 Basic Design Approach

The Government of Bangladesh has requested provision of various agricultural inputs including agricultural machinery and agro-chemicals through ERD under the 1985 Program. In response to this request, basic design approach consists of studies on quantity and type of commodities requested, utilization plan, allocation and use of counterpart funds and benefits to be derived from the Program in order to select appropriate commodities and formulate an appropriate plan which will increase the effectiveness and efficiency of the Program.

5.2.2 Basic Design

(1) Agro-Chemicals

The type and quantity of agro-chemicals requested by each agency (see Chapter IV section 5.1.2) were studied in terms of present pest occurrence in Bangladesh, planned use and past use of contributed commodities, economic effectiveness and use of agro-chemicals by farmers. The results of the study are summarized hereunder.

1) Plant Protection Wing, Ministry of Agriculture

The Plant Protection Wing, Ministry of Agriculture has requested 100t (¥135 million) of agro-chemicals under the Program in 1985, including 60t of aerial sprayed and 40t of ground sprayed agro-chemical. Study revealed however, that the majority of previously contributed aerial sprayed agro-chemical had not yet been utilized due to limited spraying capacity. Accordingly, it was concluded that only ground sprayed agro-chemical should be provided. In order to cover the same benefit area as the previous year, 160t of ground sprayed agro-chemical are required at a unit cost of ¥1,283/kg (simple average of previously contributed Diazinon 60EC, Phenthoate 50EC, Fenitrothion 50EC and MIPC 75WP). As the cost is higher compared to agro-chemicals in the previous year's contribution, allocation capacity for counterpart funds (205 million Yen) may require confirmation. Accordingly, basic design was conducted for the provision of ground sprayed agro-chemicals for two cases, i.e one with counterpart funding covering a provision of 160 tons, and one with counterpart funding for a lesser amount.

With Counterpart Fund of 205 million Yen
160t ground sprayed agro-chemical

With Counterpart Fund of 135 million Yen
105t ground sprayed agro-chemical

2) <u>Directorate of Food, Ministry of Food</u>

The economic effect of Methyl Bromide fumigant requested by the Directorate of Food, Ministry of Food was concluded to be sufficient to qualify for the Program. However, Japanese manufactured Methyl Bromide is not registered in Bangladesh and consequently it is currently impossible to import mechyl Bromde under the Aid Plan. Registration procedures including tender documents, bidding, procurement and shipping, must be concluded by mid-March, 1987 in order for the Japanese manufactured chemical to be included in the contributed commodities.

On the basis of the above conditions, the agro-chemical provision plan is as follows:

With Registration
100t methyl bromide
Without Registration
No Japanese-made agro-chemical provided

In this case, possibility of general untied status on commodity procurement should be considered because of the reasons below:

a) the demand for Methyl Bromide is high;
b) Methyl Bromide from other countries is resistered.
c) Methl Bromide has been utilized by the Ministry of Food in the past

(2) <u>Agricultural Machines</u>

Machines specified for each agency are listed hereunder.

1) BADC

a) Machinery for DTW	Quantity
DTW pump engine (36 HP)	500
Gear head 2/3 (including shafts)	500
b) Parts for pump engine	1 lot

Budget planning must be within 110 million yen. However, the amount of budget for parts purchasing is based on the request of Bangladesh.

2) BWDB

	Quantity
a) Submersible pump for DTW 3.4m3/min, total head 33m	20
b) Sheet pile Width 400mm, thickness 13mm, height 125~130mm, length 12m	1,000 t
c) Vibrating pile-driving hammer With motor power at least 40kW	2
d) Generator min. capacity 100kVA	2
e) Dragline Bucket capacity 1.2m3, 40 ton	2
f) Bulldozer 200 HP	2
100 HP	2
g) Pay-loader 70 HP, Bucket capacity 1.2m3.	1
h) Dump-truck 10 ton	5
i) Well-point pump 6m3/min,	10

j) Rod cutter
   ϕ32mm or less | 1

j) Rod cutter	
ϕ32mm or less	1
k) Pipe cutter	
ϕ300mm or less	1
l) Bending machine	
For pipe bending ϕ300mm or less	1
For rod bending ϕ32mm or less	1
m) Crane	
Rail mounted, span 30m, height 12m, 5 ton	1
n) Gas cutting machine	1
o) Arc welding machine	1
p) Spare parts for engine and vehicle	1

(Detailed contents are based on the request by Bangladesh.)

3) Ministry of Food

	Quantity
a) Truck (less than 10 ton)	40
b) Moisture meter (Electric resistance type)	500
c) Grain Dryer Flat type, engine driven	10

4) Applicable to all Agencies

Spare parts recommended by manufacturers equvalent to 10% of equipment prices are to be provided upon delivery of equipment and materials.

5.2.3 Implementation System

(1) Agro-Chemicals

The implementing agencies for request and distribution of agro-chemicals are the Plant Protection Wing, Ministry of Agriculture and the Directorate of Food, Ministry of Food. Each agency is responsible for selection of type and quantity, procurement and use of agro-chemicals. The flow chart of these works is depicted in Fig. 5-3 and 4. Implementation procedure for each agency is described below.

1) Plant Protection Wing, Ministry of Agriculture

The Plant Protection Wing determines the amount of agro-chemical required based on storage conditions, pest forecasts, etc. and then submits a request to the Ministry of Agriculture. The latter coordinates this request with requests from other departments and submits an official request through ERD. After reviewing the requests from each Ministry and verifying their appropriateness according to the import restriction list, ERD submits an official request to the Japanese Government.

Once the Japanese Government has acknowledged the request, Exchange of Notes for the Program is carried out between the Governments of Japan and Bangladesh. The Plant Protection Wing is notified of the results of Exchange of Notes via the Ministry of Agriculture. It then prepares necessary tender documents for agro-chemicals, conducts bidding, and undertakes customs clearance, transportation and storage. Finally it distributes agro-chemicals where needed on the basis of reports on pest outbreaks and damage from extension and pest forecasting personnel.

2) Directorate of Food, Ministry of Food

The Directorate of Food determines the amount and type of agro-chemicals required on the basis of the utilization plan, and submits its request to the Ministry of Food. The latter carries out the same procedures as described above for the Ministry of Agriculture. Once the Directorate of Food has concluded procedures for procurement, storage, etc., it utilizes the agro-chemicals for fumigation and pest control services based on its utilization plan and grain procurement conditions.

(2) Agricultural Machinery

The executive agencies concerning agricultural machinery in this plan are BADC, Ministry of Food and BWDB. Each agency makes its own decisions regarding the request and selection of machinery. Although BADC was the major agency requesting agricultural machines in the fiscal year 1984, in 1985 the Ministry of Food and BWDB participated hearing in request and items requested are distributed among these agencies. Project implementation and maintenance and management structure maintained by each agency are comparatively similar as illustrated in Fig. 5-5.

The implementation procedure starts with the presenting of machinery and material plan(s) selected by BADC, Ministry of Food, or BWDB to ERD through upper-level agencies. If a portion of a project is planned for realization under the structure include an Program, a Project Proforma must be presented and approved by the Planning Commission before forwarding to ERD. ERD has filed the requests from these agencies and the Japanese Government has approved these requests as objectives of the present basic design. Tendering of the equipment and materials studied in the basic design is to be done at each agency after the E/N conclusion. Following the tendering is the custom clearance and delivery of machines to their destination agencies or farmers.

The BWDB's Kurigram project deliberated in the fiscal year 1985 is planned for provision of equipment and materials under the Program. This is the first time in Bangladesh that request for assistance under the Program has been made in project from. A structural map of the Kurigram Flood Control and Irrigation Project is shown in Fig. 5-6.

5.2.4 Counterpart Fund

Regarding the allocation of counterpart funds for the equipment and materials requested in the fiscal year 1985 under the BWDB's Kurigram Project, BWDB has indicated that these items are only going to be used for construction under the Project and BWDB will cancel its request if these items are subject to the counterpart fund allocation, as there is no budget provided for this purpose.

It is anticipated that timely depositing of counterpart funds as specified in the Exchange of Notes will be difficult as the Project's equipment and materials cost is to be recovered from water utilization fees paid by farmers and not from the selling or renting of the items. According to this reason, BWDB has contended that the depositing of counterpart fund should be given exemption. At the same time, it is partially agreed among ERD's efficials that the depositing of counterpart funds can be exempted if the commodities requested under the ADP'S Project are considered as Project Aid. However, the exemption of counterpart fund depositing is basically against the regulations stated in the Exchange of Notes.

A method for depositing the counterpart fund that is considered as a compromise between the Japanese Government and BWDB positions is to deposit the fund into BWDB'S own account, instead of the present Bangladesh Bank Account No.4, and report the investment plan of the fund to the Japanese Government before the investment is made directly into BWDB projects. However, this formula for depositing may encounter difficulties in obtaining approval by ERD and ERD cannot make its own decision without discussion with the Finance Division, Ministry of Finance. This matter is likely to take some time before the decision is made.

5.3 Impact of the Implementation

The impact of the provision of appropriate machinery and materials according to the basic design is described hereunder.

(1) <u>Ago-chemicals</u>

1) Regarding the Plant Protection Wing, Ministry of Agriculture.

Agro-chemicals considerably contribute to the Program as the chemicals help reduce the amount of crops damaged by insects infestations. Economically it is considered that even a 5% reduction in yield loss brought about by applications of agro-chemicals will be satisfactorily effective. On the other hand, free-of-charge spraying of agro-chemicals by the Plant Protection Wing for local farmers has a very a significant impact on the utilization of chemicals contributed, especially under conditions where the majority of farmers cannot afford their own chemical applications.

2) Regarding the Directorate of Food, Ministry of Food.

It is anticipated that the chemicals contributed to the Directorate of Food, Ministry of Food under the Program will bring about highly satisfactory benefits by helping reduce damages of food supplies caused by pest infestations in the food silos under the supervision of the Directorate of Food. At the same time it is concluded that Methyl Bromide is the most appropriate chemical for this purpose, with a benefit/cost ratio of 1.38.

(2) <u>Agricultural Machinery</u>

1) Regarding BADC

Request for engines for deep tubewells and spare parts for irrigation engines contributed in the past has been made. Irrigation enables crop cultivation in dry season and is considered directly contributing to the increased food production. Water lifting using deep tubewells is one means of irrigation from which a stable volume of water can be obtained regardless of the fluctuation of the river stage between the wet and dry seasons. The demand for this type of equipment is increasing gradually. The benefit/cost ratio for this type of equipment is 1.16, which is considered effective.

In addition, spareparts for irrigation engines are indispensable to maintain the smooth operation of the irrigation system. Appropriate amount of spare parts are thus considered as having great impact on the Program.

2) Regarding the Ministry of Food

Trucks, moisture meters, and grains dryers have been requested. Trucks are to be used for grains transport to ensure smooth circulation of grains and reduce grain loss during the distribution process. Moisture meters are used to observe and control the moisture content of grains to reduce damage during storage. Grain dryers provide optimum conditions for drying regardless of the weather conditions and at the same time can be used to adjust moisture content of grains. For these reasons, this equipment requested by the Ministry of Food is considered as having a direct bearing on the food production program by helping reduce post-harvest loss of grains. It is thus concluded that these equipment will have a satisfactory impact on the Program.

3) Regarding BWDB

A certain number of items have been requested under the Project Proforma of the Kurigram Flood Control and Irrigation Project. This approach whereby assistance under the Program is requested in Project form is anticipated to increase in the future. The advantage of this formulation is that it is easy to evaluate the impact of the Plan as each group of items requested is clearly defined regarding its utilization under a specific project.

The Kurigram Project, with an aim at the stabilization and expansion of the nation's agricultural sector through substantial improvements of flood-prevention and irrigation systems, is considered as an effective means to increase food production. With a benefit/cost ratio of 1.97, it is concluded that this Project will bring about desirable impact under the Program.

CHAPTER VI

FLOATING PUMP BASIC DESIGN

CHAPTER VI

FLOATING PUMP BASIC DESIGN

The Government of Bangladesh is planning to expand the total irrigation area to 3.9 million ha at the end of the Third Five Year Plan. From this 3.9 million ha, 0.96 million ha will be allocated to surface water irrigation. However, a total area of 600,000 ha was irrigated by the surface irrigation network in 1984/85. On the other hand, usable capacity of the surface water that can be irrigated by low lift pumps is estimated to be about 2,800m^3/s. About 2,100m^3/s were already used as irrigation water during 1984 and 1985. The BADC Floating Pump Master Plan is formulated with an aim at the expansion of the irrigation land area by the maximum effective utilization of surface water with the help of existing chamels. The plan drawn to demonstrate the effects of floating pumping irrigation of this water is the object of the present basic design. This basic design is to be conducted based on the results of the site-surveys and the studies of the contents of the requests from BADC.

6.1 Review on the Requested Item

6.1.1 BADC Floating Pump Project

A master plan for establishment of floating pump irrigation systems has been drawn up by BADC to facilitate effective utilization of surface water. This plan is now under deliberation by the government agencies concerned. Prior to execution, BADC has proposed initial installation of floating pump units in four areas near Dhaka and has requested a grant for this purpose under the 1985 Program. The aim in conducting a basic design study on aid for this floating pump project is to estimate appropriate project scale and content through surveys and studies of necessary equipment, maintenance, local costs, objective area and benefits. Details of the master plan for the demonstration pump project are delineated hereunder.

(1) Master Plan

Project Name: Conservation and Augmentation of Surface Water for Minor Irrigation including Double Lifting

Project Area: All areas in Bangladesh which have potential for development of surface water irrigation

Objectives:

1) To bring maximum possible area under surface water irrigation

2) To augment surface water supply by dredging existing canals and constructing cross dams at river inlets, etc.

3) To investigate the potential development of and constraints to future surface water irrigation

4) To generate rural employment opportunities

Investment:	Local currency:	TK748,007,000
	Foreign currency:	TK442,211,000
	Total:	TK1,190,218,000

The Third Five Year Plan is projected to bring a total estimated area of 3,900,000ha under irrigation by the end of the last fiscal year of the Project. However, pumping is not possible where canals dry up in dry season. This problem must be overcome before completion of the Plan and the proposed floating pump project is accordingly scheduled to begin in 1986 and be completed in 1990. Items related to the project are listed below.

Land Acquisition:	10ha
Pumps:	560 units
Cross Dams:	810 sites
Creek Excavation:	780km
Pump Jets:	160 sites

A detailed list of materials required for the project is presented in the following table.

Item	Local Investment		Foreign Investment		Total	
	Q'ty	Amount (mill. TK)	Q'ty	Amount (mill. TK)	Q'ty	Amount (mill. TK)
A. 12.5cusec Pump Unit						
1. 120-150HP engine (with 10% spare parts)			400	1,200	400	1,200
2. 12.5cusec double suction centrifugal pump			400	480	400	480
3. Barge	400	1,600			400	1,600
4. 4"x 150' pipe	400	272			400	272
5. Accessories	400	120			400	120
Subtotal		1,992		1,680		3,672
B. 25.0cusec Pump Unit						
1. 240-250HP engine (with 10% spare parts)			120	720	120	720
2. 25cusec double suction centrifugal pump			120	240	120	240
3. Barge	120	600			120	600
4. 20"x250' pipe	120	165				165
5. Accessories	120	84			120	84
Subtotal		849		960		1,809
C. 50.0cusec Pump Unit						
1. 420HP engines (with 10% spare parts)			40	480	40	480
2. 50cusec double suction centrifugal pump			40	160	40	160
3. Barge	40	240			40	240
4. 26"x300' pipe	40	90			40	90
5. Accessories	40	28			40	28
Subtotal		358		640		998

Item	Local Investment		Foreign Investment		Total	
	Q'ty	Amount (mill. TK)	Q'ty	Amount (mill. TK)	Q'ty	Amount (mill. TK)
D. 5.0cusec Pump Unit						
1. 40HP engine/motor (with 10% spare parts)			750	825	750	825
2. 5cusec trolly mounted pump	750	150			750	150
3. Plastic pipe and accessories	750	225			750	225
Subtotal		375		825		1,200
E. Tugboat	4	40	4	60	4	100
F. Transport Vehicle						
1. Car			1	3.5	1	3.5
2. Jeep			2	8.5	2	8.5
3. Bicycle	5	0.15			5	0.15
4. Truck			2	14.0	2	14.0
Subtotal		0.15		25.5		25.65
Total		3,614.15		4,190.5		7,804.65

(2) Background of the Demonstration Project for 1985

This project has been planned to demonstrate the pumping system to the farmers. Water will be lifted by floating pumps from nearby rivers and stored in existing irrigation waterways that dry up in the dry season. Water stored in the waterways will be lifted by low-level pumps into the desired fields for field irrigation and this will increase the demand for low-level pumps. The project is to be implemented in the following four areas.

Shahjadpur (Sirajganj Zila, previously Pabna District)

Gazaria (Munshiganj Zila, previously Dhaka District)

Rajoir (Madaripur Zila, previously Faridpur District)

Daudkandi (Comilla Zila, previously Comilla District)

General data from BADC reports concerning these areas are as follows.

1) <u>Shahjadpur</u>

<u>Location</u>:

This area was previously called Pabna District and is a Ganga Prashad of Shahjadpur Upa-Zila in Sirajganj Zila. A total area of 150ha is to be irrigated by lifting water from the Karatoa River, using floating pumps with a capacity of 12.5cusec (350ℓ/sec).

<u>Topography</u>:

The project area is low-lying and submerged by about 1m of water during flood season. During the dry season from November to April, however, the area suffers from severe drought and as a result high potential agricultural land remains fallow. The topsoil of the project area is mainly silty loam.

<u>Agriculture</u>:

More than 90% of the population of the proposed area are directly dependent on agriculture for their livelihood. At present only single paddy cropping is practised; however, if irrigation water supply were available during the dry season, double paddy cropping with one winter crop would be possible.

<u>Proposed Project</u>:

The proposed project envisages installation of one barge-mounted floating pump with a capacity of 12.5cusec (350ℓ/sec) to irrigate a net area of about 150ha. Irrigation water will be lifted from the Karatoa River, a tributary of the Jamuna River. A canal about 450m in length links the project area with a roadside borrow pit. The distance between the canal and the river is about 18m. The Karatoa River has sufficient discharge to lift 12.5cusec of irrigation water without any adverse effects on navigation or river morphology.

Benefits:

Cropping intensity is projected to increase from 110% to 230% while crop yield is estimated to increase by 3.7t/ha after project implementation. About 200 farm families will be directly benefited by this project.

BADC Supporting Facilities:

BADC has a network of supporting facilities throughout Bangladesh. Minor repair and maintenance facilities staffed by sub-assistant engineers and mechanics are available at Upa-Zila Headquarters while major repairs can be carried out at the Pabna District Headquarters workshop which is about 30 miles from the proposed station.

The Pabna Workshop is equipped with the following machines:

Universal lathe:	2
Portable lathe:	1
Grinding machine:	1
Welding machine:	2
Manual shearing machine:	2
Air compressor:	1

Diesel fuel and lubricating oil could be easily supplied from a station 1km from the proposed site.

2) Gazaria

Location:

The proposed site is located under Gazaria Upa-Zila in Dhaka (now Munshiganj) District. Irrigation of about 900ha is proposed by using floating pumps with a capacity of 50cusec (1,400ℓ/sec) to lift water from the Megna River.

Topography:

The project area is situated on low-lying plain. During the flood season it is submerged under about 2m of water. During the dry season, however, it is subjected to severe drought and farmland remains fallow throughout the season. Topsoil is mainly silty loam and clay loam.

Agriculture:

More than 90% of the population in the area directly depend upon agriculture for their livelihood. At present, only single paddy cropping is possible; however, if irrigation water were supplied during the dry season, double paddy cropping with one winter crop would be feasible.

Proposed Project:

Installation of a floating pump station with a capacity of 50cusec (1,400ℓ/sec) is proposed to irrigate about 900ha by lifting water from the Meghna River. River discharge is abundant and lifting is projected to have minimal effect on river flow.

Benefits:

About 1,500 farm households will benefit and yield is projected to increase by about 3.7t/ha after project completion when cultivation in dry season will be made possible.

BADC Supporting Facilities:

Major repair and maintenance work can be performed at the workshops in Comilla or Dhaka about 50km from the proposed site. In addition, there are private workshops nearby.

The following equipment and machines are available at the existing workshops.

Private Workshop at Daudkandi:

Lathe
Grinding machine
Drilling machine
Welding machine (gas and electric)
Hand tools

BADC Workshop at Comilla

Universal lathe
Shaper
Grinding machine
Vertical boring machine
Welding machine (gas and electric)

BADC Workshop at Dhaka

Established about 30 years ago, this workshop has all modern facilities with large equipment required to carry out the majority of repair and maintenance works.

3) Rajoir

Location:

The proposed site is located at Takerhat under Rajoir Upa-Zila in Faridpur (now Madaripur) District. Irrigation water will be lifted from Kumar River by a 12.5cusec (350ℓ/sec) floating pump station. The Kumar River is a tributary of the Ganges River.

Topography:

The area is protected from flooding by an embankment constructed along the Kumar River. Year-round cultivation is possible with proper irrigation. The soil is predominantly silty loam mixed with fine sand.

Agriculture:

Over 90% of the population in the proposed area are directly dependent on agriculture. At present only single cropping of paddy is possible. However, if irrigation water were supplied through the dry season, double paddy cropping with one winter crop would be possible.

Proposed Project:

Irrigation of about 200ha is proposed by lifting water from the Kumar River by means of a floating pump station with a capacity of 12.5cusec (350ℓ/sec). At present some farmers are irrigating their land with low-lift pumps. River discharge is considered sufficient for irrigation without adversely affecting navigation.

Benefits:

About 400 farm households will benefit from the project. Yield is estimated to increase by 3.7t/ha after project implementation.

BADC Supporting Facilities:

Major repair and maintenance work can be handled by the Faridpur Workshop about 50km from the project site. This workshop is equipped as follows:

Universal lathe:	2
Bender lathe:	1
Drilling machine:	1

Tool grinding machine:	2
Cylinder boring machine:	2
Cylinder honing machine:	2
Valve seat grinding machine:	1
Valve grinding machine:	1
Arc welding machine:	1
Gas welding machine:	1
Shearing machine:	1
Wood lathe:	1
Wood saw:	2
Mobile generator set:	1
Compressor:	3
Hydraulic jack:	6

Diesel engine fuel and lubricants can be supplied from a station at Rajoir which is about 3km from the proposed site.

4) Daudkandi

Location:
The proposed site is located at Asmania Bazar under Daudkandi Upa-Zila in Comilla District. Installation of a floating pump with a capacity of 25cusec (700ℓ/sec) is proposed on the Gumti River to supply irrigation water to a gross area of about 600ha.

Topography:
The difference between the maximum and minimum elevations is about 60cm. The area is sometimes flooded during rainy season with occasional flash floods from Gumti River. During the dry season there is severe drought which causes extensive crop damage. Triple cropping is envisaged with provision of irrigation water supply. There are also some natural canals which can be utilized for distribution of water.

Agriculture:
More than 90% of the population are directly dependent on agriculture. At present only single paddy cropping is possible, but with irrigation water supply during dry season double paddy with one winter crop is possible.

Proposed Project:
The project area will be irrigated by lifting water from the Gumti River with a floating pump station having a capacity

of 25cusec (700ℓ/sec). River discharge is supplemented by water from the Titas River and consequently sufficient volume is ensured.

Benefits:

Approximately 500 farm households will be benefited. Crop yield under irrigation is projected to increase by 3.7t/ha.

BADC Supporting Facilities:

Major repair and maintenance work can be carried out at the workshop in Comilla about 50km from the proposed site. In addition, there are a number of private workshops nearby. Equipment and machines available at these workshops are the same as those provided at the workshops in Gazaria.

6.1.2 Background of the Project Area

Site surveys were conducted only for the four areas proposed under the BADC Demonstration Floating Pump Project. Surveys were mainly conducted to obtain necessary data on conditions at the installation sites. Surveys of waterways were also conducted. Data on river discharge and agriculture were obtained from BADC experts and farmers in each area. Survey results for each project area are presented hereunder.

(1) Shahjadpur Upa-Zila

Shahjadpur Upa-Zila (formerly Pabna District) is located in the Sirajganj Zila District northwest of Dhaka. As confirmed by BADC staff at Sirjganj and Shahjadpur, two areas were proposed for the project. The first project site is at Ganga Prashad along the Karatoa River, a tributary of the Jamuna River. The second site is the Santhia district, located along the Boral River, also a tributary of the Jamuna. This latter site was not mentioned in the original project plan but was recently proposed by local BADC staff. Geographical location of the project sites are shown in Fig. 6-1 and data on water level and discharge volume of the Karatoa River and precipitation in the vicinity are presented in Table 6-1.

1) Ganga Prashad Area

The proposed irrigation area of Ganga Prashad is located about 200m from the right bank of the Karatoa River. Previously farm fields extended as far as the river and there was a brick-lined canal connecting the river to the field. However, the field and canal were subsequently divided by a road which was built between Nagarbari and Bogra. Although the canal sections were later reconnected to the field, the canal serves only as a natural drainage way. Data on the project area, canal cross-section, and river depth near the right bank are presented in Fig. 6-2. BWDB is presently constructing a gate to prevent flooding near the irrigation area. As shown in the outline charts, if water level in the river during dry season is assumed as 0, the elevation of the field is 5 - 5.5m while that of the road is about 8m and of the canal and borrow pit are 3 - 3.5m. At these elevations, water from the Karatoa would flow into the canal around July to August (Table 6-1). Furthermore, the maximum water level in 1985 would be 10.5m assuming that the level from April to May is approximately 5m. Based on these assumptions, the area will be flooded at maximum river water level. According to Table 6-1, this river has an abundant discharge volume of 84 to 596m3/s.

Twenty shallow wells were constructed in the proposed irrigation area to replace the irrigation canal that was disrupted by the highway. These wells supply water to 60ha but are insufficient to meet demand at peak utilization, and it is impossible to install more wells. BADC therefore plans to irrigate a net area of 150ha by constructing a supplementary cross dam and to store water lifted from the river by floating pumps in the borrow pit with the aid of a new gate and the said cross dam. Stored water would subsequently be distributed by low level pumping.

Annual fluctuation in the water level of the Karatoa is close to 6m. It is therefore necessary to use floating pumps which can be adapted to such fluctuations. Moreover, installation of a pipe line connecting the pumping station and the borrow pit will be considered as discharge of water through the existing canal will aggravate erosion.

2) Santhia Area

The Santhia project area lies on the right bank of the Boral River and flooding is controlled by an embankment constructed by BWDB. The embankment however, obstructs water supply from the Boral which has abundant water resources. The only remaining water sources in dry season are shallow wells. In response to this situation, BADC proposes to lift water into the interrupted canal on the inner side of the embankment through a pipe line running over the embankment, using floating pumps. A survey team was dispatched to study project feasibility and surveys were conducted in the Santhia district.

A diagram and cross-section of the area up to the embankment as well as a cross-section of the canal based on survey results are presented in Fig. 6-3. The distance from the Boral River to the existing irrigation canal is about 230m and elevation of the embankment at the time of survey is 9m, assuming that Boral water surface elevation is zero. BADC designated an area of at least 200ha about 300m from the canal terminus as the area to be irrigated.

Boral river discharge is estimated to be over $80m^3/s$, similar to that of the Karatoa River as the widths of both rivers are approximately the same. Installation of over 250m of pipe line and a floating pump with a real lifting capacity of 10m is considered. However, there are also some similar irrigation canals nearby which can be used to increase the mobility and flexibility of the pump.

3) Pabna Workshop

The survey team also visited the Pabna Workshop to collect data on BADC maintenance facilities. The workshop is one of the zonal BADC workshops located 50km from the proposed project area in Shahjadpur. Equipment and tools are well maintained and there were some additional tools and facilities to those indicated under the demonstration project plan; namely, two 3-ton jacks, one 13mm drill and one blacksmith equipment. There is also the Bogra regional workshop 50km north of Shahjadpur which undertakes large-scale repair work.

(2) Gazaria Upa-Zila

Gazaria Upa-Zila (previously Dhaka District) is located in Munshganj Zila to the south of Dhaka. Surveys were conducted at two sites requested by the Narayanganj BADC office which is responsible for the area. Both sites are in Gazaria facing the Meghna River and they have been tentatively designated as Gazaria I and Gazaria II. The location of Gazaria is shown in Fig. 6-4.

Water level of the Meghna River from July 1984 to June 1985 is as follows:

1984	July	5.4m	1985	Jan.	1.3m
	Aug.	5.5m		Feb.	1.5m
	Sept.	5.5m		Mar.	1.9m
	Oct.	5.1m		Apr.	2.1m
	Nov.	2.7m		May	2.7m
	Dec.	1.7m		June	3.8m

1) Gazaria I

The Gazaria I project area is located on the right bank of the Meghna River. The irrigation area is shown in Fig. 6-5 with a 10km extension of the existing irrigation-cum-drainage canal. Intake is proposed at the outlet of the said canal. During the survey, inflow from the Megna reached as far as 50m upstream while the rest of the canal was almost completely dry. The elevation difference between the river water surface and the field was 2m and according to available data, the difference between maximum river stage and river stage in April was about 2-4m. The vicinity is therefore subject to flooding in the rainy season. Construction of a cross dam across the canal and installation of low lift pumps is proposed to lift water into the 10km canal extension and store it for irrigation of a total area of about 900ha. Although BADC plans to expand the secondary low lift pump network to 43 units, it would be difficult to cover the entire 900ha area with low lift pumps alone without constructing secondary and tertiary distribution canals. Lifting will be carried out by cutting off the canal outlet at the proposed intake. As the existing canal is also used for drainage in the rainy season, the gate type or rubber dam is proposed to facilitate drainage when necessary. River width is 200m and Meghna discharge volume is stable with at least $200m^3/s$. Real lift capacity of the pump is about 3m. The proposed site is only accessible on foot or by boat.

2) <u>Gazaria II</u>

The project area is located 3km downstream from Gazaria I and there is a canal connecting it to the Meghna River. This canal is shallow with a boundary depth of about 1 - 3m. Elevation difference between river stage and the field was about 2m at the time of survey. Like Gazaria I, part of this area is flooded in rainy season. Cross-sections of the field including the canal and the layout of the intake vicinity are shown in Fig. 6-6. Discharge volume of the Meghna River is estimated at over $200m^3/s$. The proposed area to be irrigated is along the canal; however, canal capacity is insufficient and as a first step, installation of a minimum capacity pumping unit is considered. This site is also accessible only on foot or by boat.

3) <u>Workshops</u>

Repair and maintenance work for this project area can be undertaken at the Regional Workshop in Dhaka (about 50km from the site) and at the Zonal Workshop in Comilla. Also available for general maintenance is the Upa-Zila Workshop in Narayanganj. The workshop in Dhaka is well equipped, with such sophisticated machine tools as crank shaft grinders and a 200-ton press for engine repair and maintenance work. The Comilla workshop is equipped as listed previously under the demonstration project and can handle overhaul of small engines.

(3) Rajoir Upa-Zila

Rajoir Upa-Zila (previously Faridpur District) is in Madaripur Zila south of Dhaka. Two areas were proposed by BADC for survey. According to field surveys conducted at each proposed site, one of the areas has sufficient water supply in the irrigation canal even in dry season and can be covered by low lift pumps. This area was therefore excluded from the floating pump project. The other site is at Takerhat.

The Takerhat project area selected is located about 30 minutes walk upstream from the ferry landing on the Faridpur-Barisai road along the right bank of the Kumar River (Fig. 6-7). A 20m wide irrigation-cum-drainage canal is situated between two irrigation canals (Fig. 6-8). There are five 2cusec low lift pumps in the smaller canals and two 4.5cusec low lift pumps installed in the irrigation-cum-drainage canal. The two 2cusec pumps and one 4.5cusec pump are operating. The fields along these canals appear to be efficiently irrigated.

BADC has cited the following reasons for replacing the presently operating low lift pumps with floating pumps.

a) The operating low lift pumps have been rented from BADC and will be removed when the rental system is abolished at the end of 1986.

b) The low lift pump stations are flooded in rainy season and must therefore be removed every year.

c) The area is efficiently irrigated at present and has sufficient number of irrigation canals to serve as a model floating pump irrigation center.

Kumar River width is 60m with an estimated discharge of $60m^3/s$. River stage fluctuation ranges from 1.8m to 6m annually. At present, elevation difference between river water surface and the irrigation-cum-drainage canal and between river water surface and the field is about 3.5m and 3.6m, respectively. The net irrigated area under the proposed floating pumps is about 200ha. Repair and maintenance works can be carried out at the BADC Zonal Workshop in Faridpur about 25km from the site. This workshop is well equipped with the machinery indicated in BADC demonstration project plan.

(4) Daudkandi Upa-Zila

Daudkandi Upa-Zila (previously Comilla District) is in Comilla Zila southeast of Dhaka. The intake site is Asmania bazar, located one hour by boat from the Daudkandi BADC office on the Gumti River (Fig. 6-9). As shown in Fig. 6-10, an irrigation-cum-drainage canal passes through the proposed area. The canal is 6km in length and is proposed for storage of water discharged by the floating pump. Net irrigated area under the project is projected at 600ha and construction of secondary and tertiary distribution canals are required for irrigation. Gumti river width at the time of the survey was 30m. It is the smallest of the rivers in the four project areas (6 sites) surveyed. The floating pump is to be installed at the deepest point of the river (1.9m). Rainfall over Daudkandi and discharge and stage of the Gumti River at Asmania Bazar from March 1985 through February 1986 is shown in the table below as a reference. Discharge at the intake site during the survey was about $29m^3/sec$.

The canal bed of the irrigation-cum-drainage canal is flat for 5km with a slope of 1.8m from 700m before joining the Gumti River. In order to use the entire canal length for water storage, embankment height should be increased by 2m for about 400m along the canal's west side, as the elevation difference between the canal bottom and the field is only 2m. Soil for banking could be obtained by dredging the canal. The pumping station could then be installed in the dredged canal instead of the Gumti River, thereby avoiding disruption of river navigation. Dredging will accordingly be studied for the project area.

BADC workshops at Comilla and Dhaka are available for repair and maintenance works for the project area. Data concerning these workshops are presented under the Gazaria plan.

RAINFALL AT DAUDKANDI AND RIVER STAGE AND DISCHARGE OF THE GUMTI RIVER

Date		Rainfall at Daudkandi (mm/month)	Gumti River Stage (Asmeria Bazar)		Gumti River Discharge (m^3/s) Asmeria Bazar
Year	Month		Max.	Min.	
1985	Mar.	450	3.5	2.7	19.8
"	April	137	3.7	2.9	12.4
"	May	526	4.4	3.3	47/8
"	June	397	4.6	4.3	72.8
"	July	389	5.6	4/8	35/3
"	Aug.	257	5.8	5.2	39.2
"	Sept.	188	5.0	4.9	41.0
"	Oct.	69	5.0	4.4	31.0
"	Nov.	0	4.4	3.8	37.6
"	Dec.	0	3.8	3.6	32.3
1986	Jan.	23	3.6	3.3	20.0
"	Feb.	0	3.3	2.9	-

Source: Bangladesh Agricultural Development Corporation, Comilla

6.1.3 Overall Plan

The optimum plan, referred to as the Floating Pump Irrigation System, was drawn up on the basis of site survey results and is composed of the following facilities:

Main Intake Facility:	floating pumps
Primary Irrigation & Reservoir Canals:	existing irrigation or drainage canals, or rivers
Secondary Canals:	existing canals and those to be newly constructed
Double Lift Pump:	floating or mobile pumps
Tertiary Canals:	existing canals

Others:	gates to block reservoirs, dredgers for canal dredging, pumping station, tugboat dredger with anchor

In this system, mobile pumping stations will replace the original fixed type pumping station as the main intake facilities. Moreover, pumps will be used for final distribution of irrigation water. This will ensure stable lifting and efficiency regardless of fluctuations in river stage.

(1) Main Intake Facility

Although there are fixed type pumping stations presently operating in the project areas, their efficiency decrease in dry season and they lack the flexibility and mobility required to adapt to fluctuations in river stage discharge volume. Under the proposed pumping system, the pumping station will be able to cover a greater range of river stage fluctuation and also to move to different intake sites. The station will thus be capable of year-round operation.

Each pumping station consists of a compact pump engine or motor installed in a raft anchored in the river. The station will automatically adjust itself to the hydrological regime and river stage. Optimum lifting sites can be selected for each respective irrigation canal.

The floating pump stations will be composed of steel or plastic pontoons or rafts that can be moved manually or otherwise to different sites as needed. Although floating pumps can move freely in the river, in some cases it requires a long uprush pipe to the distribution site during low tide. It is therefore proposed that an inlet be made to the high tide line and that the station be installed at the inlet nearest the distribution point.

In consideration of the considerable accumulation of sand on the riverbed, a small dredger barge should be used for digging. The barge should be a tugboat type that can be used as an anchor boat at the proposed intake site and moved to the other existing intake sites in the same irrigation system as needed. An inlet channel 10m wide and 3m deep should be excavated by the dredger.

Standard size of the floating pump is to be determined on the basis of the results of a separate site survey.

(2) Trunk Headraces and Reservoir Canal

The main pump discharge outlet is at the head of the headrace, existing drainage canal and floodway. These canals not only carry irrigation water lifted from the river to the intake point, but will also be utilized as reservoirs for secondary pumping by low-lifting pumps into the fields. They will be blocked at both ends by gates to prevent leakage and to maximize storage capacity. The gates will permit opening and closing of the canal as required.

(3) Secondary Headrace

Secondary irrigation canals are to constructed when long delivery pipes are required. As for intake from the main water sources, water from the secondary canals will be lifted by small floating pumps or mobile pumps which move along the canal banks. Existing canals will be used as secondary canals or secondary headraces. Where such canals are not available, new secondary headraces should be built. Canal dimensions will be decided according to the area to be irrigated. Self-propelled amphibious excavators will be used for efficient digging and canal maintenance work.

(4) Tertiary Canal

Water from the secondary headrace will be pumped into the tertiary canals and fields by low lift or mobile pumps. These secondary pumps will be motorized low lift pumps with a capacity of 1cusec (28.3ℓ/sec). As a rule, these pumps must be sufficiently compact to float in the headraces and be easily moved to different project sites. Mobile pumps which move easily along the headrace banks will be used where floating pumps are not feasible.

(5) Water Requirement

The number of pumps required is decided by the amount of water required which in turn depends upon the area to be irrigated and the type of paddy. Water requirement for paddy cropping is estimated in consideration of the following conditions:

- Effective rainfall measured from 1962 to 1976 at Chandpur and Daudkandi; ineffective at over 80mm/10 days
- Infiltration rate: 3mm/day
- Water for land preparation: 150mm/day
- Irrigation efficiency:
- Blaney Criddale coefficient k: Boro 1.4; Aman 1.5; Aus 1.0

The water requirement was estimated with the Blaney Criddale method for the BWDB Meghna-Donagoda irrigation project. According to the project, the water requirement for each type of paddy is as follows:

Year of 1/10 Probability (ℓ/sec/ha)	Boro	Aus	Aman
Land Preparation (max)	1.85 (3.08)	1.07 (1.78)	1.29 (2.15)
Irrigation (max)	1.21 (2.02)	0.72 (1.21)	1.17 (1.95)

Average Year (ℓ/sec/ha)	Boro	Aus	Aman
Land Preparation (max)	1.54 (2.56)	0.79 (1.32)	0-.91 (1.52)
Irrigation (max)	1.05 (1.75)	0.49 (0.81)	1.00 (1.66)

The number of pumps required is based upon the maximum water requirement for cultivation of Boro. However, only spare pumps will be used to supply water for land preparation as the period is short.

6.1.4 Plan for Each Area

Pilot plans for installation of floating pump stations in each district were formulated on the basis of survey results as described below.

(1) Project Area

There are six sites in four Zila in which floating pump irrigation systems are to be installed. Net irrigation area for each project site is determined according to the BADC plan as outlined below.

Upa-Zila	Location	Water Source	Target Irrigation Area (ha)
Shahjadpur	Ganga Prashad	Karatoa	150
"	Santhia	Boral	200
Gazaria	Gazaria I	Meghna	900
"	Gazaria II	Meghna	150
Rajoir	Takerhat	Kumar	200
Daudkandi	Asmania Bazar	Gumti	600
		TOTAL	2,200

(2) Facility Planning

1) Major Facility

Major facilities for each area are main pumps and tertiary pumps. Crops are selected by the amount of water used for Boro cultivation (2.02ℓ/sec/ha). The estimated discharge and capacities of pumps required for each project area are as outlined below.

Location	Net Area(ha)	Total Requirement (ℓ/sec)	Capacity (cusec)
Ganga Pr.	150	303	10.7
Santhia	200	404	14.3
Gazaria I	900	1,818	64.2
Gazaria II	150	303	10.7
Takerhat	200	404	14.3
Asmania B.	600	1,212	42.8

In view of the area to be irrigated, pumping units which can cover between 150-200ha will be used. Prices of floating pumps vary with size, and it was found that for pumps with a capacity from 20-25cusec, the price per cusec decreases as the pump size increases. On the other hand, the price of pumps with capacities of more than 25 cusec tends to increase with size. Thus, under BADC's plan, the capacity of basic pump units to cover an area of 150-200ha is designated at 12.5cusec, while capacity of pumps for an irrigation area of 600-900ha is 25cusec.

Location	Total Irrigated Area (ha)	Capacity (cusec)	
Ganga Prashad	175	12.5	
Santhia	175	12.5	
Gazaria I	875	25 x 2	12.5 x 1
Gazaria II	175	12.5	
Takerhat	175	12.5	
Asmania Bazar	525	25 x 1	12.5 x 1
	TOTAL 2,100		

2) Double Lift Pump

The capacity of the final intake pump is 1cusec (28.3ℓ/sec) with an individual coverage of 28.3ℓ/sec÷2.02ℓ/sec/ha≒14ha.

Location	Area (ha)	Q'ty Required
Ganga Prashad	175	13
Santhia	175	13
Gazaria I	875	63
Gazaria II	175	13
Takerhat	175	13
Asmania Bazar	525	37
	2,100	153

3) Other Equipment and Attachment

Other equipment and attachments required include headrace pipes and impact Boxes. Attachments consist of small dredgers, tugboats, backhoes, inspection boats and jeeps. These are discussed in detail in the section hereunder.

6.1.5 Planning for Machines and Apparatuses

Machines and apparatuses are to be designed according to the facilities planning in the previous section.

(1) Floating Pump

A floating pump is composed of a pump body, an intake pipe, a discharge pipe, valves, an engine with fuel-tank or a motor, a prime pump, and a floating station (barge etc.)

1) Pump

A floating pump is to have a suction (intake) stage range of within 1 meter. This value is to be constant regardless of the fluctuation of river stage. However, special considerations must be paid where the maximum depth of the river is less than 1.9 meter. Regarding the discharge level, the actual lift is less than 5.5 meters except for one district. This value of actual lift is to be a standard for the design. In such special case as lifting water over an embankment the design is to be made to cover a real lifting of 9 meters. Some districts require over 230 meters long of pipes. The discharge volumes of the pumps required are, according to the planning in the previous section, 2 units of 6.25 cusec (177 ℓ/s), 12.5 cusec (354 ℓ/s), and 25 cusec (708 ℓ/s). The actual lift values are 6 and 10 meters. These values were determined with an allowance of 10%.

SELECTION OF PUMP SIZES ACCORDING TO THE PUMP'S PERFORMANCE

Discharge volume			Bore (mm)	Flow velocity in pipe (mm)
cuses	m^3/s	m^3/min		
6.25	0.177	10.6	ϕ 300	2.5
12.5	0.354	21.2	ϕ 400	2.8
25.0	0.708	42.5	ϕ 600	2.5

It is desirable to keep the flow velocity under 3 m/s when the lifting of the discharge pipe is low. The diameter of the pipe when the flow-velocity is 3 m/s is determined as follows.

6.25 cusec	274 mm
12.5 cusec	388 mm
25.0 cusec	548 mm

The following pipes satisfy the conditions:

6.25 cusec	300 mm diameter
12.5 cusec	400 mm diameter
25.0 cusec	600 mm diameter

a) Determining of the total head

The length of the discharge pipe is 250 meters. According to the Hazen Willams' equation, loss of head due to friction is straight pipe is:

$$hf = 10.666 \frac{Q^{1.85}}{C^{1.85} \cdot D^{4.87}} \cdot L$$

hf : friction loss of head (m)

Q : water capacity (m^3/s)

D : pipe diameter (m)

L : pipe length (m)

C : coefficient (This changes according to pipe condition).

Cast iron pipe: 100; Coated steel pipe for water service: 130; FRP: 150

	c = 150	c = 130	c = 100
6.25 cusec	hf ≑ 3.6m	4.7	7.6
12.5 cusec	hf ≑ 3.2m	4.2	6.8
25.0 cusec	hf ≑ 1.6m	2.1	3.4

Loss of head due to bending

$$h_b = f_b \frac{V^2}{2g}$$

h_b : bending loss of head (m)

V : flow velocity in pipe = 2.8 m/s

f_b : loss coefficient determined by R/D and α

$\alpha = 60°$ R/D = 6 f_b = 0.075

g : gravitational acceleration (9.8 m/s^2)

$h_b \doteq 0.03$

Assuming that a maximum of 4 bendings are required.

h_b = 0.12

Angling loss of head

$$h_{be} = f_{be} \frac{V^2}{2g}$$

h_{be} : angling loss of head (m)

V : flow velocity in pipe = 2.8 m/s

f_{be} : loss of head determined by Reynold's number and α

α = 400 f_{be} = 0.2

g : gravitational acceleration (9.8 m/s^2)

$h_{be} \doteqdot 0.08$

Assuming that a maximum of 10 anglings are required.

$h_{be} \doteqdot 0.8$

4) loss of head due to valve

$$h_u = f_u \frac{V^2}{2g}$$

h_u : loss of head due to value (m)

V : flow velocity in pipe = 2.8 m/s

f_u : loss coefficient determined by valve aperture 70% f_u = 2

g : gravitational acceleration (9.8 m/s^2)

$h_u \doteqdot 0.8$

The total head is the sum of the above values and the actual lift.

TOTAL HEAD IN METERS

(Unit: m)

Capacity \ Real lifting	c = 150		c = 130		c = 100	
	6m	10m	6m	10m	6m	10m
6.25 cusec	12	16	13	17	16	20
12.5 cusec	11	15	12	16	15	19
25.0 cusec	10	14	10	14	12	16

According to the table above, it is desirable to use pumps with c ≧ 130 as pumps with c < 100 will have excessively long total head.

b) Selection of Pump

According to the pump's performance chart, all pumps are to be double-suction single-step centrifugal pumps. However, it is possible to use single-suction single-step machines for those with a capacity of 6.25 cusec. The prices of these single suction pumps are some what more economical than the double-suction machines. But double-suction pump will be used for this plan because of the maintenance of double-suction pump is much easer than single-suction pump. Vacuum pump will be used for start of main pump.

2) Selections of Driver

Either engines or motors are to be use as drivers for the pumps. Electric motors have an advantage as the maintenance is simple and the electric power rates in Bangladesh are much cheaper than fuels for engines. The power rates are about a half of the fuel price. Transport of motor-driven floating pumps can be facilitated by installing power outlet panels at each pumping station site. Two sites - Ganga Prashad and Rajoir - were found from the survey as having available power supply for the pumping stations. As for the BADC demonstration project, since the purpose of this plan is only for the demonstration of floating pumps during seasons when no irrigation is required, only planning for the use of diesel engines as drivers will be done. (It was requested that all demonstration pumps be driven by engines.) Introduction of motors as drivers should also be considered when possible.

Engine horse power is calculated from the following equation.

$$P = C \cdot \frac{\gamma QH}{4.5\eta p \cdot \eta t}$$

P : horse power of engine (HP)

C : driver excess
1.15 to 1.25 for an engine (1.20 is to be used here).

γ : specific weight of water = 1

Q : discharge volume [m^3/min]

H : total head (m)

ηp : pump efficiency 0.78 to 0.81

ηt : transmission efficiency
A transmission efficiency value from 0.90 to 0.98 is to be used to accommodate flat-tooth and lotus-tooth gears when speed reduction is made. In this calculation 0.92 is used.

Discharge cusec	Total head m	ηp	Engine output HP	Engine to be used HP
6.25 (10.6m^3/min)	12~13	0.78	47.3~51.2	50
	16~17	0.78	63.0~67.0	70
12.5 (21.2m^3/min)	11~12	0.79	85.6~93.3	90
	15~16	0.79	116.7~124.5	120
25.0 (42.5m^3/min)	10~11	0.81	152.1~167.3	160~170
	14~15	0.81	212.9~228.1	220~230

3) Fuel Tank

The maximum period that the fuel can be out of supply during irrigation seasons is assumed as 1 day and thus a tank is to have a two-day storage capacity. Assuming that the operation time is 24 hrs/day, the fuel tank capacity can be calculated as shown below.

$$Q = \frac{48 \cdot PE \cdot BE}{Wf}$$

BE : fuel consumption of engines with output less than 300 HP = 0.22 kg/HP.h

W_f : specific weight of light oil 0.83 kg/lit

PE : output (HP)

Q (50 HP) ≑ 650 lit

Q (70 HP) ≑ 900 lit

Q (90 HP) ≑ 1,200 lit

Q (120 HP) ≑ 1,500 lit

Q (160 HP) ≑ 2,000 lit

Q (220 HP) ≑ 2,800 lit

4) Intake Pipe

The intake head of an intake pipe is to be installed lower than the lowest river stage in order to prevent cavitation. It is also necessary that the intake pipe have appropriate dimensions to reduce the effect of the river-bed.

5) Discharge Pipe

Pipes made of such materials as steel, cast iron, hard vinyl-chloride, and reinforced plastic are considered. However, pipes with greater flow velocity coefficient should be selected for long piping to reduce the flow resistance. It is desirable that this flow velocity value be 130 or more. In addition, it is desirable that pipes for floating pumps be easy to disassemble and their weight be light enough to handle with man power. Weight of each type of pipe is presented in the table below.

	Pipe dia. mm	Ductile cast iron pipe	Coated steel pipe for water service	Hard vinyl chloride pipe	FRPM pipe	FRP pipe
Flow veloc. coeff: c		100	130	150	150	150
Unit weight: kg/m	φ 300 φ 400 φ 600	62.8 89.7 162.7	53.1 59.7 89.0	13.7 23.1 52.1	17.5 22.5 50	10.4 16.1 27.5
Total weight: kg	φ 300 φ 400 φ 600	377 (6m) 538 (6m) 976 (6m)	292 (5.5m) 355 (6m) 534 (6m)	55 (4m) 92 (4m) 211 (4m)	70 (4m) 90 (4m) 200 (4m)	42 (4m) 65 (4m) 110 (4m)

Handling of pipes by manpower has an estimated limitation of 30 kg/person (8 men for 4 m pipe, 10 men for 6 m pipe; maximum of 240 to 300 kg per section). Longer pipes require less joints and are easy to install, however, long steel pipes cannot be handled manually as most sections weigh over 300 kg. In consideration of flow velocity coefficient and weight, coated steel pipe for water service with a length from 3 to 4 meters are to be selected if steel pipes are to be used. Pipes made of vinyl or plastic are much lighter than steel pipes.

However, pipes made of hardened vinyl chloride are not suitable as they have low durability and are easily worn when exposed to ultra-violet light. Furthermore, the range of temperature that hardened vinyl chloride pipes can be used is comparatively small (-5° to 45°C). Pipes made of FRP and FRPM have higher durability with wider range of operation temperature (-20° to 60°C) than pipes made of vinyl chloride. Coated steel pipe for water service and FRPM pipes are considered possible for utilization in the floating pump project.

Considering price and mobility, pipes made of FRP or FRPM are to be used. Appropriate flexible joints made from rubber are to be used to connect spans of pipes floating on the surface of the water. Floating bases are to be made of buoyant materials such as polyethylene foam. On-land pipes are to be rigidly installed over supports and sluice valves mounted to reduce vibrations.

6) <u>Pontoon</u>

In order to allow for pontoon mobility on small rivers, draft is to be 1 meter or less. However, for protection of the water intake pipe, amount of draft should be greater than the length of said pipe.

Iron boxes or buoyant materials are to be used for pontoon construction. Roof would be a simple fabric construction. The pontoon would not be equipped with a crane for pump repair. As a power unit would be expensive, man-power would be relied upon for pontoon movement over short distances. For long distant movement, a tugboat would be utilized. The tugboat is to serve as a pump maintenance vessel, outfitted with lift crane for pump engines as well as other equipment for small scale repairs.

(2) <u>Impact Box</u>

As width of existing canals is large, impact box is to utilize water cushion. Canal bottom is to be concrete lined over a width of around 10 m.

Relevant civil works are to be performed by the Bangladesh side.

(3) <u>Cross Dam</u>

Existing drainage canal, or trench left by excavation for road embankment are to be utilized as main conveyance canal. Water would be lifted by floating pump from the source river for storage in the canal. Taking into consideration factors of i) maintaining the water storage function of the canal, ii) allowing the canal to retain its original drainage function during the rainy season, and iii) allowing for sealing of the canal by gate at the end of the rainy season for water retention and storage, the effectiveness of constructing gates at both upstream and downstream extremes of the canal is considered to be great. If blockage of the canal were to be done with earth and stone, its original function would be impaired.

(4) Accessory Equipment

The following is considered as support equipment for the floating pump plan.

1) Dredger

In the dry season, there is danger that drop in water level on the source river will reduce floating pump efficiency. In such case, dredging of the low water channel in the vicinity of the pump station is required. Also, where the distance between intake and discharge points is large, dredging of canal and intake pond on the high water channel portion becomes necessary.

The deployment of small-scale, mobile dredgers in each area of the project would be considered effective as they would have a wide range of use. Dredgers would not be self-propelled, relying on tugboats for movement from one location to another. Tugboats would also function as anchor boats for dredgers.

Dredgers would be small-scale, direct forward advancing, and capable of 10 m wide and 2 m deep excavation. Draft would be under 1.5 m to allow utilization on small rivers. Number of dredgers would total 4 units, or 1 unit for each of the four areas of the Project.

2) Anchor boat - cum Tugboat

In order to minimize cost, floating pumps are not to be self-propelled. Neither will they be equipped with cranes for pump engine removal. For these reasons, as well as the fact that the dredger described in 1) above requires both an anchor boat and a tugboat, tugboats are envisioned which are outfitted with cranes of 3t lifting capacity and other repair equipment. These tugboats would combine functions of small-scale pump repair shops and anchor boats for dredgers. Tugboat draft would be under 1.5 m to allow for use on shallow rivers. Number would be 4 vessels.

3) Amphibious Excavator

In order to realize the effectiveness of the floating pump irrigation system, an efficient network of secondary and tertiary canals is necessary. For the purposes of new canal construction as well as dredging of existing canals, an amphibious type excavator capable of operating on both land and in water is to be provided.

Although construction of secondary and tertiary canals is in principal generally to be done by hand, conditions of soft foundation and requirements for dredging in shallow water (which occur at times when irrigation is necessary) require the introduction of machinery which can perform these operations rapidly. The design number is one unit, with bucket capacity of 0.6 m^3.

4) Inspection Boat

BADC is responsible for supervision and management of the subject demonstration project. It will also need to undertake field survey pertinent to execution of the master plan, as well as to inspect the effectivity of the floating pump irrigation system. In order to collect the relevant data for performance of the above functions, an inspection boat and jeep are to be deployed at each area of the project.

Boats will be 40 HP, and jeeps will be equipped with diesel engines of at least 2,000 cc.

5) Double Lift Floating Pumps

In order to ensure effective use of water at terminal facilities, small pumps for double lifting are envisaged which can be utilized both on water and on land. Pump capacity would be the same 1 cusec (28 ℓ/sec) as low-lift pumps generally in use in Bangladesh. These pumps would be introduced on a model-basis and would serve as design reference for Trolly Mounted Type pumps envisaged in the floating pump master plan.

Solar battery powered pump stations are also considered for introduction on a demonstration basis. Pumping capacity by solar battery would be 250 t/day (12 hour operation).

Both of the above model programs would effectively serve as reference in orienting implementation of the master plan.

6.1.6 Cost Estimation

Fixed costs and variable costs of floating pumps should be studied after completion of cost estimation for each area. As a reference for selection of 12.5cusec or 6.25cusec x 2 pumps, estimated costs for the ADB Second Tubewell Project are presented below. Comparisons should be made with these data when calculating floating pump costs. The prices below have been adjusted to 1986 prices, at an exchange rate of US$1 = ¥170.

Deep Tube Well Pump (2cusec/pump)	Price (US$)
Construction	8,670
Well materials	5,080
Pumps	3,910
Diesel engines	5,930
Total	23,590 (price/cusec: $11.795)

Shallow Tube Well Pump (0.5cusec/pump)	Price (US$)
Construction	160
Well materials	320
Pumps	830
Engines	630
Total	1,940 (price/cusec: $3,880)

The outline cost for the floating pump must be within US$3,800 to 11,800 (¥646,000~2,006,000) per cusec.

In order to compare with well irrigation, the cost of floating pump irrigation was calculated including impact box and pipeline construction (assumed at 100 m in length)

	price/cusec (¥)
6.25 cusec x 2	2,924,800
12.5 cusec x 1	2,084,000
12.5 cusec x 2	1,876,000
25.0 cusec x 1	1,700,000

As can be seen from the above, the unit cost per cusec drops as the capacity of the floating pump increases. Costs are comparable or slightly less than for tubewell pumps. However, as the cost for 6.25 cusec x 2 units is excessive, this arrangement has been eliminated from planning.

Comparison of running costs between tubewells and floating pumps shows differential stemming from dissimilar lift head. Whereas average lift for a tubewell is 20 m, floating pump lift (even with double lifting) is around 12 m. Differential in fuel consumption for the two types for one year of operation (2,000 hours) is calculated as follows:

Horse power differential	:	6 HP
Fuel consumption differential	:	2,900 kg (1 season)
Cost differential	:	TK 35,000

The initial investment cost for a floating pump of capacity 12.5 cusec or over roughly approximates that of a tubewell, while the running cost for the floating pump is cheaper. A higher benefit/cost ratio than the 1.16 for the tubewell could be anticipated in the case of a floating pump.

It would normally be desirable to mount at least 2 units of pump on a pontoon. However, as the subject project is for demonstration purposes the number of pumps is planned at one 12.5 cusec unit and one 25 cusec unit.

In comparison to the incline pump and vertical pump generally installed at large-scale pump stations, the floating pump has the distinct advantage of mobility. This permits adjustment of pump location as required to respond to alterations in river channel caused by flooding. Furthermore, if the cost of a 12.5 cusec floating pump is assumed at 100, that for the incline pump and vertical pump would be 138 and 107, respectively. The initial investment for the floating pump is thus less.

6.2 Basic Design

6.2.1 Basic Design Approach

On the basis of study results described in previous sections, 12.5 cusec and 25 cusec pump units are planned to be utilized either individualy or in tandem with other units depending on the area to be irrigated. Pipe for installation on the ground surface is to be of FRP pipe while that intended for installation in the ground is to be of FRPM pipe. Pipe run over water is to consist of floaters and flexible hose. Pipe laying, impact box and cross dam construction works are to be performed by the Bangladesh side.

6.2.2 Design Criteria

Basic design criteria for each area of the project are as set out below.

(1) Shahjadpur Upa-Zila

Communal equipment

Dredger	Engine horsepower	200 HP (minimum)	1 unit
	Main sand pump horsepower	150 HP (minimum)	
	Dredging capacity	500 t/h	
Tugboat (cum anchor boat and repair boat)	Engine horsepower	150 HP (minimum)	1 unit
	Winch lift capacity	3 tons (minimum)	
Inspection boat	Engine horsepower	40 HP (minimum)	1 unit
Jeep	Wagon type		1 unit
	Diesel engine		
	Engine horsepower	65 HP (minimum)	

1) Ganga Prashad

Floating pump	12.5 cusec·TH 15m	1 unit
	1 cusec	1 unit
Discharge pipe	FRP; dia. 400mm (including joints)	270 m
	Flexible hose; floaters	1 set
Impact box (Fig. 6-11)	Concrete or sheetpile	1 structure
Cross dam	Earth	1 location

2) Santhia

Floating pump	12.5 cusec·TH 15m	1 unit
	1 cusec	1 unit
Discharge pipe	FRP;dia. 400mm (including joints)	240 m
	FRPM; dia. 400mm (including joints)	20 m
	Flexible hose; floaters	1 set
Impact box (Fig. 6-12)	Concrete or sheetpile	1 structure
Cross dam	Earth	1 location

(2) Gazaria Upa-Zila

Communal equipment

Dredger	Engine horsepower	200 HP (minimum)	1 unit
	Main sand pump horsepower	150 HP (minimum)	
	Dredging capacity	500 t/h	
Tugboat (cum anchor boat and repair boat)	Engine horsepower	150 HP (minimum)	1 unit
	Winch lift capacity	3 tons (minimum)	
	Engine horsepower	40 HP (minimum)	
Jeep	Wagon type		1 unit
	Diesel engine		
	Engine horsepower	65 HP minimum	

1) Gazaria I

Floating pump	12.5 cusec·TH 9m	1 unit
	25 cusec·TH 9m	2 units
	1 cusec	1 unit
Discharge pipe	FRP; dia. 400mm (including joints)	50 m
	FRP; dia. 600mm (including joints)	100 m
	Flexible hose; floaters	1 set
Impact box (Fig. 6-13)	Concrete or sheetpile	1 structure
Cross dam	Earth	2 locations

2) Gazaria II

Floating pump	12.5 cusec·TH 9m	1 unit
	1 cusec	1 unit
Discharge pipe	FRP; dia. 400mm (including joints)	50 m
	Flexible hose; floaters	1 set
Impact box (Fig. 6-14)	Concrete or sheetpile	1 structure
Cross dam	Earth	2 locations

(3) Rajoir Upa-Zila, Takarhat

Dredger	Engine horsepower	200 HP (minimum)	1 unit
	Main sand pump horsepower	150 HP (minimum)	
	Dredging capacity	500 t/h	
Tugboat (cum anchor boat and repair boat)	Engine horsepower	150 HP (minimum)	1 unit
	Winch lift capacity	3 ton (minimum)	

Inspection boat	Engine horsepower	40 HP (minimum)	1 unit
Jeep	Wagon type Diesel engine Engine horsepower	 65 HP (minimum)	1 unit
Floating pump	12.5 cusec·TH9m 1 cusec		1 unit 1 unit
Discharge pipe	FRP; dia. 400mm (including joint) Flexible hose		50 m 1 set
Impact box (Fig. 6-15)	Concrete or sheetpile		1 structure
Cross dam	Earth		2 locations

(4) Daudkand: Upa - Zila, Asmanic Bazar

Dredger	Engine horsepower Main sand pump horsepower Dredging capacity	200 HP (minimum) 150 HP (minimum) 500 t/h	1 unit
Tugboat (cum anchor boat and repair boat)	Engine horsepower Winch lift capacity	150 HP (minimum) 3 ton (minimum)	
Inspection boat	Engine horsepower	40 HP (minimum)	1 unit
Jeep	Wagon type Diesel engine Engine horsepower	 65 HP (minimum)	1 unit
Floating pump	25 cusec·TH9m 12.5 cusec·TH9m 1 cusec		1 unit 1 unit 1 unit
Discharge pipe	FRP; dia. 400mm (including joint) FRP; dia. 600mm (including joint) Flexible hose		50 m 50 m 1 set
Impact box (Fig. 6-16)	Concrete or sheetpile		1 structure
Cross dam	Earth		3 locations

(5) Spare Parts, Others

Spare parts recommended by the manufacturer shall be included in amount equivalent to 10% of FOB price for each item of equipment and machinery.

6.2.3 Project Implementation Structure

The prime executing agency for the subject project is BADC. In contrast to years previous to 1985, request for floating pumps has been made on a project basis with BADC responsible for operation and maintenance. The project is aimed at demonstration and promotion of floating pump irrigation system, and following acceptance by farmers of this type of irrigation method, operation and maintenance would be performed by BADC utilizing water use fees collected from farmers.

The institutional framework for project implementation is essentially identical with that described in the section on agricultural machinery (Fig. 5-5). The BADC staff structure for floating pumps is as shown in Table 6-2.

6.3 Project Benefits

In order to increase food production, Bangladesh has been engaged in the expansion of irrigation facilities aimed at making possible double-cropping and even triple-cropping in areas heretofore under single-cropped cultivation. Upgrading of existing and construction of new irrigation facilities is viewed as a direct and significant contributing factor to achievements in enhanced food production.

Both surface and groundwater sources are utilized for irrigation in Bangladesh. In conjunction with aggressive efforts on the part of Government to construct groundwater irrigation systems, utilization of this mode of irrigation is expanding. However, application of surface water for irrigation has not developed as rapidly as desirable.

Although Bangladesh has abundant rivers, systems have not been introduced to convey water to fields located distant from these sources.

In view of the above circumstances, BADC has formulated a Floating Pump Project Master Plan aimed at promoting the effective utilization of surface water. As a demonstration project, the introduction of floating pump irrigation into 4 areas in the vicinity of Dakha has been planned. Cooperation has been requested from the Japanese Government for supply of the necessary equipment under the Program for this demonstration project. On the basis of field survey and home office study, the Team determined that the initial investment for floating pumps would either approximate or be less than that for tubewells, and that the running cost of the former would be less. Benefit/cost ratio for floating pump irrigation is estimated on the safe side at least 1.16. Furthermore, the mobility of floating pumps would permit transport as required to areas needing irrigation, permitting maximized effective use of surface water.

On the basis of the above, it is concluded that establishment of floating pump irrigation would constitute a highly effective assistance under the Program, and mesh smoothly with the national and agricultural policies of the Government of Bangladesh.