No. 4

BASIC DESIGN STUDY REPORT
ON THE AID FOR
INCREASED FOOD PRODUCTION PROGRAM
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

JULY 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the People's Republic of Bangladesh, the Government of Japan decided to conduct a basic design study on the Aid For Increased Food Production Program and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Bangladesh a study team headed by Mr. Koichi MORITA, Assistant Director, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs from 27th March to 19th April, 1986.

The team had discussions on the Project with the officials concerned of the Government of Bangladesh and conducted a field survey in Dhaka and Comilla area. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the People's Republic of Bangladesh for their close cooperation extended to the team.

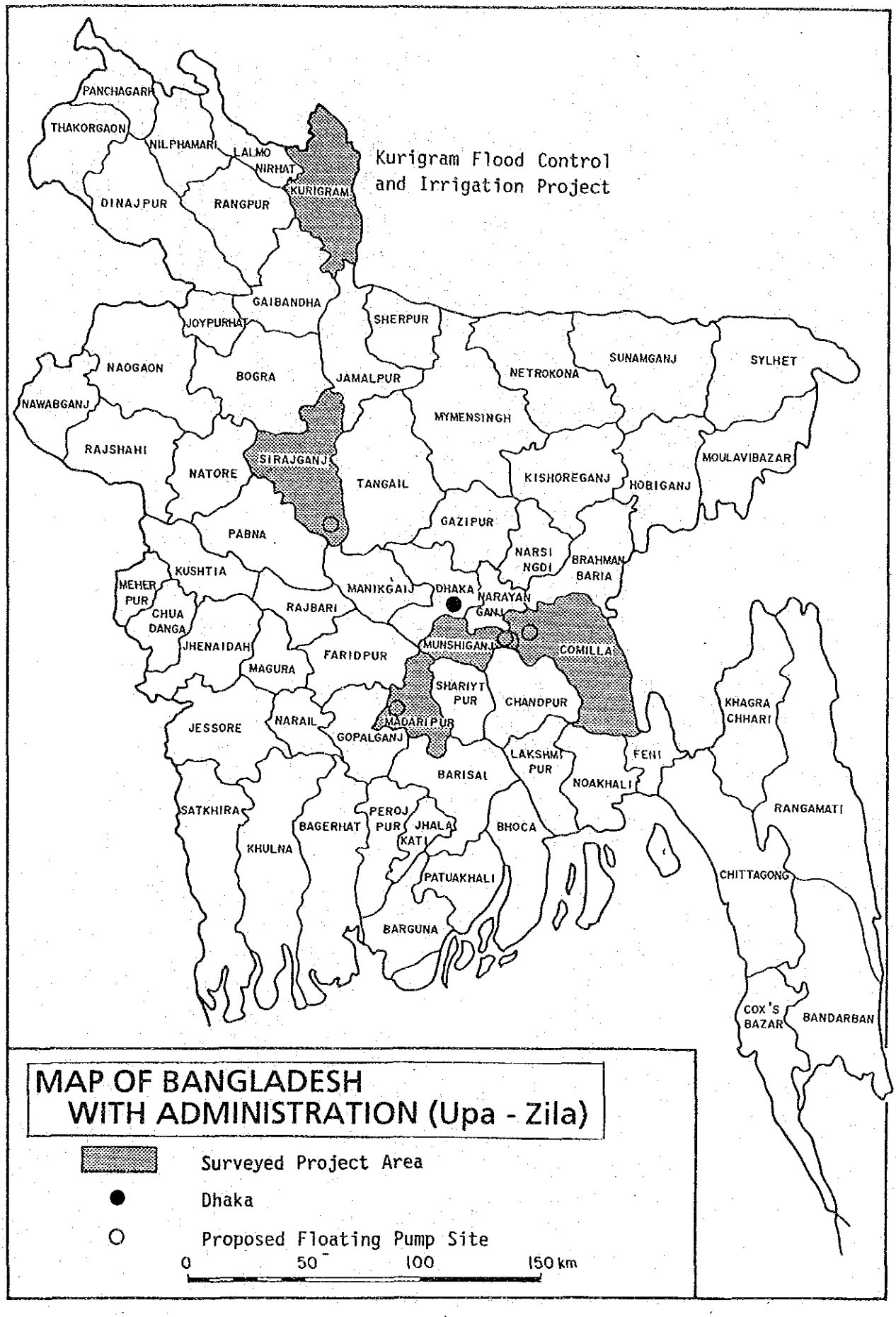
July, 1986

Keisuke Arita

Keisuke ARITA

President

Japan International Cooperation Agency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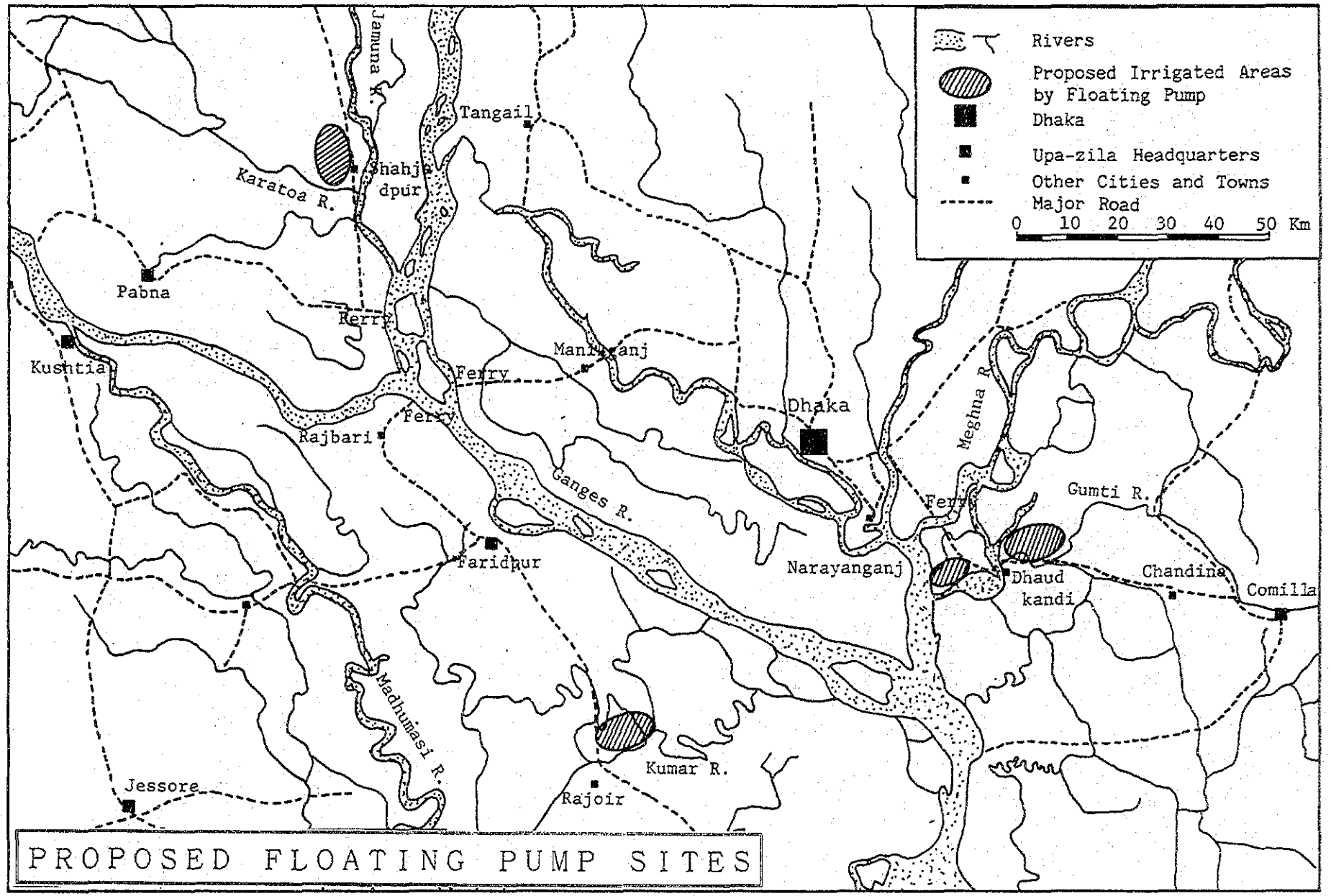
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SUMMARY

The People's Republic of Bangladesh confronts two major constraints to agricultural development due to its high popultation density and the fact that two-thirds of its gross land area is flat terrain subject to inundation in rainy season. These two problems are major factors limiting the efforts of the nation to achieve substantial improvement in agricultural production towards attainment of self-sufficiency in food supply. Steps to attain self-sufficient food supply include the implementation of the past 2 Five Year Plans, and the Third Five Year Plan from the Fiscal Year 1986. The most emphasized sector in the Third Five Year Plan is food production with an aim to step up the nation's annual grain production by 5.2%. In order to achieve this goal introduction of high-yield crops, increased application of chemical fertilizers and pesticides, and expansion of irrigation and flood control facilities have been planned.

The Japanese Govenment, in response to this need, has granted continual financial and technical assistance to Bangladesh since the country became an independent nation. The amount of finance granted from 1972 to 1985 has reached a total of 424.8 billion yen. Of this total, the amount of finance directed specially at the Aid for the Increased Food Production Program (hereinafter referred to as the Program) implemented in the eight years from 1977 to 1984 was approximately 19 billion yen. This is the second largest amount granted next to that received by Thailand among the recipient countries receiving financial assistance from the Japanese Government. Equipment and materials provided under the Program have been fertilizers, pesticides and agricultural machinery which contribute to the increase in food production, and the provisions of the items have been determined based on the request of the Government of Bangladesh without conducting detail study like basic design, etc. However, the circumstances and reasons for which the present basic design study was conducted are summarized hereunder:

a) The Government of Bangladesh has requested provision of floating pumps. Appropriate basic design is necessary for

provision of this item as floating pump units are much larger in capacity than those granted in the past.

b) Bangladesh is requesting continued provision of agricultural materials and machinery. Evaluation of the effect and the state of utilization of those items provided in the past must be conducted prior to study on the provision of materials requested beyond 1986. This will improve the effect of the program.

In response, the Japan International Cooperation Agency dispatched a Basic Design Study Team headed by Mr. Koichi Morita, Assistant Director, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs. The Team undertook the basic design study for 24 days from March 27 to April 19, 1986. At the begining of the study the equipment and materials that were the objectives of the basic design were those requested by the Government of Bangladesh, including floating pumps to be provided beyond 1986. However, while the study team was still in Bangladesh, the Government of Bangladesh excluded TSP fertilizer which dominated the major portion of the amount of finance (3.2 billion yen out of 3.8 billion yen) from the items subject to provision for 1985 and requested for advanced provision of construction machinery/equipment for the floating pump and irrigation projects instead. Study was thus conducted for items including those requested in the fiscal year 1985.

Content of the Study

1. Evaluation of the Items Provided in the Past Under the Program.

(1) Fertilizers

Fertilizers provided by the Japanese Government have been received and handled by Bangladesh Agricultural Develpment Corporation (BADC) which thereafter resells the fertillizers to farmers at rates lower than purchased prices under a subsidy system. Fertilizers provided in the past are 71,324 tons of urea fertilizer and 30,045 tons of TSP fertilizer. The ratio of the equivalent benefit of the increased yield to the CIF price invested in fertilizer application was 2.73 in 1981 and 4.34 in

1984 respectively. This benefit/cost ratio is considered a clear proof that the fertilizers were used effectively.

(2) Pesticides

Contributions of pesticides in the past are 200 tons of insecticides to the Plant Protection Wing, Ministry of Agriculture and 10 tons of insecticides to the Directorate of Food, Ministry of Food. The Plant Protection Wing has been giving free insecticide application to local farmers which is considered very effective as it is estimated that 5% of paddy yield that was being damaged by insect infestations before application is now recovered after the application. As for the portion provided to the Directorate of Food, Ministry of Food, the benefit/cost ratio is expected to be approximately 14.0 assuming that the insecticide applications would subtract 1% off the 3.75% of loss during storage. Accordingly, the economic effect of the chemicals is considered sufficiently high.

(3) Agricultural Machinery

Machinery provided in the past were mainly those used for irrigation. Among these machinery items, pump engines dominated an equivalent of 97% of the total agricultural machinery cost granted. Irrigation has considerable effect on food production as it increases the total yield by enabling cultivation of Boro rice during the dry season. The economic effect of the machinery introduction is also favorable with a benefit/cost ratio of 1.16. The total number of engines contributed in the fiscal year 1984 under the Program are:

Engines for deep tubewell pumps	1,550	nos.
Engines for shallow tubewell pumps	84,372	nos:
Engines for low-lift pumps	3,450	nos.
Total	89,372	nos.

The total number of pumps provided is equivalent to 60% of those imported by government agencies during the same period.

(4) Counterpart Funds

The procedure for entering accounts and recording expenditures of the counterpart fund is unclear, as it is proceessed under the disbursement schedule of Annual Develpment Plan (ADP) and has not been reported properly to the Japanese Government. The counterpart funds are all lumped together and deposited into one account. In addition, it appears that the counterpart funds deposited up to the present do not reach the 2/3 level of FOB Value as specified in the Exchange of Notes.

2. Basic Design for Pesticides and Agricultural Machinery for the Fiscal Year 1985.

(1) Pesticides

As it was found that a considerable amount of pesticides for aerial spraying provided to the Plant Protection Wing in the past is still in stock, it is proposed that a provision of 160 tons of insecticides for land spraying is appropriate, considering the spraying capacity and the sizes of areas to be benefited.

Contribution of 100 tons of fumigants for application inside food silos to the Directorate of Food, Ministry of Food was proved appropriate by the past fumigating effect and a benefit/cost ratio of 1.38.

The contents of the basic design for pesticides thereby can be summarized hereunder:

Plant Protection Wing, Ministry of Agriculture:

Insecticides for land application	160	tons

Directorate of Food, Ministry of Food:

Methyl Bromide	100	tons

(2) Agricultural Machinery

The contents of the equipment and materials are as listed hereunder:

1) For Bangladesh Agricultural Development Corporation.

a) Machinery for DTW use.

DTW engine (36HP)	500	nos.

	Gearhead (Including Shafts)	500	nos.
b)	Spare parts for all pumps.	1	lot
2)	For Bangladesh Water Development Board:		
a)	Submersible DTW pump		
	$3.4m^3$/min, total head 33m	20	nos.
b)	Sheet pile		
	W400mm X T13mm X H125-130mm X L12m	1,000	tons.
C)	Vibrating pile driving hammer		
	Motor capacity 40KW or more	2	nos.
d)	Generator		
	Capacity 100KVA or more	2	nos.
e)	Dragline		
	Bucket capacity $1.2m^3$, 40ton	2	nos.
f)	Bulldozer		
	200Hp	2	nos.
	100Hp	2	nos.
g)	Pay-loader		
	70HP, bucket capacity $1.2m^3$	1	no.
h)	Dump truck		
	10 ton	5	nos.
i)	Well-point pump		
	$6m^3$/min, 10 in. pipe	10	sets.
j)	Rod cutter		
	32 mm. dia. or less	1	no.
k)	Pipe cutter		
	300 mm. dia. or less	1	no.
l)	Bender		
	pipe: 300 mm. dia. or less	1	no.

	rod: 32 mm. dia. or less	1	no.
m)	Crane		
	Rail-mounted, span 30m.		
	Height 12m, 5 ton	1	no.
n)	Gas cutter	1	nuit.
o)	Electric welder	1	unit.
p)	Spare parts for engines and vehicle.	1	lot.
3)	For the Ministry of Food.		
a)	Truck		
	10 ton or less	40	nos.
b)	Moisture meter		
	Electric resistor type	500	nos.
c)	Grain dryer		
	Flat type, engine drive	10	nos.

3. Basic Design for Floating Pumps.

Waterways in Bangladesh are characterized by great differences in water levels in rainy and dry seasons, and the constant meander of river channel due to flooding. These defective conditions have reduced the scope of operations of large fixed-type pumps. It was estimated that about $700m^3/s$ of surface water has potential for irrigation. The introduction of floating pumps aims at the effective utilization of this surface water.

According to the result of survey over the 4 districts proposed, it was concluded that the implementation of floating pumps would bring about desirable economic effects in addition to the great advantages that floating pumps are mobile and can operate through out the year regardless of water level of the river. The contents of the basic design for the floating pumps are listed hereunder:

1) Installation site

4 Districts, 6 sites

2) Capacity and quantity of floating pumps

350 lit/sec	total head 15m	2	nos.
350 lit/sec	total head 9m	4	nos.
700 lit/sec	total head 9m	3	nos.
30 lit/sec	total head 9m	6	nos.

3) Attachments

Small	4	nos.
Tugboat	4	nos.
Inspection boat	4	nos.
Jeep	4	nos.

4) Construction to be undertaken by Bangladesh

Impact box	6	sites
Cross dams (simple earthen dykes)	11	sites
Discharge pipe installation	6	sites

4. Increased Food Production Program beyond the fiscal year 1986.

Request of the items under the Program beyond the fiscal year 1986 is envisaged as follows:

- Fertilizers (ammonium sulphate, potassium sulphate)
- Pesticides (silo fumigant, insecticide, germicide)
- Floating pumps and attachment
- Irrigation equipment and materials
- Equipment and materials for construction of irrigation facilities
- Post-harvest processing machinery
- Machinery for grains transport

In addition, items that can not be requested until applicable preconditions are satisfied are:

1) Items that require registration within Bangladesh:

A portion of pesticides (herbicides, seed sterilizer)

2) Items that required standardization within Bangladesh:

- Tractor
- Engine
- Power sprayer
- Portable power sprayer
- Power thresher

3) Items in the event that procurement conditions are changed to that of "General Untied".

- Fertilizer (TSP fertilizer, Zinc sulphate., etc.)
- Pesticide (Alminium phosphide)

4) Items applicable to potatoes and beans cultivations:

- Collection barge for aquatic weeds (water hyacinth, etc.)
- Composting machine
- Manure spreader
- Drip-irrigation facilities
- Sprinkler irrigation facilities
- Seeds silo
- Bean thresher
- Pesticides for upland crops

5) Items indirectly contributing to increased food production:

- Vehicles for extension station use.
- Motorcycles for extension staff.
- Audio-video equipment for farmer education, vehicles for farmer training and mobile farmer education stations
- Equipment for the suppression of insect infestation.
- Equipment and materials for agricultural research stations.

5. Conclusions

Past donations of fertilizers, pesticides and agricultural machinery are considered as having been economically effective, according to studies of the benefit/cost ratio, and as having made a contribution to increase in food production in Bangladesh.

Regarding the counterpart funds, the amount deposited appears as not reaching the 2/3 FOB value as specified in the Exchange of Notes. There is no confirmed information available regarding the utilization plan for counterpart funds.

Except for certain items, the pesticides, agricultural machinery, floating pumps, and irrigation construction materials requested for the fiscal year 1985 would contribute solidly to the Increased Food Production Program and these items are therefore considered appropriate for provision under the Program. Especially the Floating Pump Project which is anticipated to be very effective for the expansion of cropping area is evaluated as directly contributing to the Program and a continuation of the project based on its phase wise plan beyond 1986 is considered desirable.

Problems regarding the implementation of the Program are as follows:

1) Submissions of requests for items have been frequently delayed and appropriate evaluation and study could not be done due to time limitations.

2) Materials and machinery provided in the past have been distributed nationwide. This has made evaluation of the effect of the items provided difficult.

3) There are some items among those subject to provision under the Program that are manufactured in Japan no longer, as well as items that can be purchased at lower prices elsewhere.

4) Some issues regarding the depositing of the counterpart funds remain to be resolved between the two governments.

5) Some of the items requested are not in the scope of the original Program even though it is evident that these items would contribute to increased food production.

6 Proposed Improvements in the Program.

1) It is desirable that the Government of Bangladesh present the contents of request to the Japanese Government as early as possible one year prior to scheduled year for provision of equipment and materials.

2) Material and equipment to be provided should be to the extent possible requested on a project base whereby specific areas or development projects wherein the subject items are to be utilized are clearly designated. This will facilitate annual planning for assistance under the Program as well as evaluation of assistance effect.

3) Materials and machinery that can be purchased at lower rates on international markets and items with strong demand in Bangladesh but are not manufactured any more in Japan should be studied for possibility of giving general untied status as one of the counter-measures.

4) It is desirable that the Government of Bangladesh improve its depositing system for counterpart funds to comply with that stipulated in the Exchange of Notes (2/3 of FOB value.)

5) Studies should be considered to restructure the Program when there are engineering and civil works involved in addition to provision of materials and machinery. Multiple effects of the Program can be obtained if engineering and construction works are proposed as objectives of the program, and implemented parallelly or successively under cooperation in terms of loans, grants, or technology.

6) Possibility should be investigated of extending the objectives of the assistance to sectors other than food-crop cultivation, such as livestock production, fishery, forestry, farm-road construction, and sectors which indirecty contribute to food production such as agricultural extension and farm education.

7) In order to make the implementation of the Program truely useful to Bangladesh, dispatch of a JICA expert or long-term resident specialist capable of long-term study, evaluation and advice regarding the status of the Program to the recipient government would be considered effective. Study for such dispatching of an advisor is recommended.

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ABBREVIATIONS AND GLOSSARY

ADB	Asian Development Bank
ADP	Annual Development Program
AGD	Approved Grain Dealer
Aman	Rice planted before or during the monsoon and harvested in November - January
A/P	Authorization to Pay
AS	Ammonium Sulphate
Aus	Rice planted during March - April and harvested during July - August
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BB	Bangladesh Bank
BBS	Bangladesh Bureau of Statistics
BCIC	Bangladesh Chemical Industries Corporation
BKB	Bangladesh Krishi Bank
Boro	Rice planted during December-January and harvested during April-June
BRRI	Bangladesh Rice Research Institute
BRDB	Bangladesh Rural Development Board
BWDB	Bangladesh Water Development Board
DAP	Diammonium Phasphate
CAD	Command Area Development
CDST	Customs Duties and Sales Taxes
CIF	Cost, Insurance and Freight
CIP	Crop Intensification Program
CSD	Central Supply Depots
DAE	Department of Agricultural Extension
DTW	Deep Tubewell
EEC	European Economic Community
E/N	Exchange of Notes
ERD	External Resources Division, Ministry of Finance
FAO	Food and Agriculture Organization
FFYP	First Five Year Plan

F O B	Free on Board
F R G	Federal Republic of Germany
F Y	Fiscal Year (From July to June)
G D P	Gross Domestic Product
G O B	Government of Bangladesh
H P	Hyperphosphate
H Y V	High Yielding Variety
I B R D	International Bank for Reconstruction and Development
I D A	International Development Association
I D B	Inter-American Development Bank
I F D C	International Fertilizer Development Center
K S S	Krishak Samabaya Samity (Farmers' Cooperative Sociaty)
J I C A	Japan International Cooperation Agency
L L D C	Least Less Developed Countries
L L P	Low Lift Pump
L S D	Local Supply Depots
L V	Local Variety
M P	Muriate of Potash
M O A	Ministry of Agriculture
M O F	Ministry of Food
N P K	Nitrogen, Phosphate Potassium Complex Fertilizer
N M S	New Marketing System
O & M	Operation and Maintenance
O P E C	Organization of Petroleum Exporting Countries
P A B	Pesticide Association of Bangladesh
P D P	Primary Distribution Point
P P W	Plant Protection Wing
P S	Potassium Sulphate
S F Y P	Second Five Year Plan
S P	Single Superphosphate
S P U P	Small Project by Upa-Zila Prisad
S T W	Shallow Tubewell
T F Y P	Third Five Year Plan
T S P	Triple Superphosphate
U A E	United Arab Emirates

UCCA	Upa-zila Central Cooperative Association
UK	United Kingdom
ULV	Ultra Low Volume
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Emergency Fund
USA	United States of America
USAID	United States Agency for International Development
USSR	Union of Soviet Socialist Republics
WB	World Bank

Unit

g	gram
kg	kilogram
ton, t,	metric ton
Mill. T	million ton
cm^3	cubic centimeter
m^3	cubic meter
ℓ	liter
sec	second
min	minute
h	hour
d	day
ha	hectare
kg/ha	kirogram per hectare
lit/sec	liter per second
lit/min	liter per minute
m^3/sec	cubic meter per second
m^3/min	cubic meter per minute
ton/ Kℓ	metric ton or kiloliter
cusec	cubic foot per second
RPM	revolutious per minute
HP	horse power

Currency

US$	U.S. dollar
¥	Japanese yen
Taka, TK	Bangladesh taka

CHAPTER I

INTRODUCTION

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The People's Republic of Bangladesh commenced implementation of the Third Five Year Plan in 1986. Available farm area is limited by the population density of approximately 700 persons/km^2 as well as by topographical factors and frequent flooding. Although agriculture is the primary industry accounting for 55% of GDP and 68% of labor, food production is insufficient to meet domestic demand. Accordingly, the Government has given high priority in the Third Five Year Plan to increase food production with specific goals of self-sufficient supply of staple foods, increased employment opportunities and increased productivity.

Accordingly, the Japanese Government has been providing technical and financial assistance since the independence of Bangladesh in December 1972. Assistance from 1972 to 1985 amounted to ¥326.6 billion in loans and ¥98.2 billion in grant aid for a total of ¥424.8 billion. From 1979 to 1982 Japan provided the largest amount of bilateral assistance and since 1983 has been the second largest contributor after the United States. Assistance is mainly provided for food production increase and fulfillment of basic human needs which are given high priority in Bangladesh. In order to utilize the assistance more effectively, annual bilateral meetings have been held since 1981 to consult on the program.

The Aid for Increased Food Production Program (hereinafter referred to as the Program) began in 1977 to support indigenous efforts in developing countries to achieve self-sufficient food production. The Program to Bangladesh commenced in 1977 and comprises ¥19 billion of total aid provided which is the second largest amount provided to any one country. Items requested under the Program contribute directly to food production increases and include fertilizers, agricultural chemicals and agricultural machinery.

As of 1985, study on the following two points became necessary. (1) The Government of Bangladesh requested floating pumps which are considered effective for expanding irrigated agriculture, an actively

promoted policy in Bangladesh. As this type of pump is larger than those previously contributed, evaluation of the operation and maintenance system, the budget allocation for domestic currency portion, usage plan, target area and benefits, and basic pump design are necessary. (2) Bangladesh was the second largest recipient country of the Program in 1984 and plans to continue requesting assistance in future. Post-evaluation of grant commodities and study of subsequent requests is required to increase the effectiveness of the Plan.

Accordingly, the Japanese Government decided to conduct basic design for the Program. The Basic Design Study Team headed by Mr. Koichi Morita, Grant Aid Division Assistant Director, Economic Cooperation Bureau, Ministry of Foreign Affairs was dispatched from 27 March to 19 April, 1986 through Japan International Cooperation Agency (hereinafter referred to as JICA).

The original objective of the Team was to study the items requested by the Government of Bangladesh, including the floating pumps for FY 1986. However, while the Study Team was in the field, the Government of Bangladesh withdrew its request for TSP fertilizer which comprised ¥3.2 billion of the total ¥3.8 billion allotted for 1985, and requested provision of floating pumps and construction machinery in place of the fertilizer. It was therefore decided to submit the revised request under the request for 1985 instead of 1986. TSP was dropped from the original request due to the high unit price of Japanese made fertilizer compared to the international market price, and due to the allocation of counterpart funds at 100% of the CIF price, instead of at two-thirds the FOB price. The objectives of the Basic Design Study are accordingly as follows:

(1) Post-evaluation of previously granted items, study of the request background, the financial feasibility and technical viability for 1985 and on the basis of the above, formulation of a basic design; and,

(2) Planning the future Program

Discussions and hearings were held with people concerned in Bangladesh (ANNEX 3) and surveys were conducted in the proposed project areas of Shahjadpur (Sirajganj Zila), Gazaria (Munshiganj Zila), Rajoir (Madaripur Zila), Dandkandi (Comilla Zila), Joydepur (Gazipur Zila), and

Kurigram Zila. Survey results were discussed with concerned officials of the Government of Bangladesh and compiled as the Minutes of the Meeting (ANNEX 5).

This report presents the results of analysis of the national and farm economy, food production conditions in Bangladesh, the background of previous contributions under the Program, evaluation of and basic design for the request for 1985, as well as recommendations for future assistance under the Program.

CHAPTER II

BACKGROUND

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2.1 National Outline

2.1.1 Natural Conditions

(1) Topography

Bangladesh can be divided into two major topographical regions; the plain region in the lower reaches of the Ganges River, and the Chittagong Hill region along the borders of India and Burma.

Ganges Plain Region

This region encompasses the majority of land area in Bangladesh. The area is predominantly flat lowland below elevations of 9.2m and even highland areas are only 100m in elevation, with a very gentle incline. The plain is criss-crossed by a network of large and small rivers and the three largest rivers (the Ganges, Brahmaputna and Meghna rivers) with their tributaries form one of the largest deltas in the world. Silt rich in organic material is deposited by floods in the rainy season, maintaining soil fertility. Excluding the Barind forest in the northwest and the Madhupur forest belt in the central north, the soil on the plain is almost entirely composed of fresh alluvial material deposited by these three great rivers (Fig. 2-1).

Chittagong Hill Region

This region is bordered by India and Burma and the elevation increases towards the east. Joining the western edge of the Arakan Yoma and Burma mountain ranges, the region has a maximum elevation of 1,230m and comprises the largest forest area in Bangladesh.

(2) Climate

The climate belongs to the subtropical monsoon type and is divided into three seasons; winter, summer and monsoon season with the following characteristics.

1. Winter (Nov.-Feb.): This season features moderate temperature and humidity with almost no precipitation. Cyclones frequently occur during the transition period characterized by strong winds bearing heavy rainfall from the Bay of Bengal to the interior. When these cyclones occur at high tide, the high waves cause heavy damage in coastal areas.

2. Summer (Mar.-May): This is the hottest time of the year. One-fifth of annual rainfall falls during this season and humidity is high. Winds blow from the northwest.

3. Monsoon (Jun.-Oct.): This season is characterized by high temperature and high humidity, the latter sometimes reaching near 100%. Four-fifths of annual precipitation falls during this season; however, cyclones rarely occur although rain is sometimes accompanied by strong winds.

The main climatic feature is the marked difference between the amount of rainfall in the monsoon season as opposed to the dry (winter) season. As the majority of precipitation is concentrated in the monsoon season, flooding is severe and river water is swept into the ocean before it can be adequately exploited for agricultural purposes. In winter on the other hand, rainfall is so scarce that agriculture cannot rely solely on natural rainfall.

Accordingly agricultural productivity is constrained by flooding in the monsoon season which covers the large area of fertile low land. In contrast, irrigation is unavoidable for cropping during the winter season when rainfall is sparse.

2.1.2 Socioeconomy

Bangladesh is situated on a large delta plain formed by the Ganges and Brahmaputra rivers. Although the civilization of the area has a

long history, the People's Republic of Bangladesh was only recently established as an independent country in December 1971.

Bangladesh is characterized by a high population density which is aggravated by the fact that two-thirds of the total land area is submerged during floods. These factors greatly influence socioeconomic conditions throughout the country. Total land area is 144,000km^2 while the population is 100 million as of 1985, resulting in a population density of 694 persons/km^2, one of the highest in the world. Despite Government efforts to control population growth, the growth rate in 1984 was 2.4%. The average life span in 1960 was 37 years. By 1981 it had increased by 11 years to 48 years; however, this is still much shorter than those of other countries. The infant mortality rate was particularly high at 125 deaths per 1,000 (1984 figures). These conditions reflect the low caloric intake and low potable water service ratio (REFERENCE 1). Three population projections are presented in the following table. Even the most optimistic projection-3 forecasts a population of 131.7 million by the year 2000 which is about 1.5 times the 1980 population.

PROJECTED POPULATION OF BANGLADESH AT THE YEAR 2000[1/]

(Unit: 1,000)

Year	Projection-1			Projection-2			Projection-3		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
1980	88,507	45,582	42,925	88,507	45,582	42,925	88,507	45,582	42,925
1985	100,054	51,546	48,508	100,468	51,754	48,714	100,200	51,588	48,612
1990	112,865	58,160	54,705	113,005	58,213	54,792	111,300	57,269	54,031
1995	127,086	65,482	61,604	126,341	65,063	61,278	121,999	62,727	59,272
2000	142,141	73,200	68,941	139,693	71,916	67,777	131,695	67,661	64,024

Note: * Based on adjusted population of 1981 Census.
Source: BBS., Population Census 1981.

Potential for expansion of cultivable land area is minimal and cultivable area per person was about 0.09ha in 1985. If cultivable area remains the same and population increases according to Projection-1, cultivable area per person in 2000 will be reduced to 0.06ha and,

assuming a unit yield of 1.35t/ha and a cropping ratio of 153% (1983/84 standard), rice production per person is estimated to drop from the present 148kg (milled rice) to only 101kg in 2000. In addition, the farm land ownership system is changing with an increasing number of landless and small-scale farmers. This trend is expected to continue.

GDP in 1985 was TK362 billion and GDP per capita was about TK3,620 (about US$130). Of total GDP, the agricultural sector comprises 54.5%, versus the industrial and transportation and communication sectors which comprise only 8.5% and 7.4%, respectively, and consequently about 68% of the labor population are engaged in agriculture related work.

The real GDP growth rate in agricultural sector fluctuated greatly during the last six years, peaking at a high of 7.1% in 1980 and reaching a low of -0.6% in 1982. The GDP growth rate for the industrial sector also fluctuated, ranging from a high of 8.1% in 1981 to a low of 0.3% in 1983. Due to fluctuations in each sector, the annual average growth rate for the six year period was 4.6%, exceeding the annual average population growth rate of 2.4% (1984).

However, little headway was made in overcoming the fundamental problems of crop shortage and unemployment. Although emphasis was placed on agricultural development in the Second Five Year Plan in an effort to increase food production, the objectives were not achieved due to successive natural disasters including flooding and drought. Flood damage in 1985 in particular amounted to 1.5 million tons of cereal grains.

The balance of trade is marked by a constant import surplus exceeding US$1.5 billion/year and reaching a total of US$1.9 billion in 1985. Main export items consist of jute, leather, tea and fish while major import items are oil, wheat, rice, chemical products and machinery. The volume of grain imports was particularly large comprising an average of 16.8% of total imports from 1980 to 1985.

In view of the above situation, the Government of Bangladesh has placed high priority on food production increase in the Third Five Year Plan (1986-1990) in an effort to achieve self-sufficient food supply and to increase production of export crops.

2.2 Agriculture

Agriculture is the main industry in Bangladesh comprising 55% of GDP, 68% of labor and 60% of total land area. Farming is characterized by lack of land and a large labor force and is centered in the delta area. Agricultural practice is greatly influenced by the monsoon type climate.

2.2.1 Land Use

Cultivable area is about 87,000km^2 representing 60% of the total land area of 144,000km^2. As shown in Table 2-1, cultivable land area has increased by only about 2% in the last 10 years and further expansion is not considered likely as there is very little potential arable land remaining. Cropping intensity on the other hand, has increased by about 7% along with an increase in irrigated area and efforts are being focused on effective land use and increased productivity through the introduction of high yield varieties and extension of modern farming practices.

Total cropped area in 1983/84 was 13.26 million ha, of which 10.59 million ha (80%) was planted with rice. The cropped area for jute, an important cash crop was 580,000ha, second to rice cropped area, and that for wheat was 530,000ha. The large area devoted to rice is due to traditional dietary preference and the tendency of small landowner farmers to give priority to growing their own staple food. In addition, farmland is unsuitable for crops other than jute and rice due to inundation of two-thirds of the total land area in the rainy season.

The cropping and harvest seasons of major crops are illustrated in Fig. 2-2. As the cropping seasons of Aus, Aman and Boro are different, triple cropping is conceivable in areas where transplanting is possible if water supply could be regulated by irrigation. In lowland areas however, where water depth in the rainy season exceeds 1m, only broadcasted floating paddy such as broadcast Aman, can be cultivated. In this case, production is limited to single cropping of local varieties by utilizing residual water in the dry season.

The cropping seasons for jute and Aus overlap and choice of crop depends upon their respective prices. When the price of rice is higher

than that of jute, rice is generally cultivated in all areas, excluding certain lowlands where only jute can be produced. The cropping seasons of wheat and Boro also overlap. Recently, the cultivated area of wheat has increased rapidly due to Government promotion and the lower water requirement in comparison with rice. Cropping seasons for tobacco, vegetables, coarse grains and other dry season crops are the same as that for wheat.

From the above it can be seen that cropping patterns in Bangladesh vary in accordance with elevation, availability of irrigation facilities, proximity to rivers and potential for exploitation of water for irrigation.

2.2.2 Agricultural Production

The major crops in Bangladesh are rice, wheat and jute, comprising almost 90% of total cropped area. Since independence in 1971, however, the need for diversification of crops has been emphasized with resultant increases in irrigated area and a trend towards increased cropping of dry season crops. Increased wheat cropping area is particularly noticeable (Table 2-2 to 2-4). Production trends of individual crops, including the food crops rice and wheat, and the cash crop jute, as well as other crops are discussed hereunder.

(1) Rice

Rice production occupies a vital position in total agricultural production. However, although about 80%, (10.6 million ha) of total cultivated area (13 million ha) is devoted to rice production, self-sufficient food supply has not yet been achieved. Total rice production was 14.3 million tons in 1984/85. From 1978 to 1984 the average annual rate of increase for rice production was only 1.7% which is insufficient to keep pace with the population growth rate of 2.4%. The average unit yield of all varieties is 1.35 tons/ha and that for Boro rice is 2.36 tons/ha. The average unit yield increase rate of rice is only 0.7%. This low rate reflects the lack of increase in Aus and Aman yields. Only Boro production has increased and continues to increase at an annual rate of 2.2%. Irrigation facilities in Boro cropped area

have increased as has the actual area cultivated with Boro. In 1978, Boro comprised 18% of total rice production. By 1984 this had increased to 23%.

(2) Wheat

Cropped area of wheat was 530,000 ha in 1983/84 and wheat production was 1.2 million tons, which is equivalent to 8.4% of rice production and unit yield was 2.26 tons/ha. Wheat was originally cultivated only in a limited area in the northwest and was only cultivated nationwide after independence, particularly after 1975/76. Limited wheat cultivation was due to traditional preference for rice as the staple food and the need for irrigation as wheat is grown in the dry season. With the chronic food shortage, however, and imports of wheat as part of international aid, the population has increasingly become accustomed to eating wheat. Moreover, irrigated area increased and wheat became more popular as it requires less water than rice for cultivation. Furthermore, increasing yields due to introducion of high yield varieties, as well as rising market prices have encouraged farmers to cultivate wheat. As a result of the above conditions, wheat production and cultivated area have increased rapidly since 1975/76.

(3) Jute

Jute production in East Bengal in 1947 accounted for about 80% of total world jute production. Production in Bangladesh has steadily decreased since that time due to increased jute production in India and Nepal, and kenaf production in Thailand, with Bangladesh production dropping to about 35% of world production in 1969/70.

Cropped area of jute was 580,000 ha in 1983/84, unit yield was 1.49 tons/ha, and total production was at 0.9 million tons. Jute plays an important role in the Bangladesh economy; however, cropping area and production volume fluctuate greatly each year and yield is in general declining. Jute production is strongly influenced by water depth and the rainy season. Moreover, due to competition from recently developed synthetic fibres for string, etc. and resultant limits on the farm gate price, there is less

incentive for farmers to grow jute. As the growing seasons for jute and Aus overlap, jute cropping area is reduced in favor of Aus when the price of rice is high and jute is planted only in areas where rice cannot be cultivated. In general, if the price ratio of jute to rice is between 1.1~1.5 at the present level of technology, the cropping area of jute would be stable; however, the price ratio has not exceeded 1.0 since 1974/75.

According to an FAO survey, jute production cost in 1975 was 780Taka/acre and Aus production cost was 710Taka/acre. Gross income per acre was 1,217Taka for jute and 1,250Taka for Aus and profit was 437Taka and 540Taka, respectively. Accordingly, if gross income from jute is not increased by increased jute yield, there is no incentive for farmers to cultivate it.

(4) Other Crops

Sweet potato production began to increase rapidly in the late 1960s as a result of the introduction of the Dutch variety and emphasis on cultivation of secondary food crops to alleviate the food shortage. Production continued to increase after independence with a yield of 1.8 million tons in 1983/84 for a total growing area of 180,000ha, the highest yield ever attained in Bangladesh.

Pulses are a major upland crop during the dry season with a cropping area of 280,000ha (1983/84), and a yield of up to 200,000t. Although pulses are an important source of protein next to fresh water fish, its cultivation has been considered secondary to rice and little effort has been made to increase pulse yield or introduce improved varieties.

Oil seeds are mainly grown as a field crop during dry season, and rape (mustard) seed is the most widely cultivated variety.

2.2.3 Land Ownership

Under the Land Reform Law of 1950, the large landowner Zamindar System was abolished and land ownership was limited to a maximum of 33acre(13.2ha). Those who held permanent land debt rights under the

Zamindar System became owner cultivators. More than 80% of farmland was cultivated by such farmers while about 20% was cultivated by sharecroppers. In the 35 years following independence however, rural society underwent substantial change including changes in farm scale and distribution of farmland. Major trends were as follows:

a) Average landholding per person shrank and is projected to reach 0.07ha in 1990.

b) Landless farmers have been increasing annually with particularly sharp increases in recent years.

c) The ratio of sharecroppers has also been increasing.

d) The structure of rural society is rapidly changing, with increasing concentration of farmland in the hands of large landowners since the beginning of the 1970s.

e) The dispersion of land has been increasing due to carefree acquisition of land by large landowners.

Concentration of farmland under a small number of large land owners was a natural result of low agricultural productivity and unstable production. Return from investment is most assured with a large scale enterprise and small-scale farmers are unable to obtain the inputs necessary for viable farm management due to poor production. Large landowners lease the land they have purchased to tenant cultivators or hire farm labor to cultivate it; however, they are not always keen to actively invest in inputs for production increase.

The following data concerning land ownership were obtained from a land ownership survey conducted in 1977 (Table 2-5).

a) 32.8% of total farm households are comprised of landless farmers.

b) 15.3% of farm households own less than 0.5acre (0.2ha).

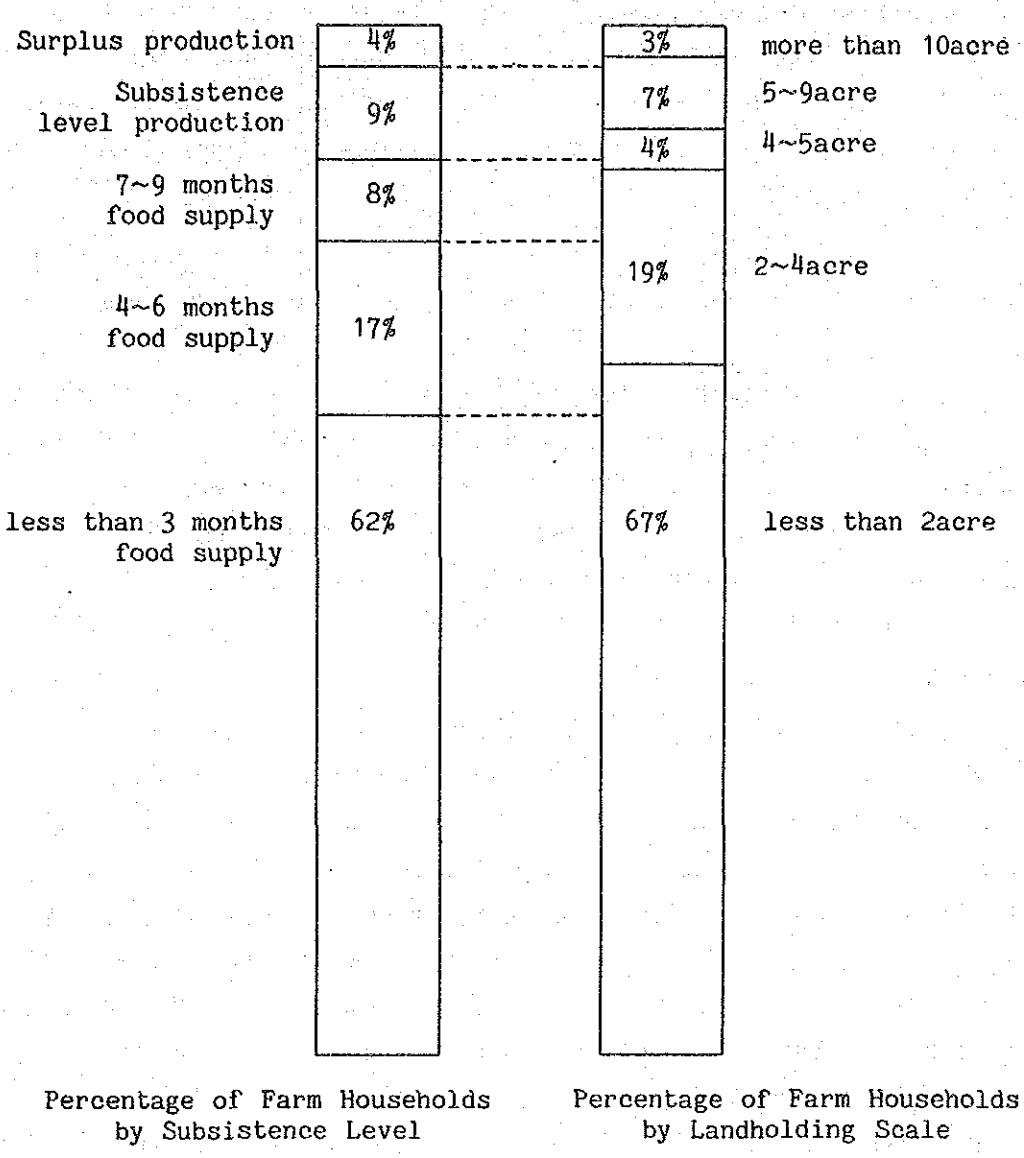
c) Assuming annual rice consumption/person is 160kg with single cropping, 2acre (0.8ha) of land will provide staple food for 6.25 people. This does not include expenses for other food stuffs and clothing or general living expenses. Farmers owning 2acre or less and landless farmers comprise 77.7% of the total number of farm households.

d) The above 77.7% of farmers own only 25.1% of total farmland.

e) According to a survey conducted in 1973/74 for the Integrated Rural Development Plan (IRDP), the self-sufficiency ratio of 62% of landowning farmers was less than

0.25% (3 months), while 17% of landowning farmers had a ratio of 0.33-0.5% (4-6 months), and another 8% had a ratio of 0.58%-0.75% (7-9 months). Of the remainder, 9% were barely self-sufficient while only 4% produced a surplus. Comparing these figures to landholding scale, it is evident that a landholding of more than 4.5acre (1.8ha) is required for subsistence farming. The ratio of farmers with over 4.5acre of land is only 8.2% including landless farmers. In other words, 91.8% of total farm households produce below the subsistence level at present production levels, and of these, 32.8% are landless farmers who must purchase their entire food supply, 41.9% produce only enough to survive for 3 months, 11.6% produce food supply for 6 months and 5.5% produce food supply for 9 months.

LANDHOLDING SCALE COMPARED TO LEVEL OF SUBSISTENCE FARMING



Source: BADC
Note: Percentage of total farm households including landless farmers.

Those farmers who cannot subsist on farming alone (about 92%) must find supplementary employment as farm labor or as laborers in other sectors. Job opportunities are scarce however, and only 20% of the available jobs guarantee a long-term position. Small landholding farmers who mortgage their farms in order to borrow money become landless farmers if they are unable to repay the loan.

As the farm economy is unstable, capital accumulation and investment in irrigation facilities, fertilizer, high yielding seed varieties and other inputs is difficult. Consequently, extension of modern farm practices which would increase economic viability is hampered. Moreover, large landholders, who own about 50% of total farmland and comprise only 10% of total farm households, are reluctant to invest in attempts to increase production, prefering to channel their capital into real estate which promises more certain returns. The combination of these factors has hindered the achievement of increased productivity.

Land management in 1977 is presented in the following table. Owner-cultivators are farmers who mainly use family members for farm labor with temporary hired help when necessary. This type of farmer comprises 23.5% of total farm households and 10.5% of total farmland area. Owner-manager refers to those farmers who, although they employ regular farm labor, also help with farm work themselves frequently with other family members. This type of management constitutes a commercial base system. This type of farmer accounts for 37.7% of farm households and 43.55% of farmland. Owner-cum-tenants comprise 32% of total farm households and they own 23.3% of farmland. The tenant farms managed by this type of farmer comprise 18.5% of total farmland area. Tenant farmers occupy 6.8% of total farm households and the tenant farms they operate account for 4.4% of total farmland.

LAND MANAGEMENT SYSTEM

	Total Farm Households (100 HH)	Ratio (%)	Owner Cultivator Land		Tenant Farm	
			Area (1,000ha)	Ratio (%)	Area (1,000ha)	Ratio (%)
Owner Cultivator	1,993.8	23.5	798.6	10.4	-	
Owner Manager	3,082.0	37.7	3,315.1	43.5	-	
Owner Tenant Cultivator	2,618.3	32.0	1,767.0	23.2	1,408.6	18.5
Tenant Cultivator	559.5	6.8	-	-	335.1	4.4
Total	8,183.6	100.0	5,880.7	77.1	1,743.7	22.9

Source: BBS, Summary Report of the 1977 Land Occupancy Survey of Rural Bangladesh, Dacca, 1977.

Tenant farms occupy 22.9% of total farmland area while the remaining 77.1% consists of owner-cultivator farms. However, many small farmers, using their farm as collateral, borrow money from large-scale farmers and until the loan is repaid, these farmers are treated as tenant cultivators. The number of potential tenant cultivators is therefore estimated to be much greater than indicated by the above figures.

Although the custom of cash payment for cultivation rights by tenants is increasing, payment of a percentage of the harvest is still predominant as 93.3% of tenant cultivators is sherecroppers. Moreover, as many as 5.5% of farm households expend more than 50% of their harvest as farm rent. In addition to a percentage of the yield, tenant cultivators are often required to pay a fixed fee for cultivation rights. A feature of this tenancy system is payment of 50% of yield at each harvest. If crops are harvested twice a year for example, the tenant must pay 50% of each yield, thus paying tenancy twice a year. Although the tenant is given the right to use tenant land, he must bear the cost of necessary inputs such as seeds, fertilizer, agro-chemicals and irrigation facilities himself. The following table shows survey results on farm inputs cost burden by tenant-cultivators and landowners (total of 3,178,100 households).

COSTS FOR FARM INPUTS ON TENANT FARMS[1]

	Cost Borne by Landowner		Cost Borne by Tenant-Cultivator	
	No. of Farm Households (1,000HH)	Ratio (%)	No. of Farm Households (1,000HH)	Ratio (%)
Seeds	18.8	0.59	3,159.3	99.41
Fertilizer	11.4	0.36	3,166.7	99.64
Agro-chemicals	7.0	0.22	3,171.1	99.78
Irrigation Facilities	1.0	0.03	3,177.1	99.97

Source: BBS, Summary Report of the 1977 Land Occupancy Survey of Rural Bangladesh, Dacca, 1977.
Note: Figures based on report by tenant cultivators (1977)

The table below covers the period a tenant works under a certain landowner. The tenancy period for 7% of tenant cultivators is less than one year (i.e. one cropping period only), while 23.8% have tenancy periods of one year which means they must find a new landowner every year. Thus about 30% of tenant cultivators have no stable guaranteed means of livelihood. Moreover, 70% of tenant cultivators lose their tenancy rights within three years. As 78% of total farm households are comprised of small-scale farmers and farm laborers with less than 2acre (0.8ha) of farmland, the number of people willing to become tenant cultivators is substantial and consequently it is a seller's market.

Therefore the conditions of tenancy are very severe and the rights of tenants are not well protected. It is difficult to expect much investment for productivity increase under the current conditions of tenanted area at 30% of the total cropped area and tenanted farmers comprising 40% of the total farm households.

PERIOD OF TENANCY

	Number of Tenant Households (1,000HH)	Rate of Tenant Households (%)	Area under Tenant Cultivation (1,000Ha)	Rate of Area Cultivated by Tenant
less than 1 year	223.1	7.0	77.1	4.4
1	757.4	23.8	304.6	17.5
2	778.0	24.5	452.9	26.0
3	493.1	15.5	320.9	18.4
4	203.4	6.4	105.5	6.0
5	176.4	5.6	105.8	6.1
6	78.8	2.5	72.0	4.1
7	47.6	1.5	42.3	2.4
8	94.9	3.0	71.4	4.1
9	18.9	0.6	9.9	0.6
more than 10 years	306.5	9.7	181.2	10.4
Total	3,178.1	100.0	1,743.7	100.0

SOURCE : BBS, Summary Report of the 1977 Land Occupancy Survey of Rural Bangladesh, Dacca, 1977
NOTE : Figures based on Report by Tenant Cultivators (1977)

2.3 Cereal Demand and Supply

Although rice is the focus of agriculture in Bangladesh, there is a chronic shortage in rice supply due to limited land area, low productivity and high population. The Ministry of Food mainly obtains supplementary rice supply through international aid. The import volume varies according to fluctuations in domestic production which is greatly influenced by weather conditions. Due to bumper crops of Boro and Aman, the import volume in 1985/86 was only 32% of the import volume (2.2 million tons) for the previous year. Details of rice imports are shown in the following table.

MONTHLY IMPORT VOLUME OF GRAIN

(1,000 ton)

Month	1983/84	1984/85	1985/86
July	215	181	102
August	146	185	158
September	163	171	174
October	90	352	115
November	-	417	22
December	41	287	64
January	279	294	40
February	155	314	21
Total	1,089	2,201	696

Source: Directorate of Food

The revised projection of cereal demand based on data from the Bangladesh Planning Commission is shown in the following table.

DEMAND PROJECTION OF RICE AND WHEAT

Year	Population (million)	Total Demand (million tons)	Projected Cereal Production (million tons)
1984/85	100.2 1/	16.03 2/	16.00 3/
1989/90	113.0	18.08	20.70 4/
1994/95	122.0	19.52	
1999/2000	131.7	21.07	

Source: Calculated from Planning Commission data.
1/: Projection 3 of BBS
2/: Estimated on the assumption, 160kg/person/year
3/: Actual of 1985/86
4/: Target of Third Five Year Plan

Based on Projection-3, the most optimistic projection of population growth, the rate of increase in cereal demand averages 2.1% up to the year 2000. The production increase rate for rice and wheat from 1977 to1983 was 2.9% which exceeds the 2.8% population growth for Projection-1. The rate of self-sufficiency in cereal production is therefore projected to increase slightly. The high rate of production increase for cereals is due to rapid expansion of wheat production. The annual rate of production increase for rice is only 1.7%, indicating that further efforts to increase food production are required.

2.4 The Third Five Year Plan and Food Production Increase

The Third Five Year Plan aims at long-term integrated development through achievement of the following objectives.

a) Reduction of the annual population growth rate;

b) Creation of productive employment opportunities;

c) Extension of educational facilities and development of human resources;

d) Establishment of the technological base for long-term structural change;

e) Attainment of national self-sufficiency in food supply;

f) Fulfillment of minimum basic needs;

g) Acceleration of economic growth; and

h) Self-reliance and self-sufficiency.

In the Third Five Year Plan, top priority is given to reduction of the population growth rate with a target annual growth rate of 1.8% at the end of the plan as opposed to the present rate of 2.4%. Next in importance is self-sufficient food supply through both national and farm-level efforts. Target increase in food production is 29% in the next five years.

Agriculture occupies a vital position in the Bangladesh economy, providing food and accounting for more than half the GDP. It has consequently been the central focus of two previous Five Year Plans. During these plan periods, the percentage of GDP occupied by the agricultural sector decreased from 61.1% in 1972/73 to 51.6% in 1979/80

and 51.2% in 1984/85, with a proportionate increase in the share occupied by other sectors. Emphasis was placed upon establishment of irrigation facilities, increased fertilizer application and extension of high yield varieties, as the major means of achieving increased crop yields. Although target production has not yet been reached, production of several types of crops is increasing steadily.

In the Third Five Year Plan, six general objectives have been established for the agricultural sector as presented below.

(1) Food Supply

The target is self-sufficient food supply by 1989/90 and production of 20.7 million tons of grain. Production targets concern not only food grains but also all other produce required for proper nutrition.

(2) Increased Employment Opportunities

Employment opportunities are to be promoted through increased investment in farm inputs which require concentration of farm labor. Labor demand will particularly increase with the targetted 57% increase in the present irrigated area (2.45 million ha).

(3) Improvement of Trade Balance

The Plan aims to increase production of presently imported crops thereby decreasing the need for imports and at the same time to increase production of export crops to obtain foreign capital.

(4) Effective Land Use

Effective use of available land resources will be realized through improved soil fertility and promotion of soil conservation practices. Specific measures for achievement of this objective are i) shift in crop production from single cropping to multiple cropping, ii) promotion of winter cultivation, iii) reclamation of wasteland, iv) cultivation of fodder and leguminous crops, v) use of chemical fertilizers, vi) maintenance of the ecological balance by the development of forestry, and vii) reclamation of coastal land and its protection by plantation and planned settlement.

(5) Stabilization of Agricultural Production

The Plan aims to stabilize agricultural production through establishment of irrigation and drainage systems and flood control.

(6) Broadening the Genetic Base of HYV

Introduction of new breeding technologies is planned to broaden the genetic base of high yielding varieties.

The following programs are planned for achievement of the above objectives.

a) Price support and subsidies

b) Agricultural credit

c) Crop diversification program

d) Crop production program

e) Farm assistance program (agricultural extension, research and education)

f) Agricultural input program

g) Development of farm market system

h) Establishment of food grain storage facilities

Target production of major food grains is 20.7 million tons which is sufficient to supply the basic food needs of the projected population in 1989/90 as shown in the following table.

FOOD GRAIN PRODUCTION TARGET (1985-90)

Cereal Food	Bench-mark (1984/85)		Target (1989/90)		Annual Growth Rate of Output
	area (100,000 ha)	out (Million t)	area (100,000 ha)	output (Million t)	
I. Rice:					
Aus	29.4	2.78	29.1	3.42	4.23%
Aman	57.1	7.93	58.3	9.18	2.97%
Boro	15.4	3.91	19.4	5.40	6.69%
Subtotal (Rice)	101.9	14.62	106.8	18.00	4.29%
II. Wheat	6.8	1.46	9.7	2.60	12.23%
III. Coarse Grain	0.4	0.03	0.2	0.10	27.00%
Total (Food grain)	109.1	16.11	116.7	20.70	5.20%

Source: The Third Five Year Plan

As increases in Aman and Aus production were restricted by cropping season and rainfed cultivation under the Second Five Year Plan, production increase is projected to be greater for Boro with use of irrigation and flood control.

2.5 Assistance for Food Production Increase from Foreign Countries

(1) General

Disbursement of foreign economic assistance in Bangladesh since 1975/76 is presented in Tables 2-6 and 2-7 according to country and type of aid. With alleviation of the food shortage and progress towards attainment of 100% self-sufficient food supply, the amount of assistance expended on commodity aid and project aid, as opposed to food aid, has been increasing. The amount contributed as grant aid is greater than that contributed as loans and the amount has been increasing, reflecting the economic situtation in Bangladesh. In comparison with the assistance ratio in the 1970s however, it appears that the rate of aid increase in recent years is lessening.

The main agencies and countries which provide assistance include IDA, ADB, USAID, Canada, Japan, Saudi Arabia and West

Germany. Of total assistance in 1983 (about US$1.267 billion; disbursement base), the above entities provided 20.9%, 3.6%, 12.7%, 10.8%, 7.4%, 5.6% and 4.8%, respectively.

(2) Assistance Related to Food Production Increase

Assistance provided specifically for food production increase by the main agencies and countries is as described hereunder.

1) ADB

The main form of assistance provided by ADB for food production increase is the Crop Intensification Program (CIP) which is being implemented in three stages as outlined below.

1. First Crop Intensification Program (CIP-I)

Period: Feb. 1980-Dec. 1986

Loan Amount: US$11.8 million

Main Content: Provision of TSP 32,000MT
Construction of 10,000MT fertilizer storage capacity

2. Second Crop Intensification Program (CIP-II)

Period: Jun. 1982-Jun. 1986

Loan Amount: US$18.0 million

Main Content: Importation of TSP 35,600MT
Importation of 600MT improved seeds
Construction of 10,000MT fertilizer storage capacity

3. Third Crop Intensification (CIF-III)

Period: Mar. 1984-Dec. 1987

Loan Amount: US$70.0 million

Main Content: Provision of TSP 260,000MT
Provision of zinc sulphate 3,000MT

ADB also plans to implement the Fourth Crop Intensification Program (CIP-IV) commencing in 1987 for two years. Under this program, it is planned that 350,000t of

TSP and 6,000t of zinc sulphate will be contributed comprising US$66 million of the total program cost (foreign currency portion) of US$69 million.

2) IDA:

IDA had contributed US$50 million in fertilizer up to 1983. Moreover 30% of total IDA assistance in the agricultural sector was provided for consolidation of fertilizer distribution system, irrigation facilities, extension of improved seed varieties and expansion of storage facilities.

3) USAID

USAID has contributed 4.46 million tons of wheat, 850,000t of rice and 250,000t of cooking oil as food assistance at a total cost of US$1,029.5 million. It also contributed a total of US$1,44.5 million to the agriculture sector including provision of fertilizer, construction of fertilizer factories, technical cooperation for improvement of the fertilizer marketing system and construction of fertilizer storage facilities at a cost of US$ 359.9 million, comprising approximately 74% of total USAID assistance.

4) Canada

Canadian assistance has focussed mainly on agriculture, health, and transportation. In the agricultural sector, Canada contributed to rice research and extension, crop seed improvement research, construction of granaries and the increased wheat production program, as well as providing food stuffs and fertilizer. Statistics from 1980 indicate that Canada has annually contributed muriate of potash fertilizer, the total volume of which is 315,000t at a cost of about US$45 million.

5) West Germany

Assistance from West Germany is mainly concentrated on rural development, energy development, conservation of natural resources and education. In the agricultural

sector, West Germany is supporting such programs as increased food crop production, crop protection, seed development and food storage.

CHAPTER III

MAIN CATEGORIES UNDER THE PROGRAM

CHAPTER III

MAIN CATEGORIES UNDER THE PROGRAM

3.1 Fertilizer

3.1.1 Effects

(1) Fertilizer Utilization

Fertilizer consumption in Bangladesh has increased quite rapidly since independence; however, in comparison to other countries, consumption is still fairly low. Nutrient consumption amounted to only 53kg/ha in 1984/85 as compared to 71kg/ha in Sri Lanka and 282kg/ha in South Korea. The intensity of fertilizer use is still quite low in comparison with these two countries and accordingly land fertility tends to decrease after plant (paddy) intake despite fertilizer application.

The Bangladesh Agricultural Research Council (BARC) recommends standard fertilizer application to farmers and also guides them in fertilizer application methods. BARC recommendations for specific crops are presented below.

1) Aus, Aman

One third of nitrogen and all phosphorous, potassium, sulphur and zinc should be applied broadcast as basal application with incorporation prior to transplanting in the case of transplant cultivation, and seeding in the case of broadcast seeded cultivation. The remaining nitrogen should be applied broadcast in two equal installments at the rapid tillering stage, incorporated at weeding time, and broadcast 5-7 days before panicle initiation.

2) Boro

As Boro is a dry season crop, the application method is based on water control. Nitrogen can be used more efficiently when it is applied in three equal installments. One-third should be applied first at tiller initiation, another third should be applied at the rapid tillering stage and the final third should be applied 5-7 days before

panicle initiation. All of these applications should be broadcast. Phosphorus, potassuim, sulphur and zinc should all be applied broadcast and incorporated prior to transplanting as basal applications.

(2) Effect of Fertilizer on Farm Economy

The effect of fertilizer use on farm economy and management in Bangladesh can be summarized as follows:

a) Direct increase in yield with use of fertilizer

b) Increased employment opportunities arising from increased fertilizer consumption

c) Increased investment in fertilizer related sectors

d) Reduction of rate of agricultural input by increasing farmer's income

These effects are directly related to increased agricultural production activity. In this case, it is important to examine fertilizer use in terms of its effect on the farmers' budget.

Tables 3-1 to 3-4 show the yield and input use in 1981 of farms from 20 Thana in 20 Upa-Zila of Bangladesh. The average yields of Aman, Boro, Aus and wheat are 1,837kg/ha, 3,265kg/ha, 1,452kg/ha and 1,434kg/ha, respectively while average fertilizer inputs for the same are 85.8kg/ha, 179.9kg/ha, 88.6kg/ha and 110.7kg/ha. Moreover, the use of fertilizer is higher for high yield varieties than local varieties of each type of crop. Urea was used on 83% of the total area cultivated with HYV Aman, 94% of total HYV Boro area, 95% of total HYV Aus area and 69% of total HYV wheat area. Fertilizer volume consumed for HYV Boro was 249kg. Fertilizer input ratio to yield as shown in the table below ranged from 1 to 5% for local varieties and 7 to 11% for high yield varieties.

INPUT/YIELD RATIO

	Aus			Aman			Boro		
	LV	HYV	All var'y	LV	HYV	All var'y	LV	HYV	All var'y
1. Income	3,122	6,065	3,781	4,677	7,628	5,504	7,619	14,443	12,316
2. Fertilizer Cost	159	701	282	155	568	270	81	1,109	739
2./1. x 100	5.1	11.6	7.5	3.3	7.4	4.9	1.1	7.1	6.0

Source: Agricultural Production, Ferilizer Use and Equity Considerations, IFDC, Feb. 1984

In general, the percentage of farm income used for fertilizer in Bangladesh is small. However, as the majority of farms are small in scale, and the majority of these provide only a subsistence level income, even a small investment represents a large sum of money to the farmer.

3.1.2 Consumption

(1) Consumption According to Fertilizer Nutrients

Consumption of each nutrient (nitrogen, phosphate, potassium) since Bangladesh achieved independence is shown in Fig. 3-1. Although the volume of consumption decreased temporarily in 1975 due to the increased price of fertilizer arising from the oil shock, fertilizer consumption has increased steadily since then. Consumption of nitrogen in particular has increased markedly. Phosphate consumption has also shown an increase in recent years. The ratio of fertilizer ingredients is fairly constant; nitrogen comprises 64-71% of fertilizer ingredients used, while phosphate and potassium comprise 23-28% and 6-9% respectively.

(2) Consumption According to Type of Fertilizer

The amount of fertilizer sold for each type of fertilizer since independence is shown in Table 3-5. The main types of fertilizer used are urea for nitrogen fertilizer, Triple Super Phosphate (TSP) for phosphate fertilizer and muriate of potash

(MP) for potassium fertilizer. In addition, NPK complex fertilizer is used in some places. In recent years the volume of gypsum and zinc sulphate used has been increasing although the actual volume is still rather small. These fertilizers are particularly effective for improving soil with deficiencies in zinc and sulphur, conditions which are prevalent in many areas of Bangladesh.

(3) Fertilizer Consumption According to Crop Type

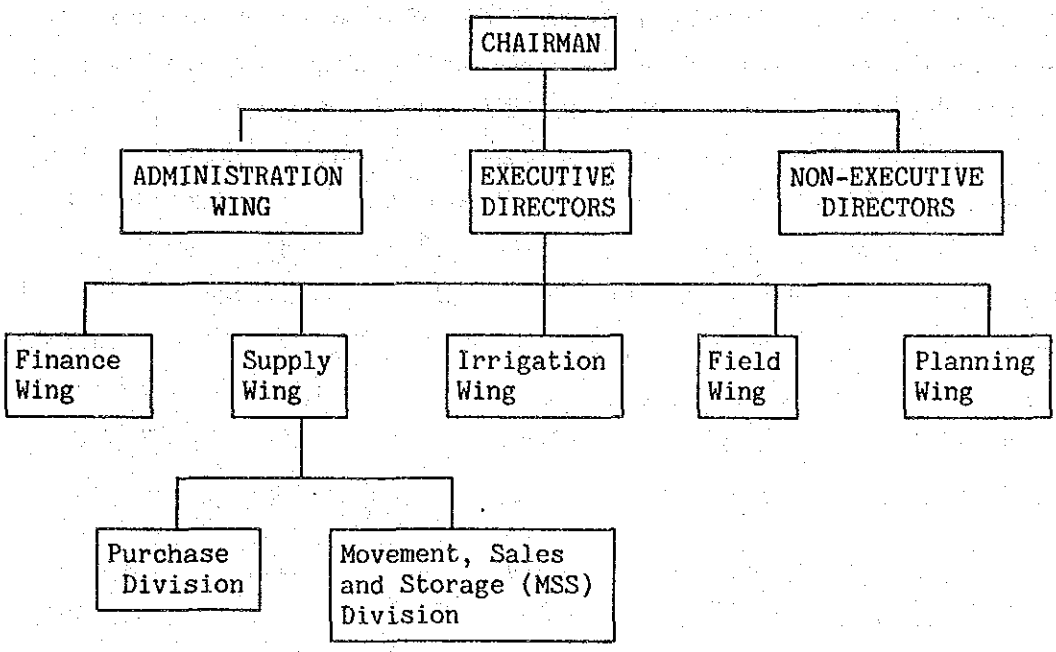
Consumption of fertilizer for each rice cropping period is presented in Table 3-6. As the table shows, the majority of fertilizer is used for rice amounting to 82% of total fertilizer consumed in 1983/84. Among the different rice varieties, the ratio of fertilizer used for high yield varieties is increasing, particularly in the case of the Boro variety the ratio for which has been increasing remarkably from 22.0% in 1977/78 to 29.2% in 1983/84. The ratio for local varieties has been decreasing annually indicating that the main portion of the increased fertilizer volume is used for high yield varieties.

3.1.3 Marketing System

(1) Management

Decisions concerning procurement, sale, storage, distribution and price of fertilizer are planned and implemented by the Bangladesh Agricultural Development Corporation (BADC) under the jurisdiction of the Ministry of Agriculture. BADC is also responsible for marketing of seeds, irrigation pumps and farm machinery. A budget of US$333 million was allocated to BADC in 1984/85. Of this, 60% was derived from sale of fertilizer and seeds, 26% from government financing, and 14% from foreign aid. The organization of BADC is illustrated in the following chart. All work concerning fertilizer is supervised by the Supply Wing.

BADC ORGANIZATION CHART



(2) Procurement

Both domestically produced and imported fertilizers are used in Bangladesh. There are five factories in Bangladesh which manufacture fertilizer, and the types of fertilizer produced are urea, TSP, Ammonium Sulphate (AS) and gypsum. Urea is produced at four factories; a) Ghorasal Urea Fertilizer Factory; b) Fenchugonj Natural Gas Fertilizer Factory; c) Ashugonj Zia Fertilizer Company; and, d) Polash Urea Fertilizer Factory which just began operation in 1986. Additionaly ammonium sulphate fertilizer is produced at Fenchugonj National Gas Fertilizer Factory. TSP and gypsum on the other hand, is only produced at the Chittagong TSP Complex.

The volume of domestically produced fertilizer purchased by BADC and the volume imported are presented in Table 3-7 while the volume imported by each agency is summarized in Table 3-8. Some fertilizer in Bangladesh is imported. From 1980/81 to 1984/85 the amount of imported fertilizer increased from about 350,000t to about 670,000t and dependence on imports during the same period ranged from 33% to 49%. The rate of domestic production of urea

is high; however, imports of TSP in a recent 5 year period ranged from 67-87% of total TSP procurement and this trend is increasing. As other fertilizers are not domestically produced, the entire volume used is imported. In order to increase domestic production of fertilizer, the Government of Bangladesh having completed the Polash Urea Fertilizer Factory, is presently constructing the Chittagong Urea Factory for operation by 1988. Production capacities for these fertilizer factories are as follows:

Name of Factory	Type of Fertilizer	Production Capacity (t/y)
1. Ghorasal Urea Fertilizer Factory	(urea)	340,000
2. Fenchugonj Natural Gas Fertilizer Factory	(urea)	106,000
	(AS)	12,000
3. Ashugonj Zia Fertilizer Company	(urea)	528,000
4. Polash Urea Fertilizer Factory	(urea)	100,000
5. Chittagong TSP Complex	(TSP)	152,000
6. Cittagong Urea Factory (under construction)	(urea)	561,000

(3) Fertilizer Distribution and Storage

Fertilizer factories in Bangladesh are all affiliated with the Government-run Bangladesh Chemical Industries Corporation (BCIC). Domestically produced and imported fertilizer is under the jurisdiction of BADC and is distributed to the farmers as shown in Fig. 3-2. The distribution system is referred to as the New Marketing System (NMS) and was established in 1978. Its objectives are as follows:

a) Promotion of fertilizer use at the farm level through increased distribution and participation of the private sector in order to revitalize the distribution system;

b) Improvement of the monopoly system by minority dealers;

c) Reduction of government subsidy;

d) Fostering of free competition at the retail level of fertilizer distribution;and,

e) Strengthening of marketing management by BADC.

Fertilizer procured by BADC is distributed to 75 Primary Distribution Points (PDP) throughout the country and 26 BADC Thana Sales Centers in Chittagong Hill Tracts. Dealers obtain fertilizer from the PDP or BADC Thana Sales Centers at fixed prices and sell it at a free market price. Some fertilizer is purchased by Upazila Central Cooperative Association (UCCA) wholesale dealers under the Bangladesh Rural Development Board (BRDB) which distributes it to the associated farmers. The total number of dealers presently exceeds 23,000.

The present status of storage facilities and capacity in Bangladesh is as delineated below.

Type of Facility	Number
Transit Warehouse	15
Primary Distribution Point	88
Thana Sales Center	75
Total Storage Capacity	530,000t

To ensure stable supply of fertilizer, the BADC has planned storage of an estimated two months supply of urea, and an estimated five months supply of TSP/DAP and MP. After the summer of 1985, the storage volume exceeded the target by a large margin, and as of March 1986 the total storage volume of fertilizer was approximately 800,000t (Fig. 3-3). This surplus in stored fertilizer is due to increased fertilizer imports, reduced purchases by farmers due to the fall in rice prices and a descrepancy between the import period and application period for fertilizer.

(4) Fertilizer Price

The official fixed selling prices of fertilizer since 1975 are presented in Table 3-9. The selling price from BADC to retailers is controlled by the government. From 1960-72 the prices of all fertilizers were fixed. From 1972-77 however, fertilizer price increased by five times the original price and has by about four times since then. The average annual rate of price increase since 1977 was 13.5% for urea, 16.3% for TSP, 15.8% for MP and 13.0% for DAP.

BADC's selling price is decided in discussion with BADC, the Ministry of Agriculture and the Ministry of Planning, and at present the price has been lowered by a government subsidy in order to increase fertilizer sales and to protect the farmer.

In fact, although the actual rate of subsidy for each type of fertilizer tends to decrease (Table 3-10), the total amount of subsidy shows a slightly increasing trend reflecting an increase in overall consumption of fertilizer (Table 3-11). The retail price is correspondingly increasing and thus farmers must gradually pay a higher price for fertilizer. Moreover, IBRD/IDA recommended that the Government of Bangladesh abolish the input subsidy which is biased in favor of a certain group of farmers, and replace it with an output subsidy which would benefit all farmers equivalently. The Government of Bangladesh accepted this recommendation and intends to discontinue the present input subsidy by August 1986.

3.1.4 Forecasted Fertilizer Consumption

It is very difficult to forecast fertilizer consumption due to the unpredictability of weather conditions, fluctuations in the prices of rice and imported fertilizers, etc. The Government of Bangladesh sets an annual target for fertilizer distribution as well as making a long-term forecast for fertilizer consumption. The target during the Third Five Year Plan is to increase fertilizer consumption from 1,260,000t in 1984/85 to 1,885,000t by 1989/90. The target rate of increase for each type of fertilizer is 9.9% for TSP, 8.8% for MP and 7.7% for urea. For other fertilizers, the increase target is a relatively high level of 9.0%, given the need to rectify zinc and sulfur deficiency of soil widely prevalent in Bangladesh. Forecasted fertilizer consumption under the Third Five Year Plan is shown in the following table.

FORECASTED FERTILIZER CONSUMPTION
UNDER THE THIRD FIVE YEAR PLAN

Year	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	Average Annual Rate of Increase (%)
Urea	832	896	965	1,040	1,120	1,206	7.7
TSP	346	380	418	459	504	554	9.9
MP	69	75	82	87	96	105	8.8
Other	13	14	15	17	18	20	9.0
Total	1,260	1,365	1,480	1,603	1,738	1,885	8.4

Source: Third Five Year Plan

The above forecast for fertilizer consumption in the Third Five-Year Plan is analyzed from the viewpoint of procurement of fertilizer and consumption considering the following points.

1. The relationship between domestic products and imports based on the capacity utilization of fertilizer factories.
2. The relationship between forecasted fertilizer consumption under the Third Five Year Plan and recommendations for fertilizer application by BARC.

(1) Forecasted Fertilizer Procurement

Domestic production of urea is estimated to increase up to 1,635,000t by 1989/90 with completion of the Polash Urea Fertilizer Factory this year and targetted completion of the Chittagong Urea Fertilizer Factory by 1988. Achievement of self-sufficient urea supply is therefore considered possible during the Third Five Year Plan. Fig. 3-4 shows the relationship between self-sufficient production and forecasted consumption. This forecast is based on the assumption that each urea factory will reach a capacity utilization of 90% in the near future, and in fact, some factories have already achieved a ratio of 90%. The average working rato in 1984/85 was quite high at 76% and the potential for reaching the target is thus very high. According to

the forecast, self-sufficient production will be achieved by 1988 while a surplus will occur in 1989.

The present capacity utilization for TSP factories on the other hand is low and no concrete plan has yet been made for construction of TSP factories. Consequently, even if the capacity utilization increases to 70% by 1988, Bangladesh will be dependent upon about 1.8 million tons of TSP fertilizer imports for the next five years.

Supply of other fertilizers will likewise continue to depend almost entirely upon imports.

2) Estimated Fertilizer Consumption Based on BARC Standards

BARC issues standards for fertilizer application as a guide to farmers. In these standards, the crop yield target is divided into three levels (high, moderate, and low), and the appropriate amounts of fertilizer nutrients are determined according to the soil conditions (low, medium or high grade soil). In addition to the main fertilizer nutrients of nitrogen, phosphate and potassium, other nutrients appropriate for specific crops are also determined and application standards established. In the case of rice, zinc and sulpher are necessary (Table 3-12).

Based on the standard application for a moderate rice yield target and medium grade soil in 1983/84, fertilizer application was estimated for the rice cropping area of the first year of the Third Five Year Plan, 1984/85, and for the target rice cropping area in 1989/90. Fertilizer nutrients used in estimation were urea (nitrogen), TSP (phosphate) and MP (potassium) and only the area of high yield varieties was considered to increase. The results of estimation are presented in Table 3-13.

According to the results, application of nitrogen in rice cropped area is estimated to increase to 1,143,133t which is close to the targetted 1,206,000t. Even considering nitrogen application for other crops, total application is estimated to reach close to the targetted

amount. TSP and MP application on the other hand, are not expected to reach the standard application during the Third Five Year Plan.

3.2 Agro-Chemicals

3.2.1 Pest Damage

The rate of damage caused by pests in Bangladesh is thought to be comparatively high as the climate is suitable for their propagation; however, proper surveys of damage before and after harvesting have not yet been undertaken. According to BRRI estimations, on-farm yield losses due to pests represent about 16-20% of the total harvest. Moreover, the Plant Protection Wing of the Ministry of Agriculture reports that the area damaged annually by the main insect pests such as Rice Hispa, Green Leafhopper and Brown Planthopper accounts only for few percent of the total rice cultivated area (Table 3-14).

The main crop protection method is application of agro-chemicals and use of disease resistant varieties. At present, 90% of agro-chemicals are used for rice crops and remaining proportion is used for oil seeds, potatoes and jute, etc. as shown in Table 3-15. Insects are classified into field pests and storage pests and explained hereunder.

(1) Types of Pest Insects in the Field and Protection Measures

Types of pest insects their characteristics and measures required to control them are described hereunder.

Rice Hispa (Dicladispa armigera): A parasite of rice and gramineous crops; 5.5mm in length when mature; blue-black in color with sharp protuberances on its back. The first generation attacks Boro, the second to fifth generations attack Aus and the sixth generation attacks Aman rice plants. The larvae crawl along inside the leaf veins eating the soft part of the leaf between the viens as they grow into pupae. The adult insects eat the surface of the leaves leaving a white trail. Although generally the damage is not outstanding, the effective leaf area is reduced

resulting in a corresponding reduction in yield. Protection Measures: Application of Fenitrothion or Diazinon once or twice in the early stages of rice plant growth. Burning off surrounding grass cover is also effective as the adult insects move to nearby grassy areas after harvest.

Green Leafhopper (Nephotettix virescens): A parasite of rice and wild rice. Leafhopper population gradually increases from the beginning of the rainy season and they move into the rice seedlings in the seedbed or immediately after transplanting where they begin propagating. They carry tungro and yellow orange leaf disease which withers the rice plant turning it yellow-orange. An attack during the early growth stage of the rice plant will result in a large yield loss. In 1956 20-50% of the Aus crop was destroyed due to a large infestation. Protection Measures: Application of Mipcin, Fenitrothion, Diazinon or Phentheate in the early stages of plant growth.

Brown Planthopper (Nilaparvatga lugens): A rice and gramineous crop parasite. The eggs are about 1mm in length and shaped like bananas and they are laid within the leaf sheath. The adult hopper grows to a length of 4-4.5mm and is changed to dark brown in color. Both the larva and the adult insect suck from the leaf sheath or plant stem, damaging the plant. These insects concentrate in one place and damage is intensive due to sudden drastic increases in density. The rice plant generally withers and yield is greatly reduced. When infestation occurs after heading, almost no grain is obtained. Brown planthoppers also carry grassy stant disease. Protection Measures: Application of MIPC, Fenitrothion, Diazinon and Phenthoate. It is also possible to control outbreaks by planting resistant varieties.

Rice Swarming Caterpillar (Spodoptera maurita): A parasite of rice and gramineous crops, sugar cane and other plants. The adult caterpillar is grey in color and 25-30mm in length. The eggs are light yellow, round and laid in clutches of 30-200 in the base of the leaf. In tropical areas these pests occur year round wherever there is a host plant. Every 3-4 years a large outbreak occurs, and damage is particularly bad after flooding. The worst damage

is caused by outbreaks which occur 20 days after germination in the seedbed or in a directly seeded paddy field as they consume the leaves untill the plant is totally destroyed. Protection Measures: Application of DDVP and Carbaryl or their equivalent at the early stage of caterpillar infestation. Inundation of the seedbed for 2-3 days is also an effective control measure.

Rice Ear-cutting Caterpillar (Pseudalertia separata): A parasite which occurs in gramineous crops and brassica crops. The eggs are 1mm in diameter, and the larva period ranges from 20-45 days. In tropical areas, they propagate 5 times a year. The largest infestations generally occur in September and October in Bangladesh when the Aman crop is maturing, and there is usually one severe outbreak somewhere in the country each year. In a given area a large infestation recurs every 3-4 years. A young larva will consume the leaf surface in a blotch-type pattern and as it grows, will destroy the entire leaf. Protection Measure: Same as for the rice swarming caterpillar above.

Rice Stemborer (Chilo suppressalis): A parasite of numerous varieties of gramineous crops including rice. They propagate as many as 5-6 times a year in tropical areas. The egg stage lasts 5-6 days, the young larva stage about 30 days, the pupa stage about 6 days, and the adult stage 3-5 days. The instar larvae consume the underside of the leaf towards the leaf sheath congregating in groups and entering the stem of the plant. The leaf sheath changes color, withers and falls, promoting the formation of white heads and of water logging, and sometimes destroying the roots. Protection Measures: Application of Fenitrothion, DDVP, Diazimon or Pentheate during the young larva stage.

(2) Insect Pests in Godowns and Protection Measures

The term insect pests usually refers to insects which infest crops in the fields. However, substantial damage can also be caused by insect pests in the godowns in tropical areas. The types of insect pests occuring in godowns in Bangladesh and control measures for the same are described below.

1) Major Insect Pests

Main Insect Pests	Scientific Name
Rice Weevil	Sitophilus oryzae
Granary Weevil	Sitophilus granarius
Khapra Beetle	Trogoderma granarium
Angoumois Grain Moth	Sitotroga cerealella
Lesser Grain Borer	Rhizopetha dominica
Rice Moth	Corcyra cephalonica
Red Grain Beetle	Tribolium castaneum
Pulse Beetle	Callosobruchus chinensis
Sawtoothed Grain Beetle	Oryzaephilus surinamensis

There are also numerous other varieties which occur in lesser amount. Insect pests in godowns can be broadly divided into two types, namely, beetles and moths. These insects consume stored grain attacking first the embryo and then the endosperm. They also cause secondary damage by increasing the temperature of the grain which results in fermentation or oxidization and fosters the growth of fungi and molds. Rodents and birds are also responsible for losses in stored grain.

2) Control Measures

Prevention of grain loss in the godowns is extremely important. The basis of control is proper sanitation and care should be taken to prevent contamination of the godown, machinery, transportation equipment and processing equipment by insect pests. In addition, pesticides should be supplied as required including insecticides, acricides and fumigants. Pesticides can be classified as preventive or curative depending on their useage as described below.

a) Preventive Pesticide - These types of pesticide include contact insecticide and acricide which are sprayed as dust formulation, oil solution or wettable powder and effectively destroy insects crawling over the sprayed surface. The main pesticides used are Malathin, Fenitrothion, Dichloryos and Pyrithrins.

b) Curative Pesticide - These types of pesticide consist of fumigants which permeate the interior of the godown exterminating mites and other insects concealed inside. There are three types of fumigants as follows: Gaseous fumigants: including Methyl Bromide and Hydrogen Cyanide, which are liquid at low temperature or high pressure, but turn to gas at room temperature or normal atmospheric pressure. Liquid fumigants: which are liquid at room temperature but vaporize if exposed to outside air. Solid fumigants: such as Aluminium Phosphide which come in pellet, sheet or granular form and turn to gas when exposed to air.

As fumigants are extremely toxic, caution should be exercised when using them. In particular, due consideration should be given to environmental and pest conditions when determining the quantity of fumigant and period of use in order to minimize the aftereffects.

3.2.2 Crop Protection

Crop protection in the field is basically conducted by farmers. The Plant Protection Wing, Ministry of Agriculture arranges various types of support programs for farmers as shown in Table 3-16. Control of insect pests in the government godowns on the other hand, is conducted by Directorate of Food, the Ministry of Food.

(1) Insect Pest Control by Farmers

The amount of pesticides which have been used in Bangladesh are minimal with TK135/ha (3.5% of the variable expense) for high yield varieties of Boro and TK37/ha (1% of variable expense) for local varieties in 1984/84, none for Aman in 1982, TK37/ha (2% of variable expense) for Aus in 1984/85, and TK12/ha (0.6% of variable expense) for wheat in 1984/85. Based on interviews with the Pesticide Association of Bangladesh the reasons for the low rate of pesticide use are: the high price of pesticides; the low

price of farm products; and, the belief of farmers, which arises from inadequate application in the past, that pesticides are ineffective. Monthly sales of pesticides according to the Pesticide Association of Bangladesh are presented in the following table.

MONTHLY SALES OF PESTICIDE

Month	1984/1985			1985/1986		(in MT)
	Conventional	Granular	TOTAL	Conventional	Granular	TOTAL
July	57.36	235.26	292.60	176.06	49.69	221.75
August	46.26	159.01	205.27	136.21	170.60	306.81
September	60.47	230.97	291.44	326.00	703.00	1029.00
October	340.31	46.00	386.31	20.00	198.00	418.00
November	416.70	82.48	499.18	284.00	193.00	477.00
December	86.51	36.33	122.84	51.00	37.00	88.00
January	121.60	170.36	291.96	154.00	93.00	247.00
February	241.10	108.59	349.69	340.00	190.00	530.00
TOTAL	1,370.31	1,069.00	2,439.31	1,683.27	1,634.29	3,317.56

Source: Pesticide Association of Bangladesh

Comparison of annual agro-chemical usage reveals that the amount of agro-chemicals sold from September to November during the transplanted Aman season increased by 118% from 1984/85 to 1985/86. Part of this increase was likely due to a large pest infestation as the increase was mainly in granular pesticides bought in the month of September. However, if this portion is subtracted, the amount of agro-chemicals used still shows an increasing trend.

Agro-chemicals for Boro bought between December and February increased 13% from 1984/85 to 1985/86. This is reportedly due to expansion of the Boro cultivated area and to insect infestation.

(2) Insect Pest Control by Plant Protection Wing, Ministry of Agriculture

The Plant Protection Wing is one of the twelve departments of the Ministry of Agriculture and is mainly concerned with pest forecasting, crop protection and registration of agro-chemicals. An organization chart is presented in Figure 3-5. Content of crop protection works carried out by the Plant Protection covers wide scope of works such as pest forecasting, ground spraying, aerial spraying, tests and surveys for an integrated pest control system, rodent control and extension of crop protection practices and knowledge. Excluding extension work, all of the above are carried out in cooperation with farmers and extension personnel.

The Plant Protection Wing is also the agency which handles agro-chemicals contributed by Japan under the Program. Ground and aerial spraying is conducted by the Plant Protection Wing free of charge. Although in the past Bangladesh received some agro-chemicals from FAO, at present Denmark and Japan each provide 100t/year under their respective grant aid programs. Agro-chemicals were applied to more than 80% (506,460ha) of the total area of 614,720ha damaged by major rice pests (rice hispa, stemborer and brown planthopper) in 1984/85. Ground spraying was the application method used in about 88% of the entire area treated while aerial spraying was used for only 12% (Table 3-17).

(3) Insect Pest Control by Directorate of Food, Ministry of Food

In accordance with the priority placed upon attainment of self-sufficient food supply, the objectives of the Ministry of Food are establishment of an adequate food supply to ensure national security, and supply of food to the average citizen at stable prices. To fulfill these objectives, it is necessary to establish appropriate post-harvest facilities and food supply management technology and minimize yield loss and reduction in quality. The Ministry emphasizes improvement in the following three areas:

a) Increased awareness among farmers and dealers of the importance of quality in buying rice;

b) Pest control during storage;and,

c) Strict grading of rice for procurement and distribution.

The amount of rice procured by the Ministry of Food is estimated at about 200,000t/yr which is about 2% of annual domestic production (Table 3-18). Importation of rice is also done by the Ministry of Food and amount of import is 1.01 million ton in 1983/84, 2.2 million ton in 1984/85 and 0.7 million ton in 1985/86 respectively. Crop storage facility capacity as of February 1986 is 1,950,000t. However, on average only 25-45% of this capacity is used with the maximum being about 62% or 1,200,000t. Many of the facilities are old and in poor condition, and improvement is urgently required to reduce storage loss and deterioration in quality.

According to the Ministry's calculations, rice loss during storage and handling after procurement was about 5%, the major cause of which was pest infestations in the godowns (loss due to pests in godowns was 3.75%). In order to minimize such loss, the Ministry is promoting pest control through use of agro-chemicals.

The Directorate of Food is one of seven Directorates in the Ministry of Food as presented in the organization chart of Fig. 3-6. One of the functions of the Directorate is control of pests in the godowns. Agro-chemicals employed for this purpose in 1985 are as follows:

Agro-chemical	Consumption MT
1. Aluminium Phosphide	29.92
2. Contact Insecticide	13.00
3. Methyl Bromide	73.63
4. Racumin	88.00

3.2.3 Agro-Chemical Supply

As agro-chemicals are not produced in Bangladesh they must be imported. Agro-chemical imports are managed by private enterprises which depend on a limited amount of foreign currency. Import volume in 1981 dropped drastically and, although it recovered somewhat thereafter, it has still not returned to the 1980 level. Up until 1980, imported agro-chemicals were almost all formulated; subsequently, however, the

import ratio of technical materials has been increasing and this trend is expected to continue. Approximately 90% of total agro-chemical imports are pesticides, followed by fungicides and herbicides. The low demand for weedicide is assumed to be the result of cheap and abundant labor supply (Table 3-19).

The price ceilings for major agro-chemicals from March 1981 to 1986 are presented in Table 3-20. Registration of agro-chemicals is under the jurisdiction of the Plant Protection Wing of the Ministry of Agriculture which carries out strict on-farm and laboratory tests before awarding registration. Even if the composition of the agro-chemical is identical, registration must be carried out individually for each company and product, and without registration agro-chemicals cannot be imported into the country. Registered agro-chemicals in 1985-86 consisted of 7 brands of acricide (6 chemical types), 19 brands of fungicide (18 chemical types), 15 brands of herbicide (5 chemical types), 70 brands of pesticides (30 chemical types) and 4 brands of rodenticide (3 chemical types) as presented in Table 3-21. 25 Members of the Pesticide Association of Bangladesh which handles the sale of agro-chemicals, agro-chemical suppliers and their scale are shown in Tables 3-22 and 3-23.

3.2.4 Future Demand

The demand for agro-chemicals is gradually increasing after a drastic fall from 4,000t in 1980 to 1,360t in 1981. The following factors, both positive and negative, must be considered in forecasting future demand.

a) With extension of Boro paddy and increased fertilizer use under Government policy, year-round paddy cultivation is forecasted to expand with a simultaneous increase in insect pests.

b) GOB is promoting agro-chemical use, allowing free entry of agro-chemicals.

c) With adoption of the output subsidy system for rice, agro-chemical use will increase.

d) The price of agro-chemicals will rise, following Taka devaluation.

e) Rice price is unstable.

f) The majority of farmers are unable to invest in agro-chemicals.

On the basis of the above factors, agro-chemical demand is projected to increase gradually.

3.3 Agricultural Machinery

The mechanization of agriculture in Bangladesh faces conditions which place constraints on the use of field machinery, such as:

a) Small scale of individual farm holdings.

b) Smallness and irregular shape of landholdings aggravated by dispersal of holdings of individual farmers.

c) High under-employment in farm villages.

For these reasons, most of the actual work on farms is done with agricultural hand tools and animal power. From this standpoint the Government of Bangladesh is subsequently actively promoting the mechanization of agriculture along with emphasis on irrigated agriculture. Fortunately, as quite a high ratio of rice milling is done on a commercial basis, the utilization of mechanical power in this agricultural sub-sector is comparatively advanced. The present status of irrigation facilities, field machinery and post harvest mechanization including rice milling, will be reviewed below.

3.3.1 Irrigation Facilities

Water control is of steadily growing significance for agriculture in Bangladesh. In the rainy season from May to October, the fields are submerged, while during the dry season from November to April, there is a shortage of water. Flood control during the rainy season and the securing of water for agricultural use during the dry season become indispensable for agricultural development. Thus establishment of adequate irrigation facilities including flood control is one of the top priorities of agricultural policy of the Government of Bangladesh.

(1) Utilization of Irrigation Facilities

According to the statistics for 1983/84, indicated in Table 3-24, about 60% of the total land area of Bangladesh or some

8,650,000 hectares are arable, of which the cropped area is 13,250,000 hectares. Of this cropped area, some 1,920,000 ha. or 15% are irrigated. The greater part of this irrigated land, some 1,200,000 ha. is cultivated with Boro rice, as shown in Table 3-25. The following table compares the total areas planted in paddy and wheat.

For 1983/84	Rice				Wheat
	Total	Aman	Aus	Boro	
Cropped area (1,000ha.)	10,550	6,010	3,140	1,400	530
Irrigated area (1,000ha.)	1,502	159	145	1,198	215
Irrigated ratio (%)	14.2	2.6	4.6	85.6	40.6
Production (1,000t)	14,300	7,800	3,200	3,300	120
Unit yield (t/ha)	1.35	1.30	1.02	2.36	2.26

As may be seen from this table, over 85% of the area planted in Boro paddy is irrigated and the unit yield is more than twice that of other rice. Hence, although Boro paddy is cultivated on only 13% of all paddy land, it accounts for 23% of all paddy yield. In short, the establishment of adequate irrigation facilities during the dry season is an effective measure for increasing rice production.

Both surface water and groundwater irrigation methods are used in Bangladesh. In surface water irrigation, the following methods are used: gravity and low lift pump (LLP), and the traditional methods including the swing basket irrigation and doon irrigation method. In groundwater irrigation, the deep tubewell (DTW), shallow tubewell (STW) and hand tubewell (HTW or HP) methods are used.

Irrigated areas according to irrigation method and number of pumps are shown in Table 3-26 but the figures differ widely depending on source, which makes it difficult to grasp the true

picture. Looking at the general trend from Fig. 3-7 and Fig. 3-8 which was compiled from tables, the groundwater irrigation (shallow tubewell, deep tubewell) percentage is increasing, the low lift pump irrigation percentage remain on a stable level.

(2) Future Trend in Irrigation Facilities

The main government agencies promoting construction of irrigation facilities are the Bangladesh Water Development Board (BWDB) and the Bangladesh Agricultural Development Corporation (BADC).

Large scale projects such as the control and management of flood waters during the rainy season are mainly under the jurisdiction of BWDB. In addition to flood control, the BWDB also constructs irrigation drainage systems. The projects it manages are generally large-scale, covering comparatively wide areas. The BADC on the other hand handles smaller scale irrigation projects including those applying low lift pump, deep tubewell, shallow tubewell and hand tubewell irrigation methods. In the past, the irrigation equipment provided by Japan under the Program has been of this type and the BADC had been the receiving agency. Besides the above governmental agencies, non-governmental groups such as the Bangladesh Krishi Bank (BKB) are promoting the dissemination of shallow tubewell and hand tubewell irrigation methods.

The Third Five Year Plan shows the goal of future irrigation facilities and of flood control and drainage facilities. Table 3-27 shows the results of the First Five Year Plan and the Second Five Year Plan and the annual growth rate of the various types of irrigation facilities, and Table 3-28 shows the target figures for the Third Five Year Plan. But because the figures for shallow tubewells and the area irrigated thereby for the year 1984/85 differ too widely from those of the Yearbook of Agricultural Statistics of Bangladesh of the previous year, the 1983/1984 figures have been used to compute the annual growth rates which are given below.

	First Five Year Plan 1973-1977/78	Second Five Year Plan 1980-1984/85	Third Five Year Plan 1985-1989/90
Surface water irrigation			
Power pump irrigation	5.2	18.1	25.8
Low lift pump	5.2	4.1	2.6
Traditional irrigation	-2.1	-3.2	-1.2
Grondwater irrigation			
Shallow tubewell	44.3	35.8	22.2
Deep tubewell	21.8	11.6	12.0
Hand tubewell	10.1	21.5	8.4
Flood control drainage	8.4	6.0	5.2

From here on, promotion of modern irrigation methods is planned in Bangladesh.

3.3.2 Field Machinery

As previously noted, there are a number of conditions constraining the introduction of field machinery in Bangladesh. The import of farm machinery used in land preparation work sowing, transplanting and pest control operations has not been fixed up to this time. Although in the past BADC and other organizations have introduced tractors and tillers, at present the continued use of such machinery has not taken root. However, due in part to the dying of cattle from floods, the potential demand for small field machinery such as tillers, is quite high.

(1) Land Preparation work.

In the majority of paddy fields, plowing and harrowing using a ladder-type harrow pulled by a team of two zebus is generally practiced. The furrows made by the tiller are very shallow, being only about 5 cm. In Bangladesh an attempt was made to deepen the furrows by importing tractors. As shown in Table 3-29, until 1970, some 2,000 tractors were imported by private individuals and

by the Government. As may be seen in Table 3-30, the BADC imported 24 tractors in 1973 under its Mechanized Cultivation Programme for the four districts of Comilla, Sylhet, Rangpur and Brisal. These were rented out for service with rotary, disc plow and disc harrow attachments. At the completion of this programme in 1976, BADC sold these second-hand tractors and attachments to the farmers. The BKB in that year procured 30 tractors, which are being used for transporting construction equipment. As these tractors were seldom used as farm machinery, it is assumed that they are not contributing to the promotion of agricultural mechanization.

By 1971, some 8,000 units of Japanese manufactured tillers alone had been imported into Bangladesh. From 1972 up to 1976, the BADC and BKB imported a further 650 units. Parallel with imports, the production of domestic IRRI - type tillers has been promoted and in 1978 tillers were placed on the import restriction list. However, import of tillers on a non-governmental basis was resumed in 1983. The import sources are Japan, the Republic of Korea and China, with imports averaging 500 units a year. Because numerous livestock perished in the great floods of 1985, the demand for tillers increased and more than 800 units were imported. However, most importers of these tillers are engaged in commercial leasing of these machines, and are renting them at around 170 TK/ha.

(2) Seeding and Transplanting.

Seeding and transplanting are done almost completely by hand. Although manual seeder have been manufactured experimentally, and rice transplanters of foreign manufacture have been introduced, such efforts are still at the experimental stage and their widened use among the general farming population is still far removed.

(3) Field Management

Weeding is done mainly by agricultural hand tools. As rice planting is generally done in regular rows, it is possible to