Government of the Peoples Republic of Bangladesh
Flood Action Plan

North West Regional Study (FAP-2)

DRAFT FINAL REPORT

VOLUME 13

ECONOMICS

October 1992

PREFACE

The North West Regional Study Draft Final Report describes proposals for the Regional Water Development Plan and the results of the project preparation studies for the Gaibandha Improvement Project. It consists of the following volumes:

Vol. 1	The Regional Plan
Vol. 2	Regional Data and Planning Units
Vol. 3	The Regional Plan - Engineering
Vol. 4	The Regional Plan - Initial Environmental Evaluation
Vol. 5	Gaibandha Improvement Project - Main Report
Vol. 6	Gaibandha Improvement Project - Engineering
Vol. 7	Gaibandha Improvement Project - Topographic Survey and Geotechnical Investigations
Vol. 8	Gaibandha Improvement Project - Environmental Impact Assessment
Vol. 9	Hydraulic Studies
Vol. 10	Hydrology and Groundwater
Vol. 11	Social Impacts
Vol. 12	Agriculture and Fisheries
Vol. 13	Economics
Vol. 14	Ecology
Vol. 15	Health, Navigation and Cultural Heritage

The first four volumes describe the Regional Plan and aspects specifically related to regional planning. Volumes 5 to 9 are concerned with the Gaibandha Improvement Project. The remaining six volumes describe supporting studies relevant both to regional planning and the project preparation studies.

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ACRONYMS AND ABBREVIATIONS

ASI	Agricultural, Social and Institutional Programmes
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BRAC	Bangladesh Rural Advancement Committee
BRDB	Bangladesh Rural Development Board
BRE	Brahmaputra Right Embankment
BWDB	Bangladesh Water Development Board
CFD	Controlled Flooding and Drainage
CIDA	Canadian International Development Agency
DAE	Directorate of Agricultural Extension
DOE	Department of Environment
DOF	Department of Fisheries
DTW	Deep Tube Well
EIP	Early Implementation Projects (Programme)
EIRR	Economic Internal Rate of Return
FAO	Food and Agricultural Organization of the U.N.
FAP	Flood Action Plan
FCD/F.C.D1	Flood Control, Drainage and Irrigation
FFW	Food for Work
GIS	Geographic Information System
GIP	Gaibandha Improvement Project
GLE	Ghagot Left Embankment
HYV	High Yielding Variety
LCS	Labour Contracting Societies
LGED	Local Government Engineering Department
LLP	Low Lift Pump
MIKE-11	Computer Model for River Routing
MPO	Master Plan Organization
NCA	Net Cultivated Area
NGO	Non-Governmental Organization
NPVR	Net Present Value Ratio
NWP	National Water Plan
NWRM	North West Regional Model
NWRS	North West Regional Study
O&M	Operation and Maintenance
PWD	Public Works Dation (Water Level)
R&H	Roads and Highways Department
SIRDP	Sirajganj Integrated Rural Development Project
SRP	Systems Rehabilitation Programme
SSFCD1	Small Scale Flood Control, Drainage and Irrigation Programme
STW	Shallow Tube-Well
SWMC	Surface Water Modelling Centre
WARPO	Water Resources Planning Organisation
WFP	World Food Programme
Char	A shoal in the active flood plain
Thana	Smallest administrative unit in Bangladesh

ANNEX 13
ECONOMICS

A. REGIONAL PLAN

1. Introduction

1.1 Objectives and Scope of the Economic Analysis

The economic analysis in the regional plan comprises an appraisal upto pre-feasibility level of the scenarios and project options forming the regional plan. The analysis provides economic criteria for the ranking of project options, although these criteria should be placed in the broader framework of the multi-criteria analysis. It also provides other indicators of socio-economic impact, for example increased employment opportunities associated with a project or scenario, and a financing plan for the short-and medium-term projects proposed in the plan as a whole.

1.2 Context of Regional Water Development

The regional plan aims to provide a framework for water resource, and specifically flood control development, over the next 20-30 years, taking account of existing and planned developments. One of the features of the NW Region is the considerable degree of water resource development that has already taken place or is underway. Such developments include public-sector projects of a variety of scales and types, and the rapid development of minor irrigation based on groundwater and now primarily undertaken by the private sector.

While the latter development in particular has been impressive and has had a huge impact on foodgrains production, some of the other projects undertaken in the water resources/flood control sector have been less successful. The FAP 12 evaluation of FCDI projects, for example, which included six projects in the NW Region, concludes that at least one of these projects (the Nagor River project) can be regarded as an almost total failure, and others (for example, Chalan Beel Polder D) have been significantly less successful than planned for, and have in addition created external/downstream problems.

The regional planning exercise has therefore taken account of these existing/planned developments: partly in the sense that a large element of the plan involves redesign of an existing set of generally unsuccessful FCD projects in the Lower Atrai basin, and partly in the sense of viewing developments in a region-wide perspective, with an explicit policy objective to minimise negative external and downstream impacts.

The regional plan is explicitly a plan for flood alleviation: it is not a fully integrated water resources development plan. Nonetheless the analysis does, to an extent, include consideration of the multiple uses/impacts of the proposed developments, and such an integrated analysis needs to be carried a stage further in sub-regional planning and feasibility stages.

1.3 The FAP Guidelines for Project Assessment

The Guidelines for Project Assessment (Final version May 1992) have been produced by the FPCO with the aim of standardising the methodology and assumptions applied in the economic analyses

undertaken by the various FAP studies. They are based on widely accepted techniques for the appraisal of water resource development projects and provide a good basis for achieving the necessary degree of uniformity and comparability between FAP studies.

The guidelines provide some specific values, criteria and principles to be applied in the economic analysis, including the following:

1. Only primary benefits to be included.

2. Analysis period: 30 years from the start of project construction.

3. Exclude residual values of project facilities and equipment.

4. Price basis: costs and benefits to be expressed in mid-1991 Taka, for projects evaluated in 1991/92.

5. Appropriate exchange rate: the early 1992 official rate of approximately Tk38.00/US$1.

6. Costs of specific measures to mitigate a project's adverse social and environmental impacts, including those associated with an environmental management plan, should be included.

7. "Sunk" costs should be excluded.

8. Physical contingencies on project costs: 25% for pre-feasibility studies, 15% for feasibility studies.

9. Discount rate of 12% to be used.

10. A standard conversion factor (SCF) of 0.87 to be used, reflecting the general divergence between "border" prices and internal market (financial) prices caused by taxes, subsidies, monopoly prices etc.

11. Conversion factors to convert financial prices of inputs to economic prices:

- unskilled labour shadow wage rate (SWR)	0.66
- urea fertiliser	1.45
- TSP	1.88
- MP	2.02
- animal draft power	0.87
- diesel fuel	0.63
- electricity for pumping	1.54
- transport equipment	0.68
- cement	0.79
- steel	0.75
- bricks	0.87

12. Conversion factors to convert financial prices of outputs to economic prices:

paddy	-	0.88
wheat	-	1.29
jute	-	1.06
sugar cane	-	0.95
other crops	-	0.87

13. Economic decision criteria:

- EIRR (Economic Internal Rate of Return

- NPV (Net Present Value)

- Switching values: the percentage change in a given variable necessary to reduce a project's NPV to zero or the EIRR to 12% should be calculated.

- Other sensitivity analyses should be made, to test the effects of changes in possibly critical variables such as capital and O & M costs, project benefits and delays in project implementation and in the achievement of full benefits.

In general, these guidelines have been used in the analysis, but the following points need to be made:

(a) Economic Decision-Making Criteria

The Guidelines only mention two criteria, the EIRR and NPV. However, the most valid criterion for economic ranking in the Flood Action Plan is the NPVR(1), i.e. the present value of benefits minus the present value of costs (at economic prices) in the numerator, divided by the present value of public sector capital and O & M costs at financial prices, in the denominator. The rationale for adopting this criterion is that the greatest constraint on water resource development is considered to be the availability of funds in the public sector rather than in the Bangladesh economy as a whole (the rapid expansion of private sector minor irrigation testifies to this). Using the NPVR(1) for ranking therefore enables returns to the scarcest resource, public sector funds, to be maximised.

The Water Resources Planning Organisation (formerly MPO) used the NPVR(1) for the National Water Master Plan, and earlier versions of the guidelines recommended its use. The analysis and economic ranking of projects in this study has therefore used the NPVR(1). (Nonetheless, overall selection of priority projects should be based on the multi-criteria analysis, of which the NPVR(1) is one component).

(b) Conversion Factor for Fish Output.

No conversion factor was given in the guidelines for the financial (market) price of fish. Evidence of rising real prices of capture fish species, and the adverse impact of FCD projects on fish migration and recruitment onto the floodplains, are indicators of a depletion of fish stocks that on current trends is likely to continue. The study has therefore assumed an economic price for fish output 25% above the market price (this is discussed further in section 5 of this annex).

(c) Derivation of Economic Price of Crops and Fertiliser.

In deriving farm-gate economic prices for crops and fertilisers which are internationally traded it is standard practice in many countries to use projected prices based on the World Bank's Commodity Price forecasts. The reason is that, since the benefits of most projects will be received for many years into the future, expected long-term future prices should be used rather than presently prevailing prices or past prices. Another advantage of this approach is that it means different projects analysed in separate studies use a uniform set of world market prices.

However, it is difficult to make long-term forecasts of world market commodity prices with any accuracy, so these prices are not necessarily a better guide than present or past prices. In regard to the issue of uniformity between studies, the guidelines themselves are intended to fulfil that role.

The guidelines base their estimates of economic prices of inputs and outputs on present prices and estimates of future commodity prices, and on this basis the guidelines derive conversion factors to be used in FAP studies. However, there is a problem with the approach used to derive crop conversion factors. The factors have been based on the ratios between recent (1989-91) financial prices and projected economic prices, the latter being based on World Bank price forecasts for 1995. This is not valid: the same period should be used for both sets of prices for valid comparisons to be made. Thus the economic prices to be applied should be those for 1989-91. If long-term prices are to be used, 1995 is not an appropriate reference year since it is unlikely that the benefits from FAP projects will have even started to be realised at that stage. A reference year of 2005 would be more appropriate for projects which have an analysis period of 30 years.

The analyses in this study have been based on recent prices rather than on projected prices, and the conversion factors given in the guidelines have been followed to ensure consistency with other studies. However, it should be noted that an analysis of the conversion factor for paddy using economic prices for 1989-91 yields a conversion factor of 0.94 rather than the factor of 0.88 given in the guidelines.

In relation to the prices of fertilisers, recent policy decisions by GoB involving reduction of subsidies have led to an increase in the financial price of fertilisers and a narrowing of the difference between local and world market prices. These changes have happened too recently for the guidelines to take them into account, but for this study the economic price of fertilisers has been suitably adjusted.

2. Regional and National Trends

2.1 Trends in Food Output and Availability

The major economic benefits to be derived from flood alleviation programmes are expected to accrue in the crop production sector, both through the expansion of area available for paddy production (since the impact of the projects is during the monsoon when paddy is almost the only major crop that can be grown) and through reduction of crop damage. It is therefore pertinent to examine current trends in the foodgrains production sector to understand the context of the projects under consideration.

The dominant foodgrain is, of course, rice, followed by wheat. In terms of production of these foodgrains, rice accounts for about 95% and wheat only 5% (total foodgrains production is about 19 million tons). In terms of consumption, rice accounts for about 85% and wheat 15%. Until recently, there was a national deficit in production of both types of foodgrains and both were imported. For the last three years, however, imports of rice have effectively ceased: Bangladesh is at present more

or less self-sufficient in rice production. There remains a deficit in wheat production and little likelihood of this gap being breached since the limit to wheat production in the country has probably been reached, at least in terms of area coverage.

The achievement of virtual self-sufficiency in rice production is an impressive achievement, and is the result of the "green revolution" which has taken place in Bangladesh as elsewhere in South and South East Asia. The development has been based on the spread of HYV rice varieties, controlled irrigation (particularly from groundwater) and more intensive use of fertilisers. The use of HYVs has developed from virtually nothing in the late 1960s to about one-third of total cereal area in the mid 1980s: currently HYVs probably occupy about 35% of the total cereal area, so that there is clearly further scope for expansion.

The growth of rice output has been estimated at 2.5% per annum over the period 1974/75 to 1986/87 (based on figures in the BBS Statistical Yearbook), compared with population growth of about 2.3% over that period. Foodgrains availability in the aggregate,as well as output, should therefore be increasing but figures are ambiguous on effects on poor households' consumption. Data from the Household Expenditure Surveys show the percentage of rural population with daily calorie intake per person below a standard of 1805 calories declined from 44% in 1973/74 to 22% in 1985/86, but then rose again to nearly 29% in 1988/89.

The growth of minor irrigation has been fundamental to the overall growth in foodgrains output. The area of total cultivated land irrigated grew from an estimated 17% in 1974/75 to 25.7% in 1984/85 (figures quoted in Mahabub Hossain, Green Revolution in Bangladesh, 1989), and it has accelerated in the late 1980s. Estimates of numbers of irrigation equipment in operation suggest that irrigation may have spread to another 9% of net cultivable area over the period 1986/87 to 1989/90 (David Gisselquist, Development Potential of Minor Irrigation in Bangladesh, 1991). The same study suggests a consequent acceleration in the growth rate of foodgrains production, possibly as much as 5.9% per year over the same three year period.

The importance of irrigation to the growth in foodgrains production is apparent when one looks at the growth in paddy output during the different seasons, boro, aus and aman. In 1970/71 boro paddy made up almost 20% of total foodgrains production, aus 26% and aman 53% (wheat accounted for the remaining 1%). Even in 1983/84 the respective percentages had not changed dramatically: boro 21%, aus 21%, aman 50% and wheat 8%. But by 1989/90 boro accounted for 39%, aus 14%, aman 42% and wheat 5%. The main contribution to growth of foodgrains output has therefore come from the dry season boro crop, which for high yields more or less requires availability of controlled irrigation.

Other trends support the conclusion that growth in foodgrains output has come primarily from the boro crop. The annual growth rate of boro over the period 1974/75 to 1986/87 was 6.8% (based on data in the BBS Statistical Yearbook) compared with 2% for aman and -0.2% for aus. The acreage growth of boro over the same period was 4.2% per annum and yield growth 2.5%. The growth in aman was more due to yield growth than to increased area, while the decline in aus growth was more due to a reduction in aus area. The explanation for these trends is again related to irrigation. The expansion of irrigation has not only allowed boro to displace non-irrigated aus, some broadcast aman, and some rabi crops, it has also allowed the conversion of some previously fallow land to boro production.

The yield increases in boro are also related to irrigation, since the latter is necessary in the dry season to realise the yield potential of the HYV seeds. BBS statistics show that in 1987/88 83% of the total boro area was planted with HYV seeds, compared with 21% of the aman area and 18% of the aus

area. The respective figures in 1974/75 were 57%, 9% and 9%. Essentially what is happening is the displacement of local varieties by modern high yielding varieties, resulting in an overall yield increase. Yields of HYVs themselves are fairly static however: it has been this substitution of HYVs for local varieties that has allowed growth, plus some area expansion. The fact that most boro area is already planted to HYVs shows that one source of growth will soon be no longer available.

Nonetheless, there is still plenty of scope for areal expansion since irrigation is estimated to cover only about 35% of net cultivable area. The recent trends in irrigation development suggest that this will still be the main source of growth in the coming years. In addition, the main potential lies here. The study by Gisselquist quoted earlier underlines that the main source of growth in foodgrains is the spread of HYVs, and that the potential for additional use of HYVs exists in the dry season.

Using the concept of hectare-months to describe the development potential of land (a farmer with one hectare has 12 hectare-months for crops in one year), Gisselquist compares three development strategies in terms of their potential for expanding the number of hectare-months planted to HYVs (currently estimated to be about 21%). The strategies are: spread of minor irrigation, spread of new crops, varieties and cropping patterns, and expansion of flood control and drainage. Using a number of assumptions, Gisselquist estimates that the first two strategies could each expand the area of hectare-months under HYVs by 30%, while the FCD option has the potential, under current methods of FCD development recommended in the National Water Plan, for an expansion of only 5%.

The accompanying graphs (Fig. 2.1 - 2.34) give a fairly clear picture of the trends in area and production of major food crops, both for Bangladesh as a whole and for the NW Region. The directions of the trends for particular crops are basically the same at national and regional level. Main features of the graphs include:

(i) Per capita production of foodgrains is generally on an upward trend, and the contribution of rice to total foodgrains production has increased again since the late 1980s.

(ii) Per capita production of some other important crops, pulses and oilseeds, has declined, partly as a direct result of the expansion of boro production. The apparent jump in production in 1983/84 is simply a statistical adjustment to correct for previous under-reporting. Nonetheless the trend is downwards. The trend in production closely resembles the trend in area (for oilseeds), indicating practically no yield improvements in these crops.

(iii) Graphs of b. aman, local aus, and boro together show an increase in boro and a decline in b. aman and local aus. Boro has to a large extent replaced b. aman and local aus. The faster the growth in boro the more precipitate the decline in the other crops. This is clearly shown in the graphs for Bogra District which has experienced the greatest growth of boro in the NW Region.

(iv) Both local aus and HYV aus areas are generally declining, and production even of HYV aus is also declining (although with rising irrigation costs some farmers may switch back to HYV aus instead of boro). Aus production over the years shows the greatest variability since it is dependent on pre-monsoon rains.

(v) There is a general trend for HYV t.aman to increase and local t. aman to decrease, although in terms of area local t. aman continues to be important.

FIG. 2.1 PER CAPITA PRODUCTION OF RICE AND WHEAT

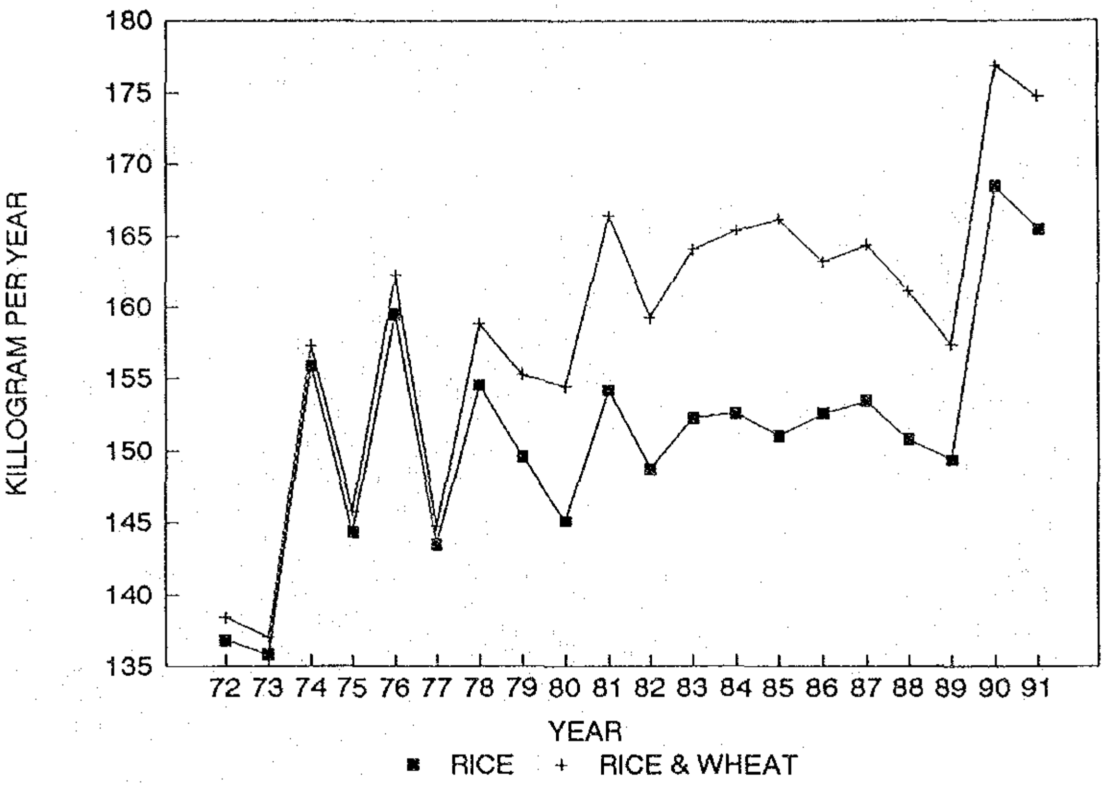


FIG. 2.2 AREA UNDER B.AMAN AND BORO VARIETIES

IN BANGLADESH

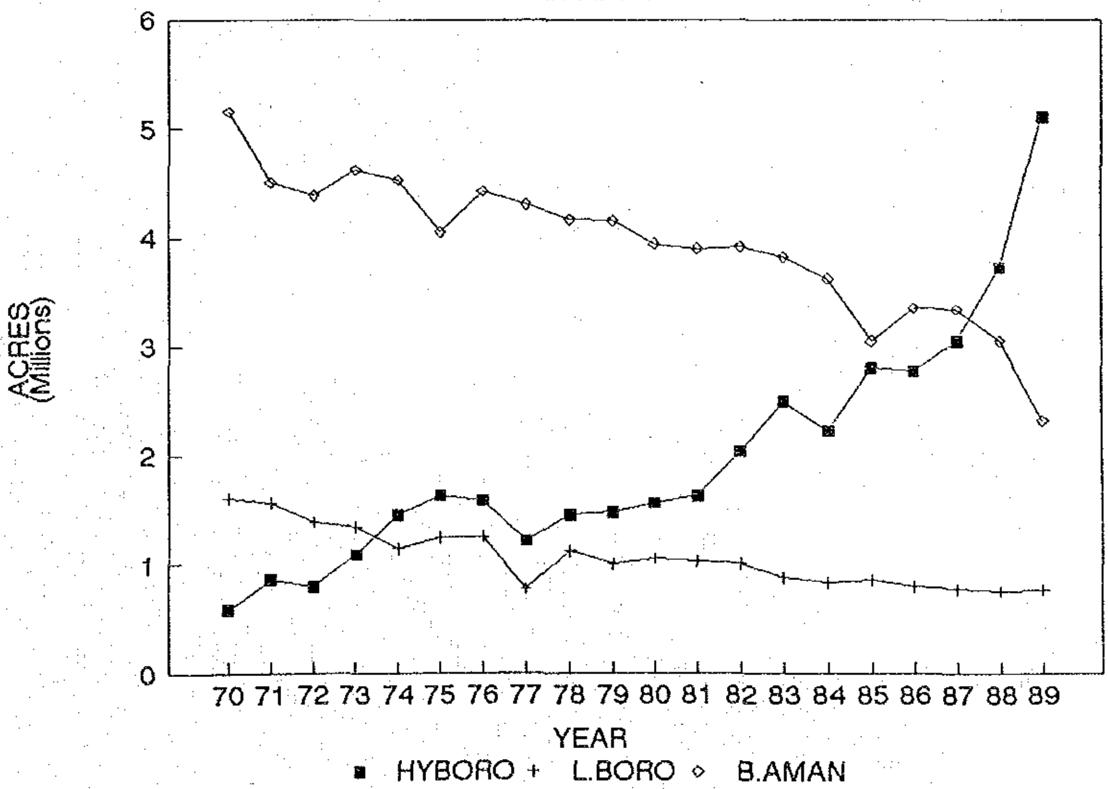


FIG. 2.3 AREA UNDER B.AMAN L.AUS AND BORO

IN BANGLADESH

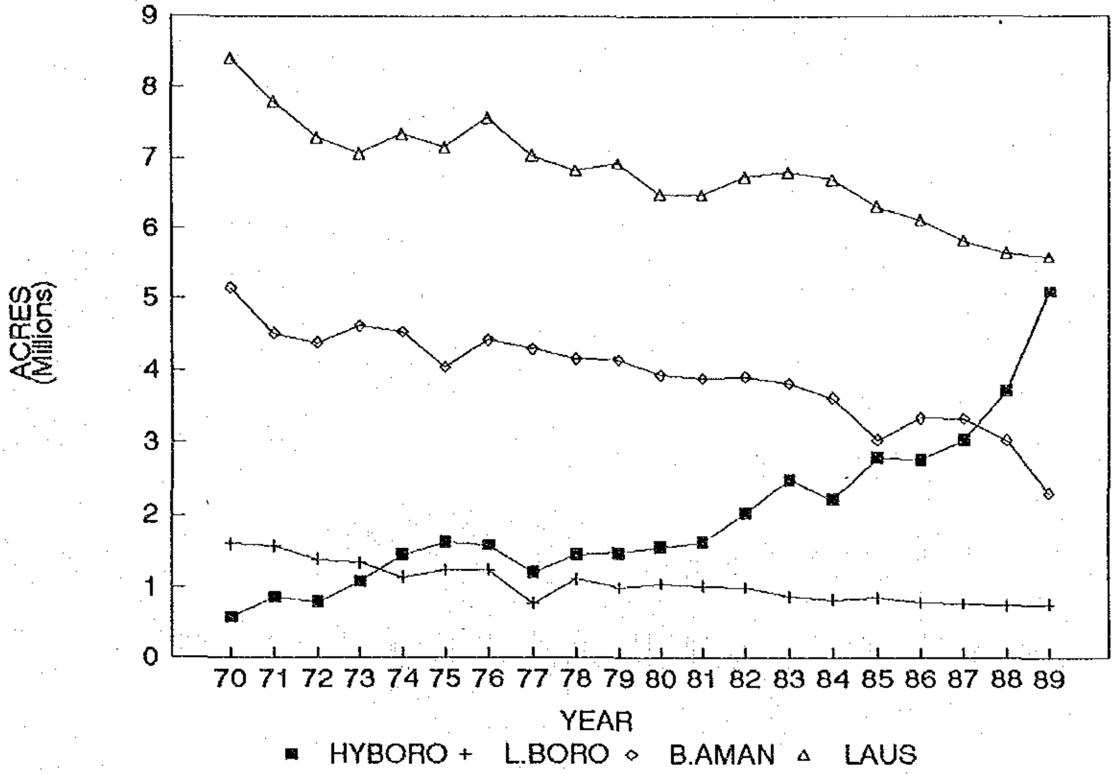


FIG 2.4 AREA UNDER AMAN CROP BY VARIETIES

IN BANGLADESH

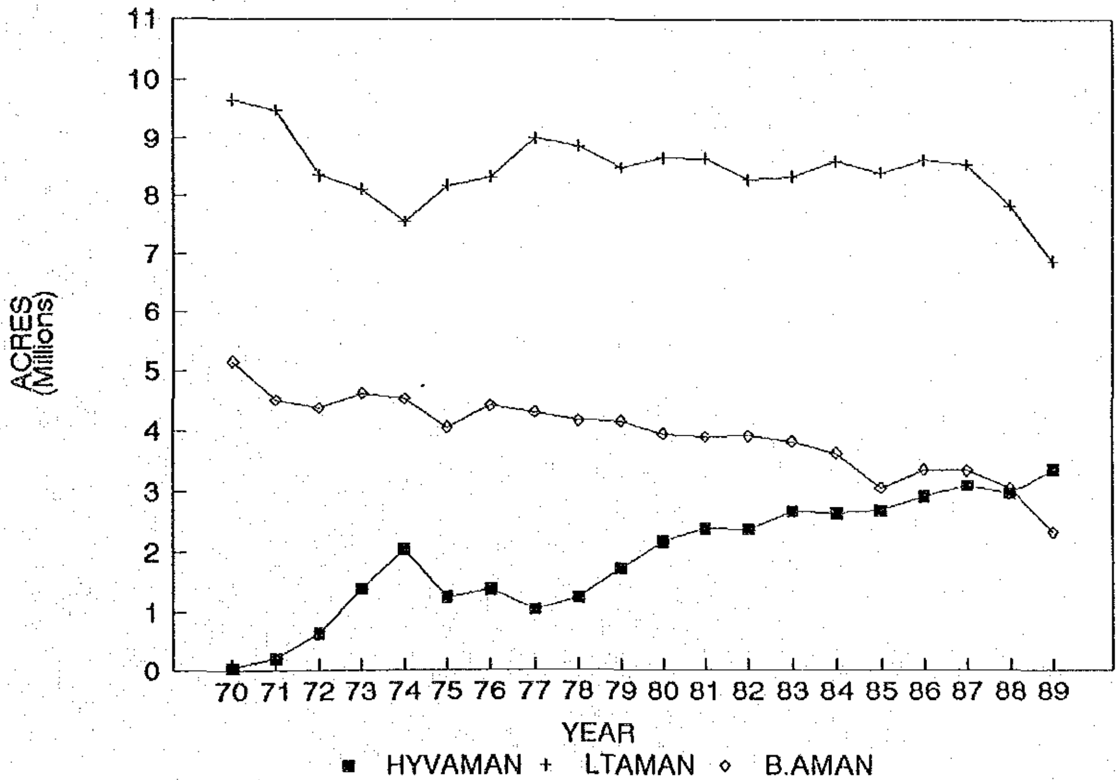


FIG. 2.5 AREA UNDER AUS VARIETIES

IN BANGLADESH

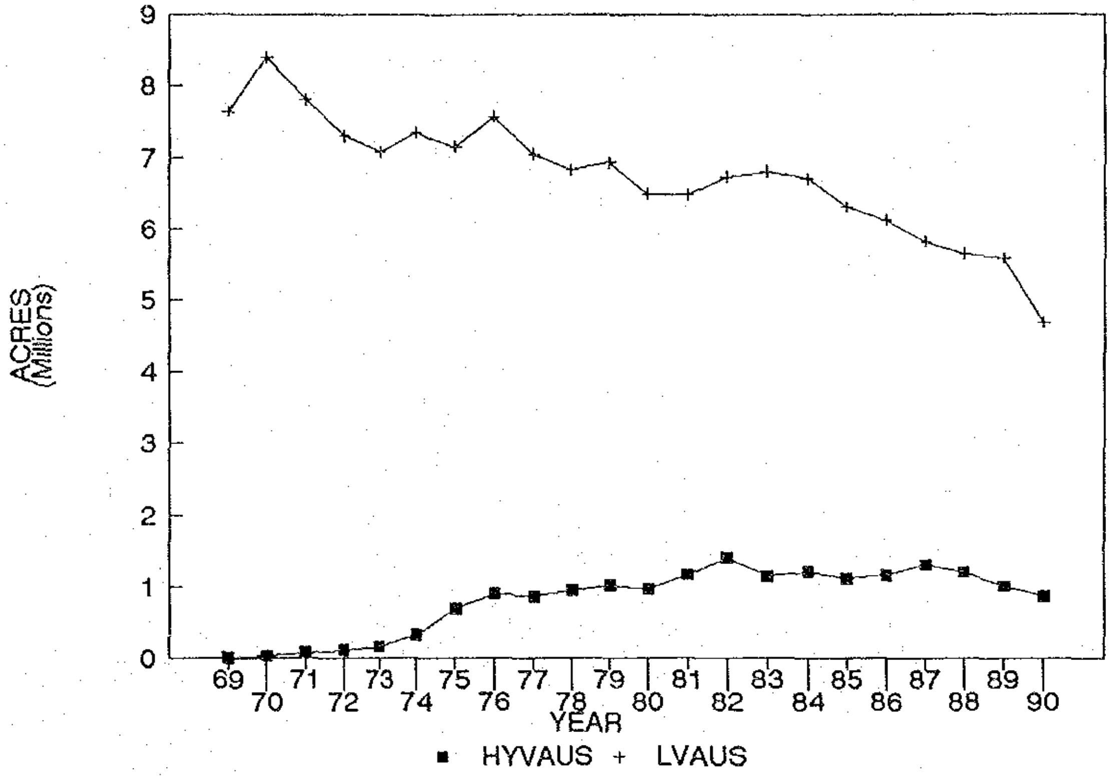


FIG. 2.6 PRODUCTION OF AMAN BY VARIETY

IN BANGLADESH

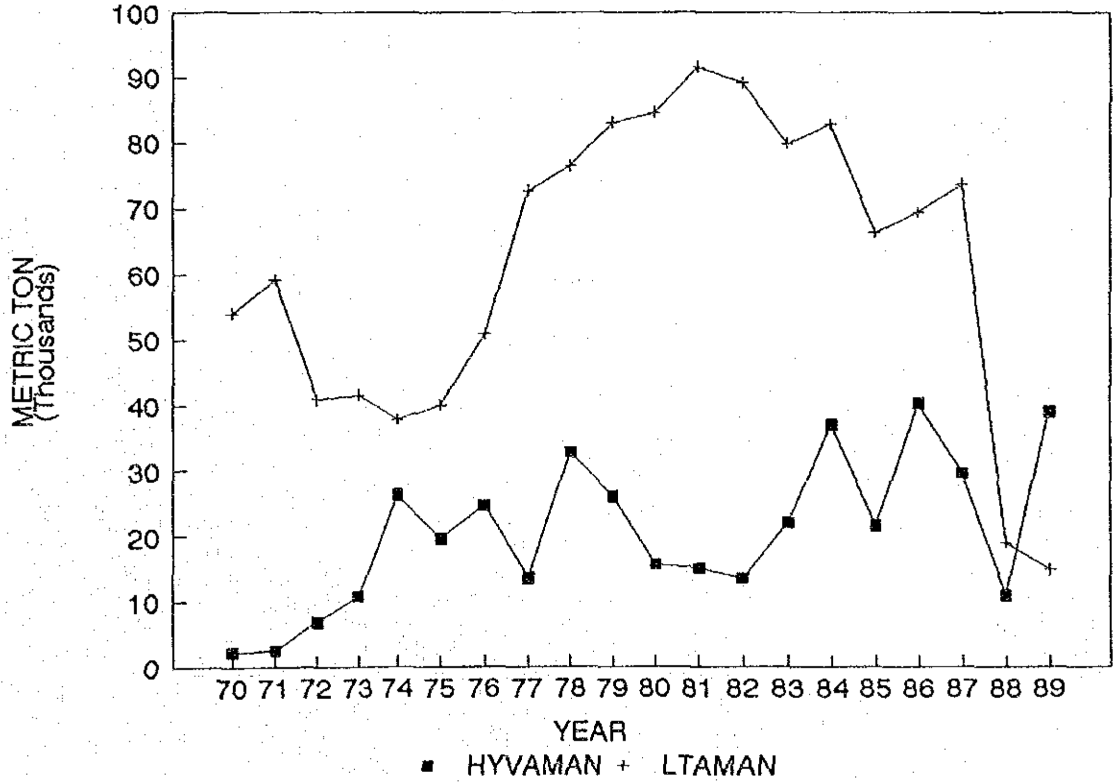


FIG. 2.7 PRODUCTIONR OF OILSEEDS

IN BANGLADESH

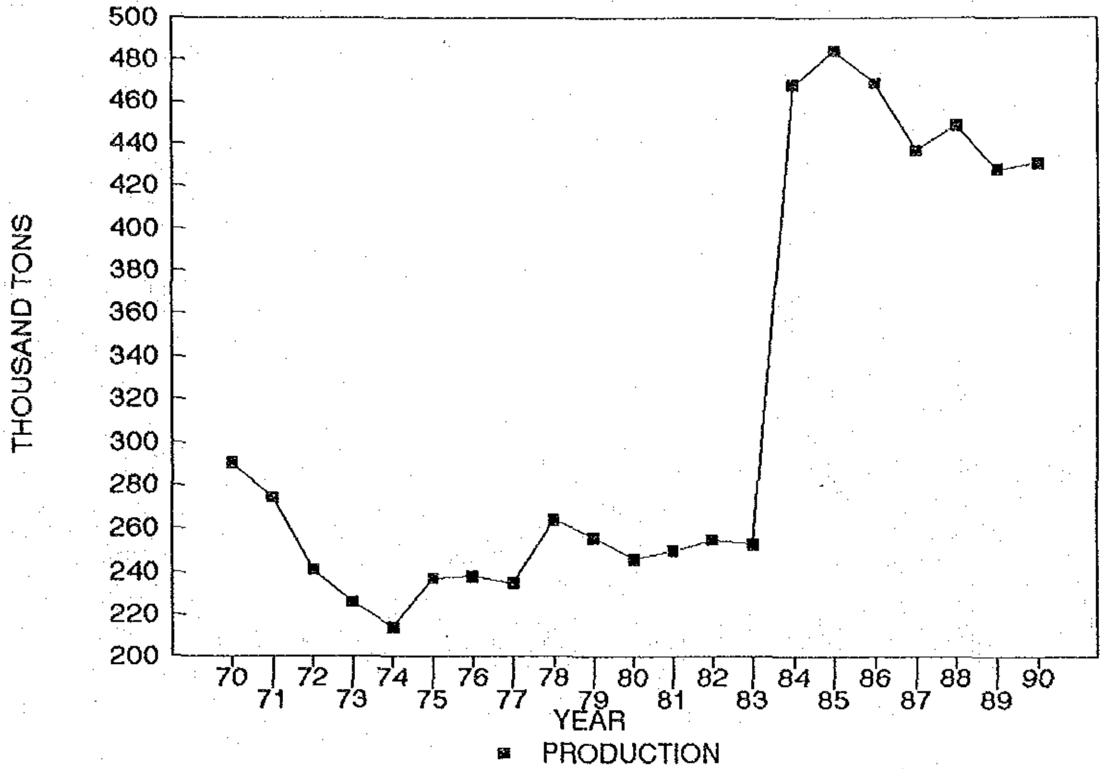


FIG. 2.8 PRODUCTION OF PULSES

IN BANGLADESH

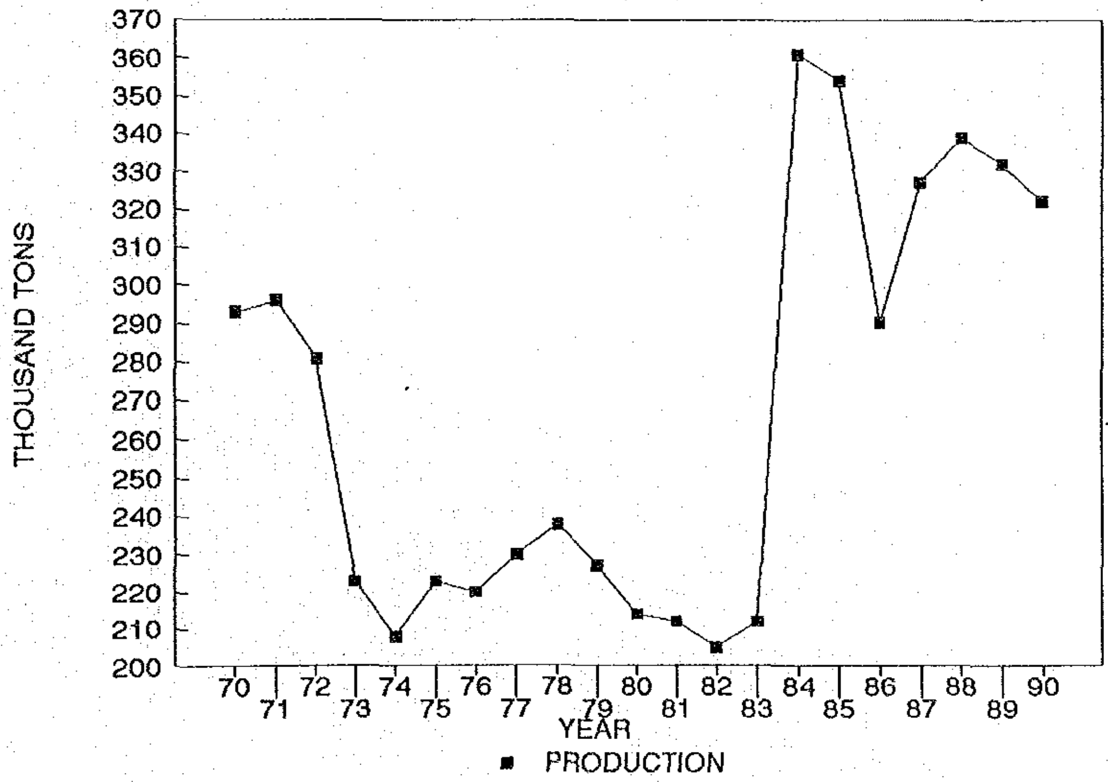


FIG. 2.9 AREA UNDER OILSEEDS

IN BANGLADESH

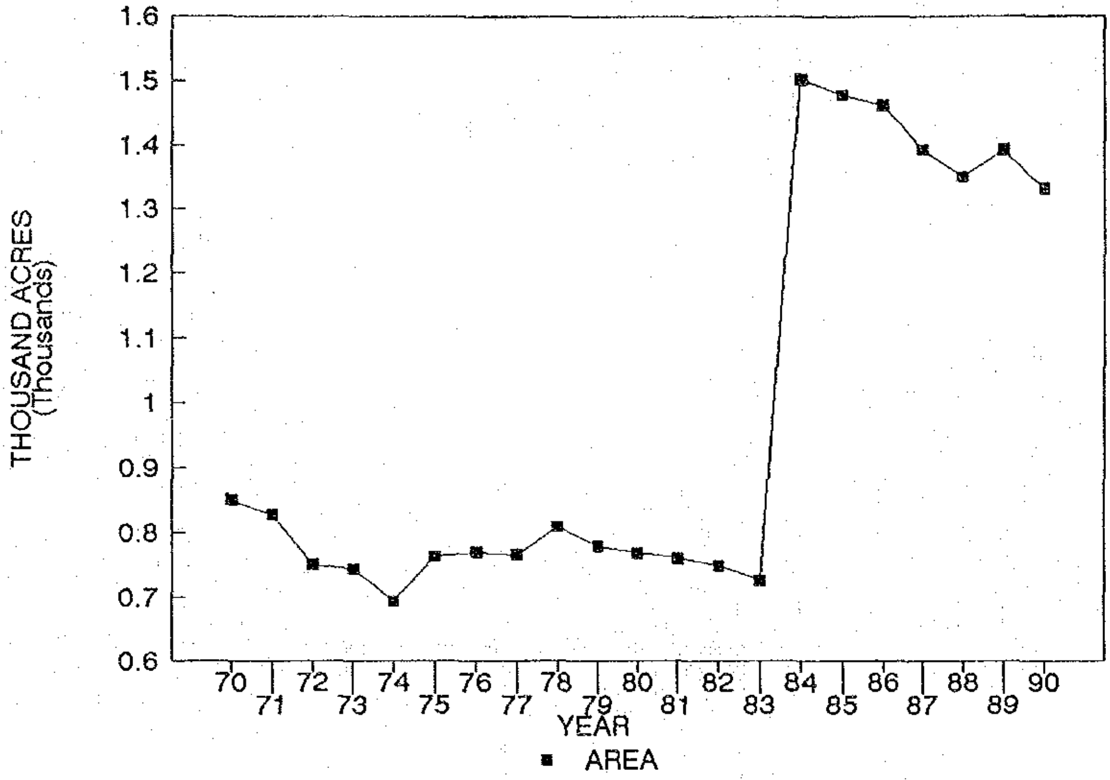


FIG. 2.10 PER CAPIT PRODUCTION OF OILSEEDS

IN BANGLADESH

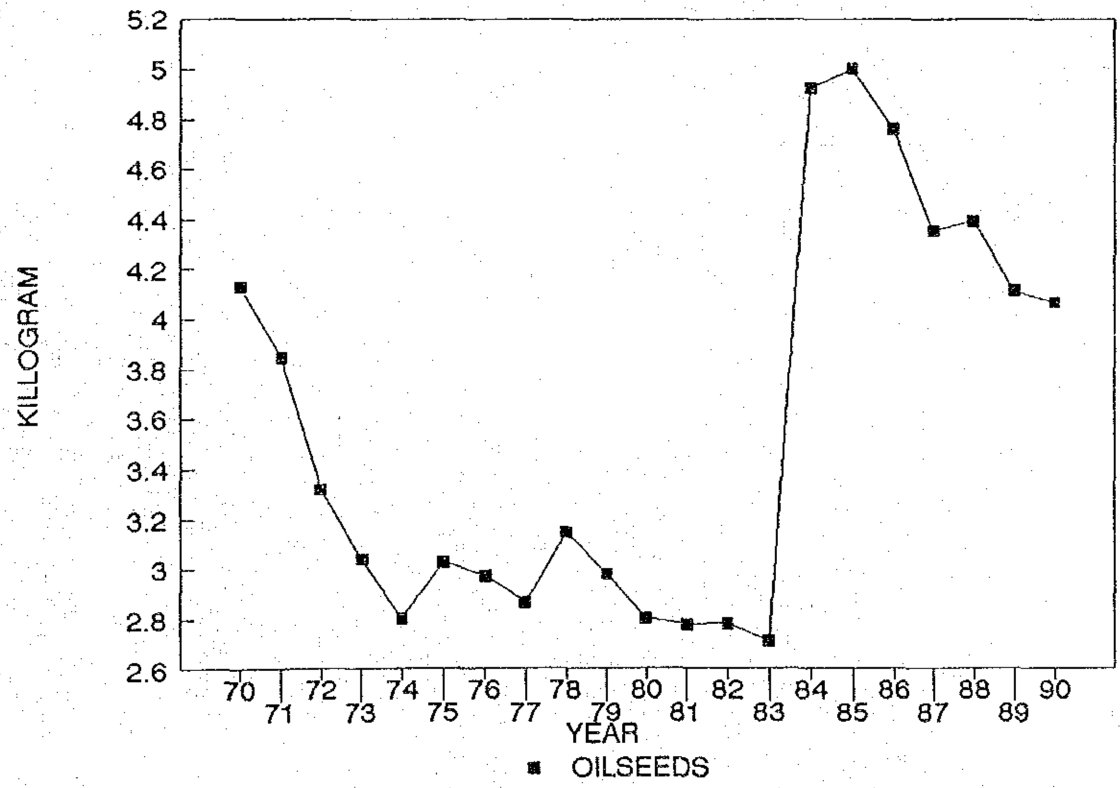


FIG. 2.11 PER CAPIT PRODUCTION OF PULSES

IN BANGLADESH

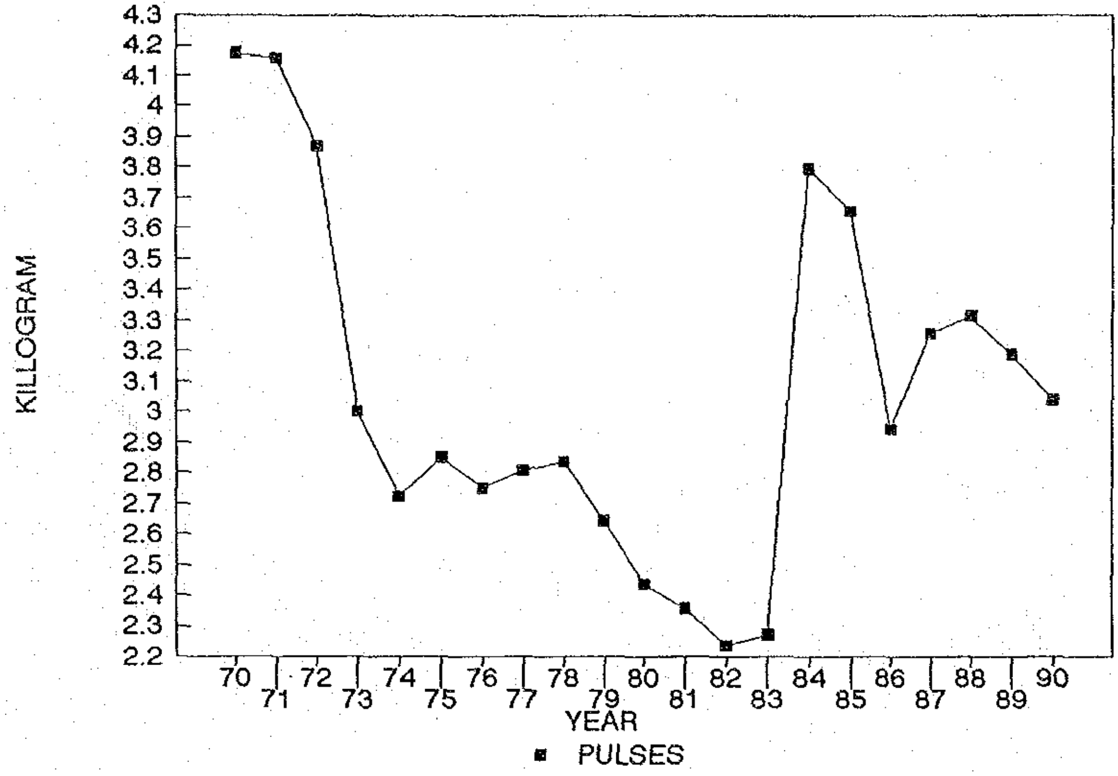


FIG. 2.12 AREA UNDER B.AMAN AND BORO VARIETIES

IN RAJSHAHI DIVISION

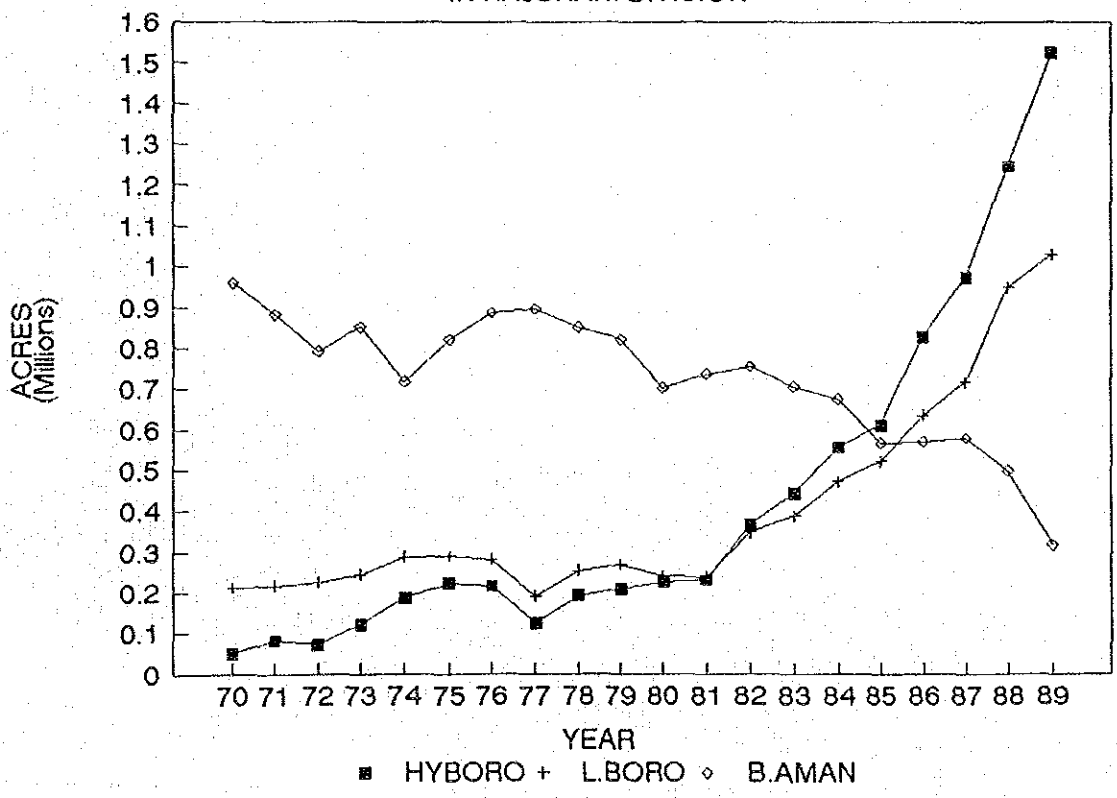


FIG. 2.13 PRODUCTION OF AMAN BY VARIETY

IN RAJSHAHI DIVISION

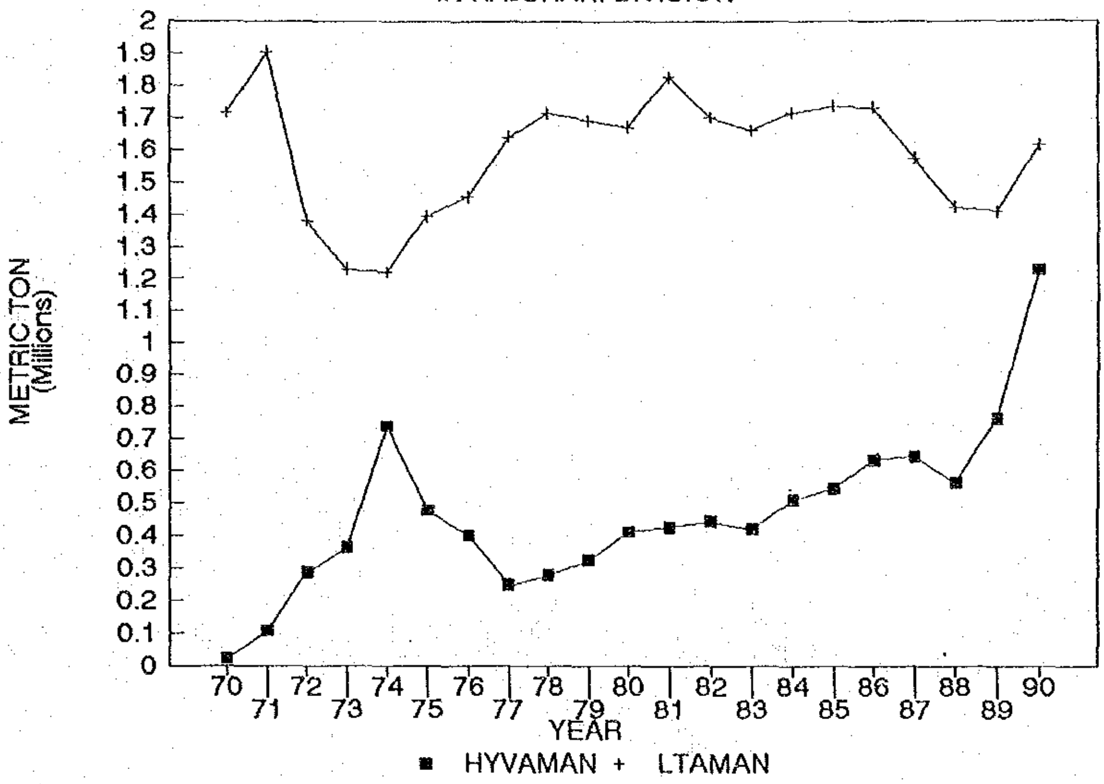


FIG. 2.14 PRODUCTION OF AUS RICE BY VARIETIES

IN RAJSHAHI

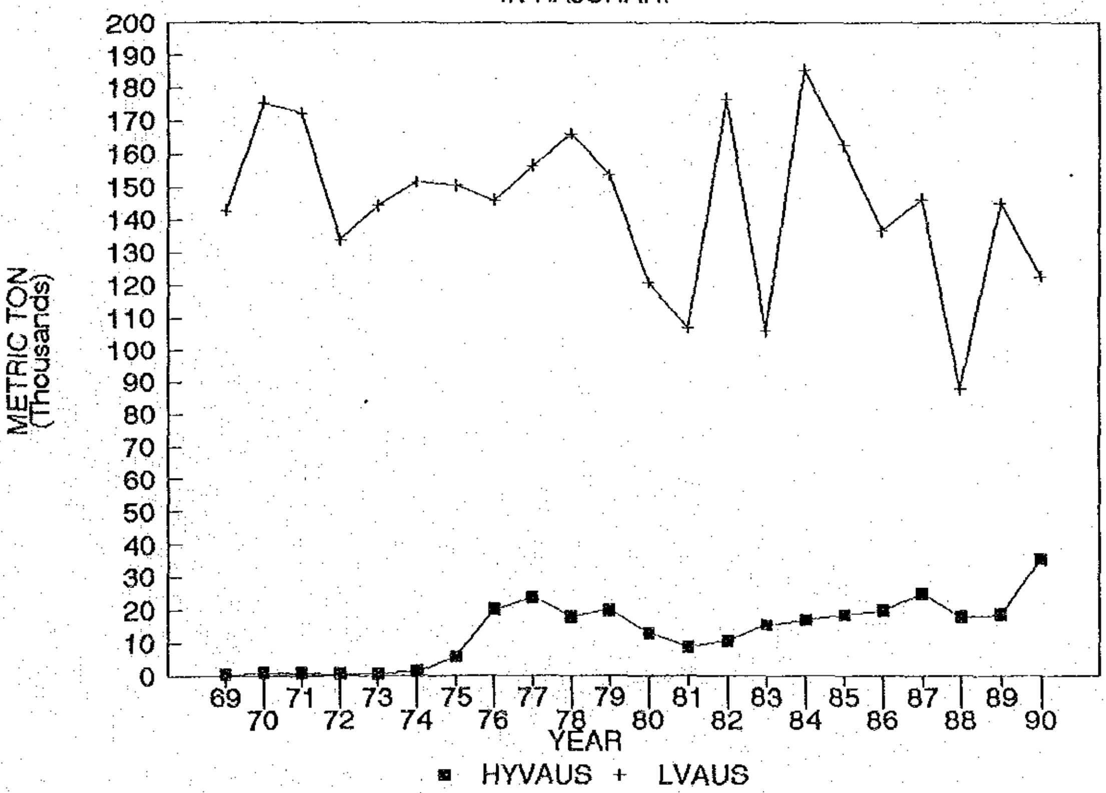


FIG. 2.15 AREA UNDER AMAN CROPS
IN RAJSHAHI DIVISION

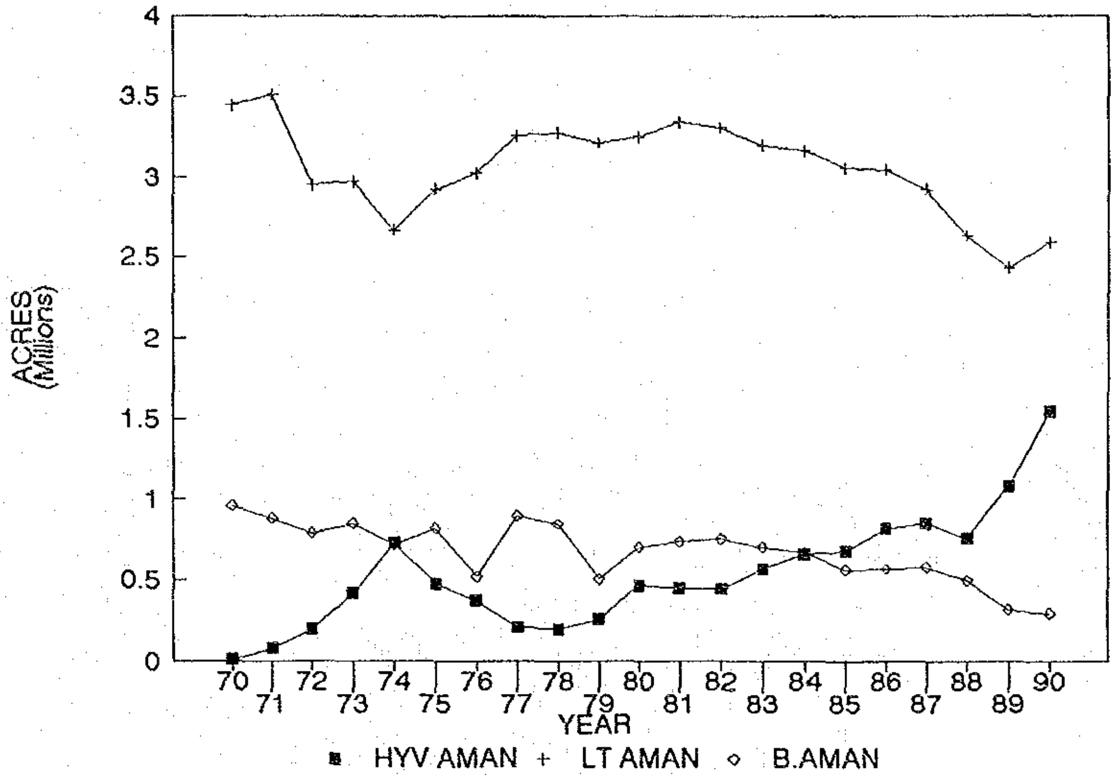


FIG. 2.16 AREA UNDER AUS VARIETIES
IN RAJSHAHI DIVISION

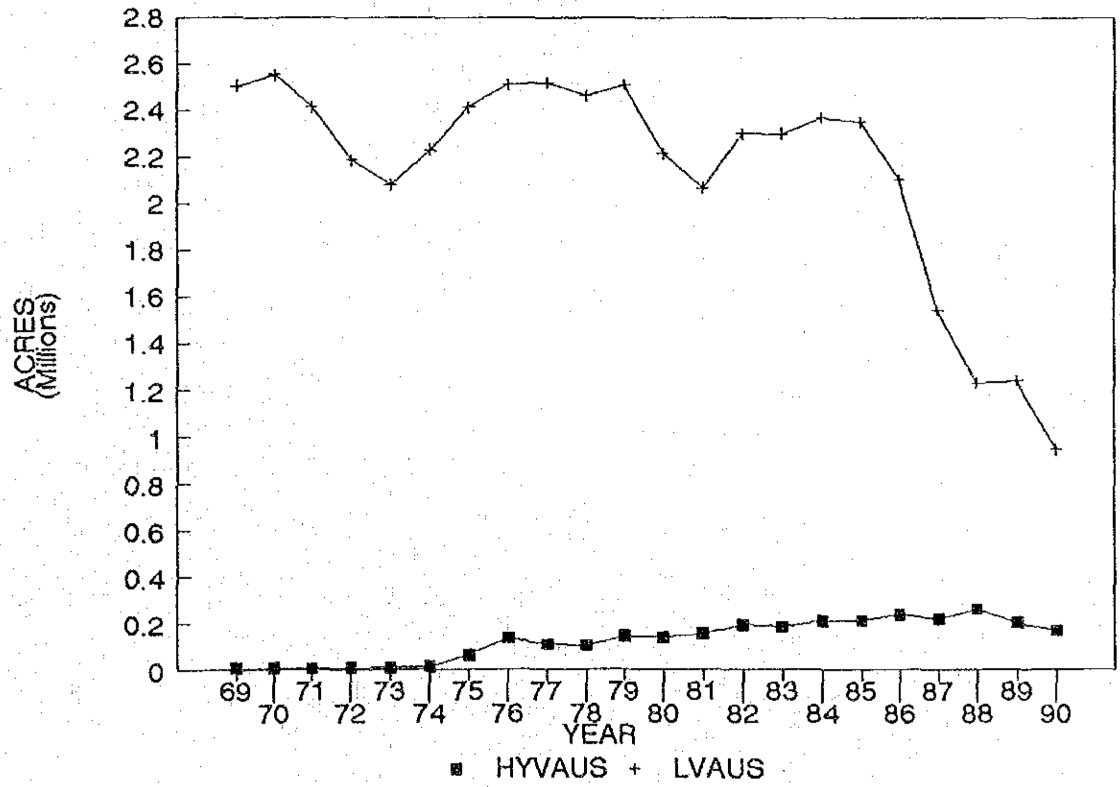


FIG. 2.17 AREA UNDER B.AMAN L.AUS AND BORO

IN RAJSHAHI DIVISION

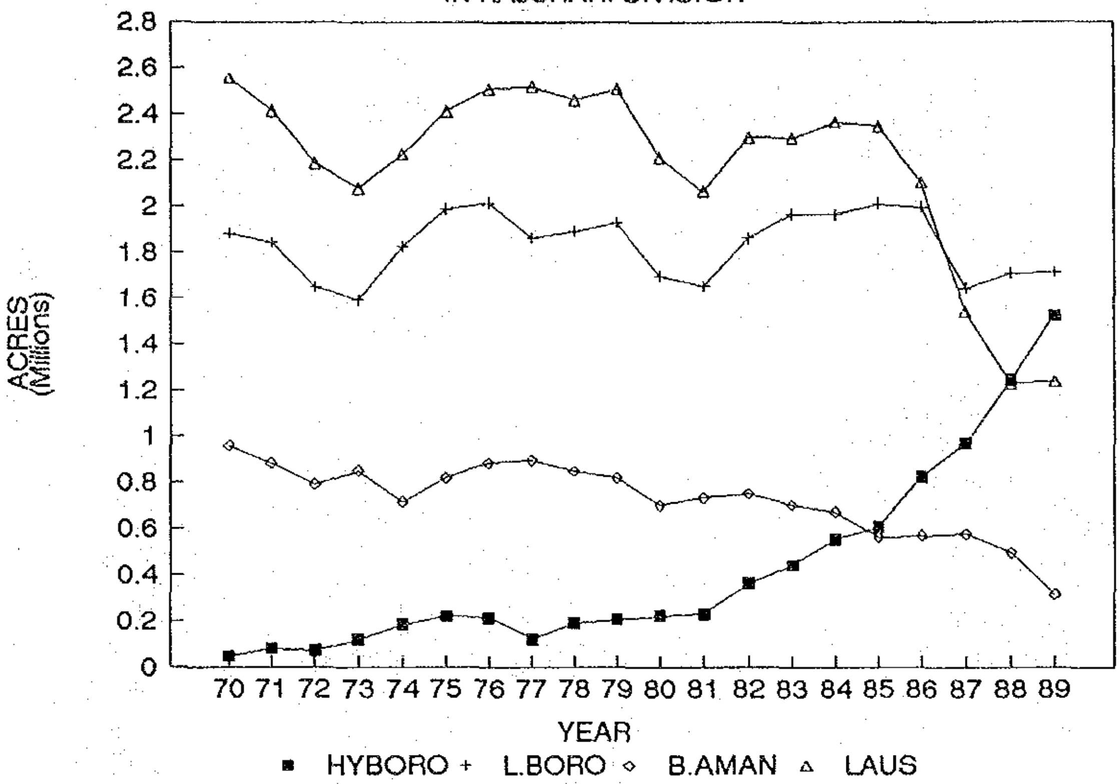


FIG. 2.18 AREA UNDER B.AMAN L.AUS AND BORO

IN BOGRA

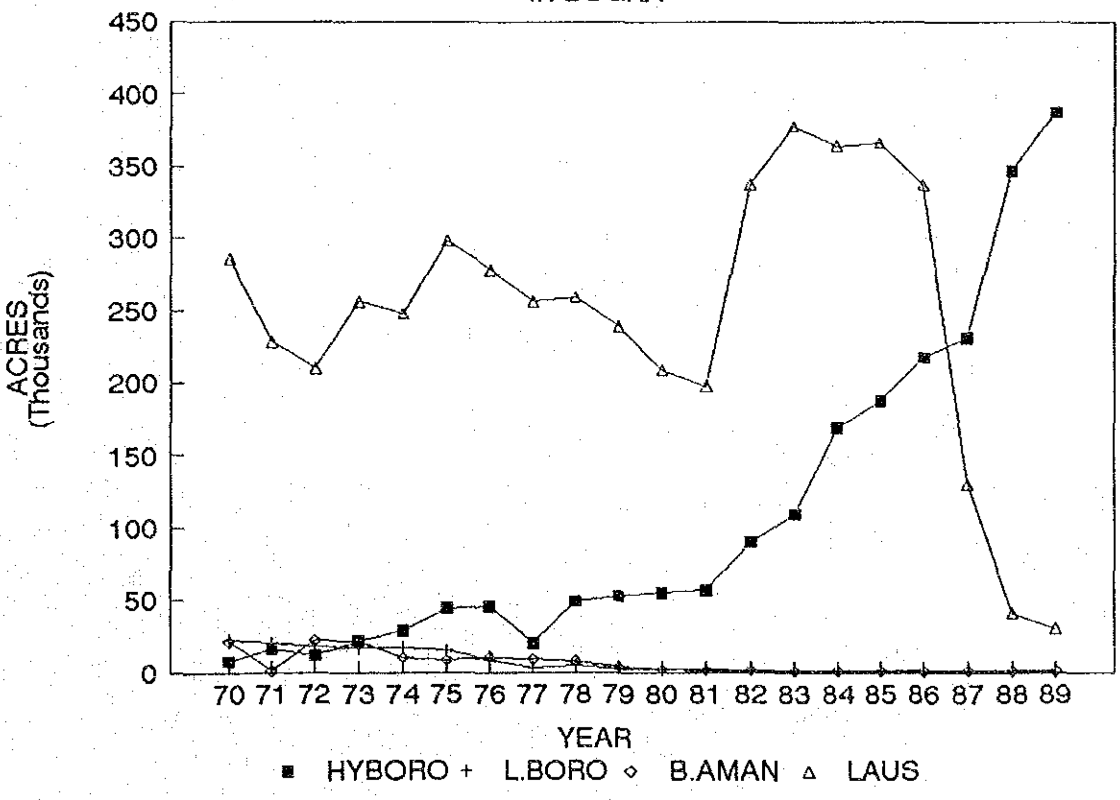


FIG. 2.19 AREA UNDER B.AMAN L.AUS AND BORO

IN PABNA

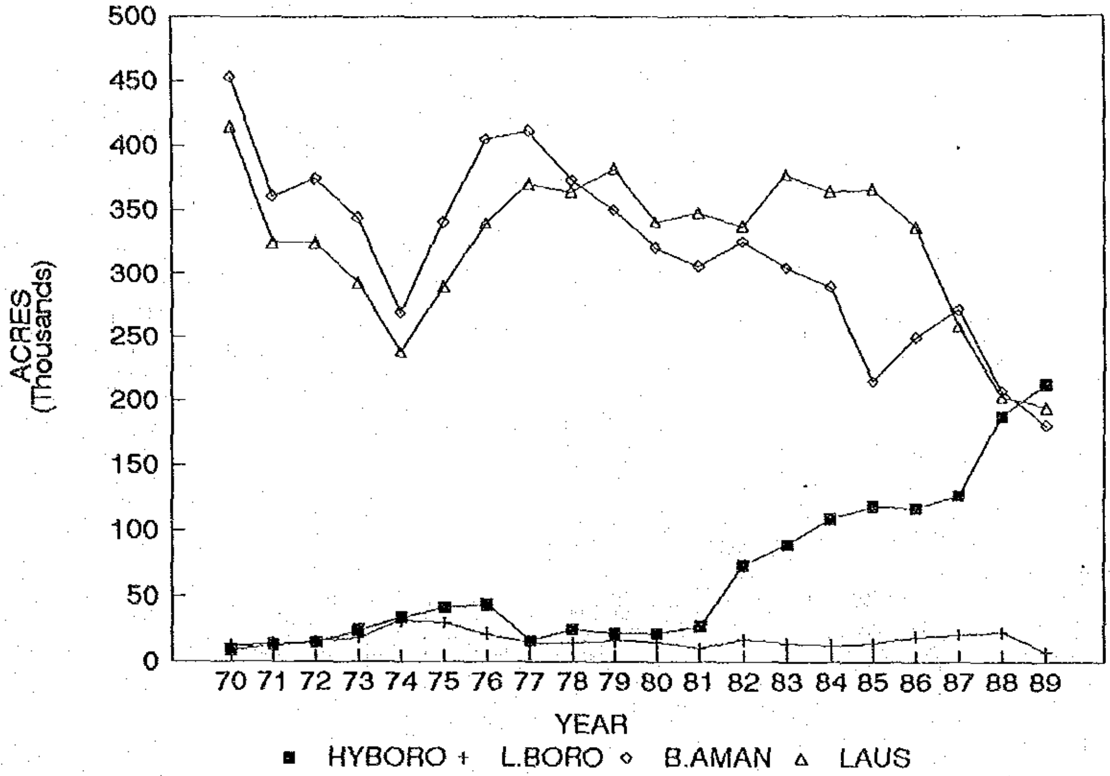


FIG. 2.20 AREA UNDER B.AMAN L.AUS AND BORO

IN RAJSHAHI

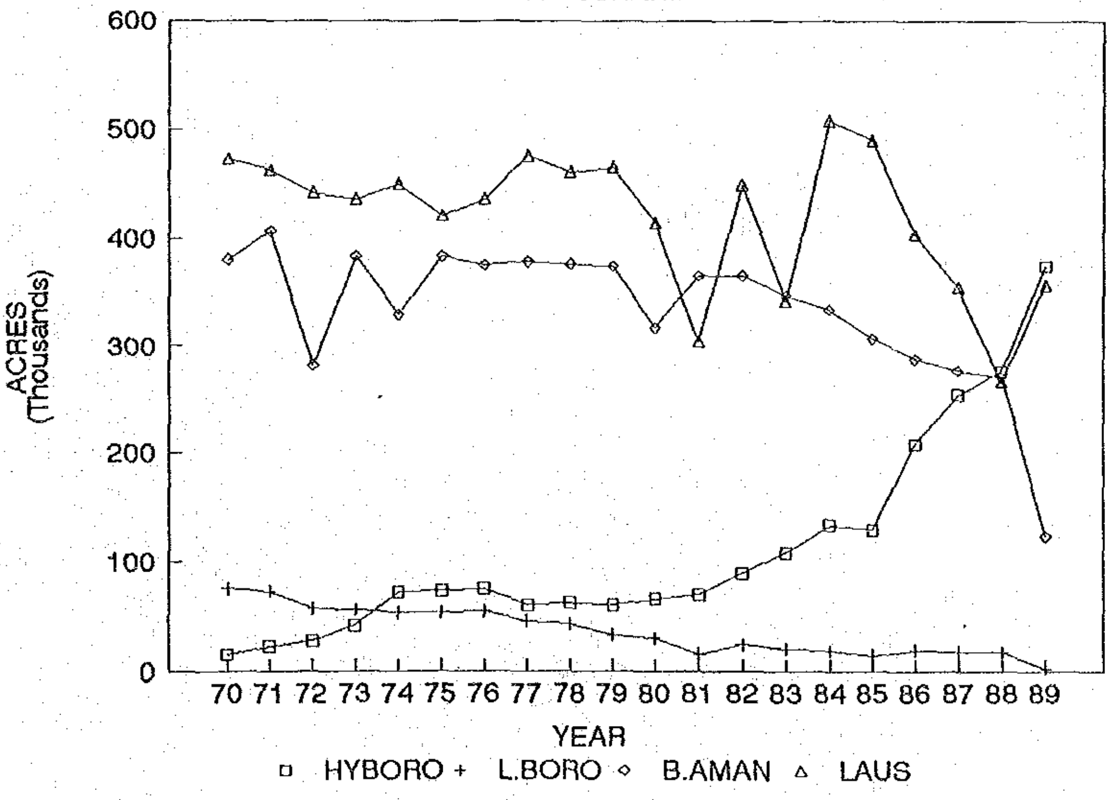


FIG. 2.21 AREA UNDER B.AMAN L.AUS AND BORO

IN RANGPUR

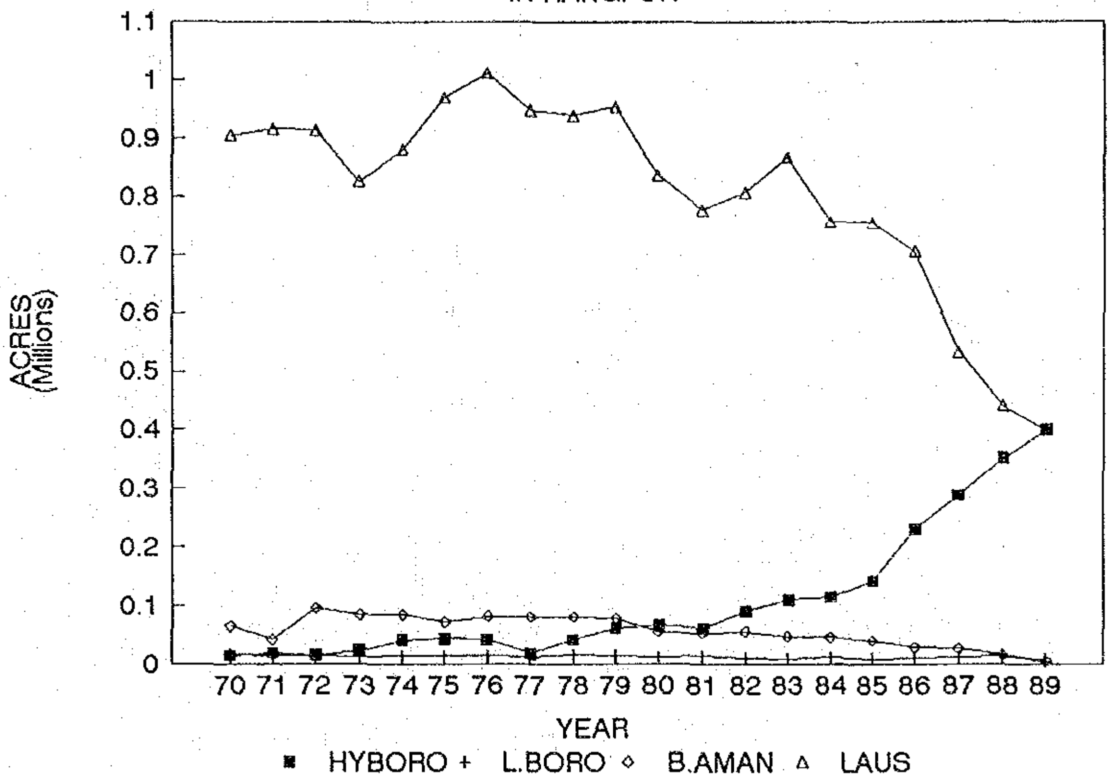


FIG. 2.22 AREA UNDER B.AMAN L.AUS AND BORO

IN DINAJPUR

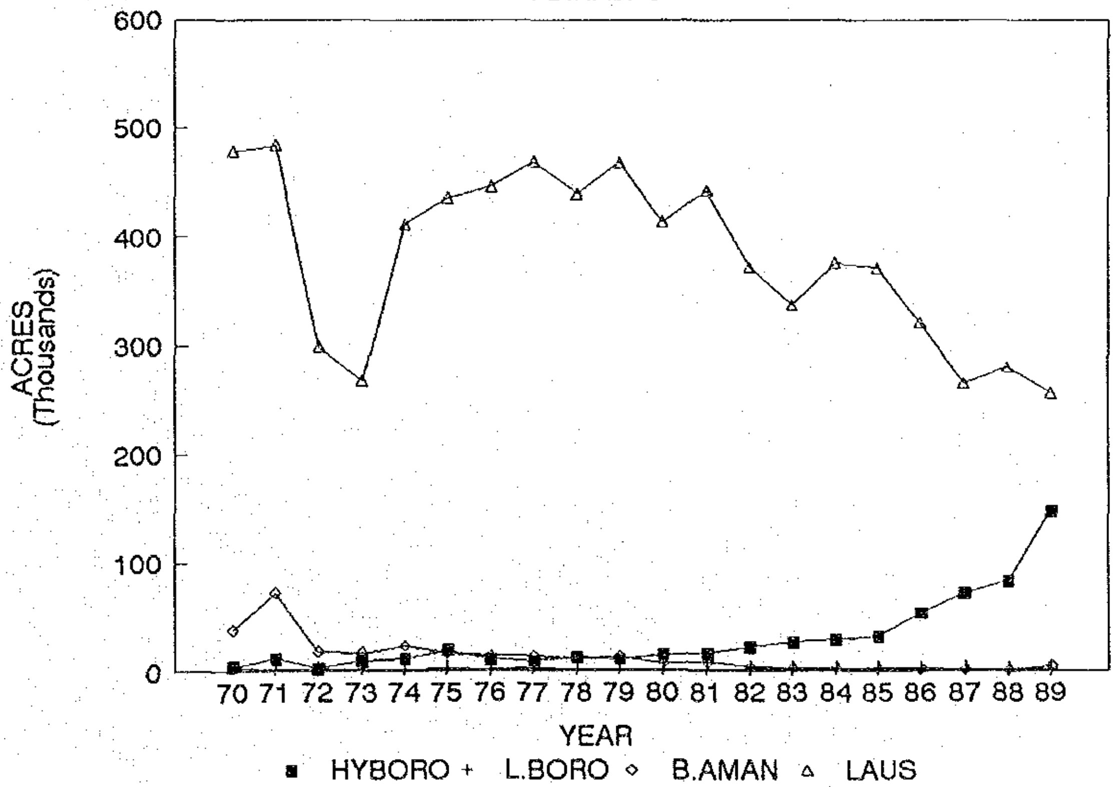


FIG. 2.23 AREA UNDER B.AMAN AND BORO VARIETIES

IN BOGRA

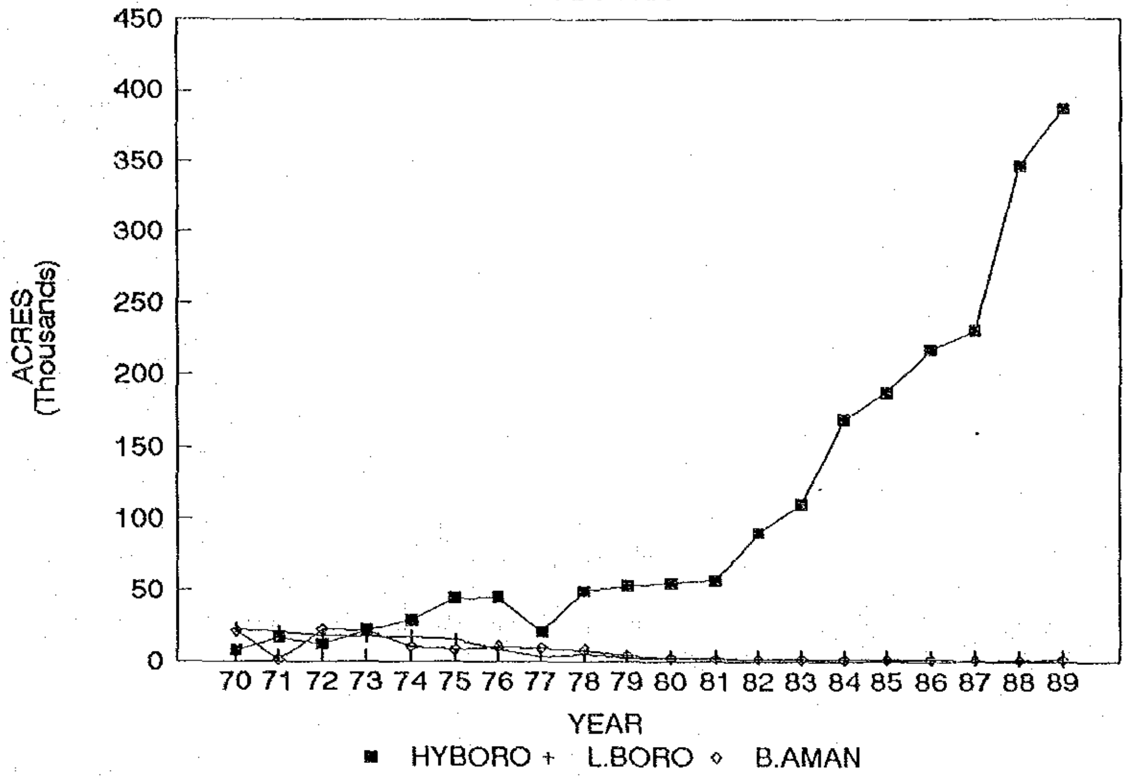


FIG. 2.24 AREA UNDER B.AMAN AND BORO VARIETIES

IN PABNA

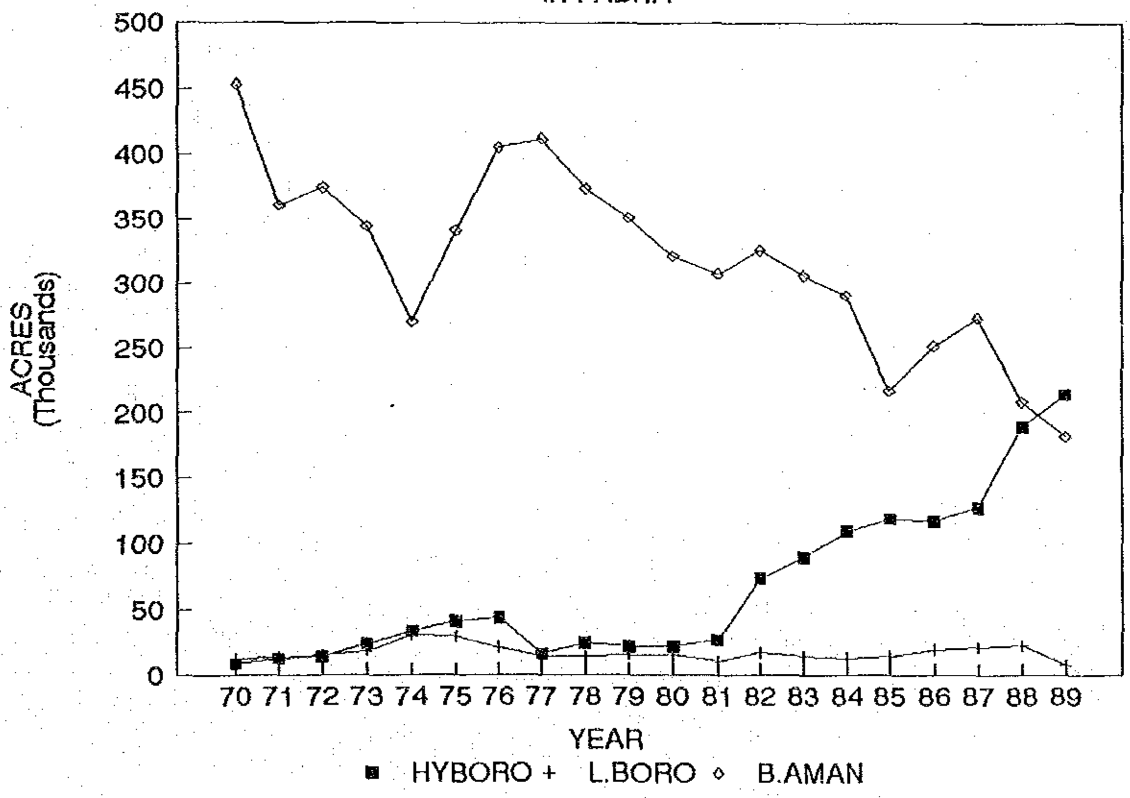


FIG. 2.25 AREA UNDER B.AMAN AND BORO VARIETIES

IN RAJSHAHI

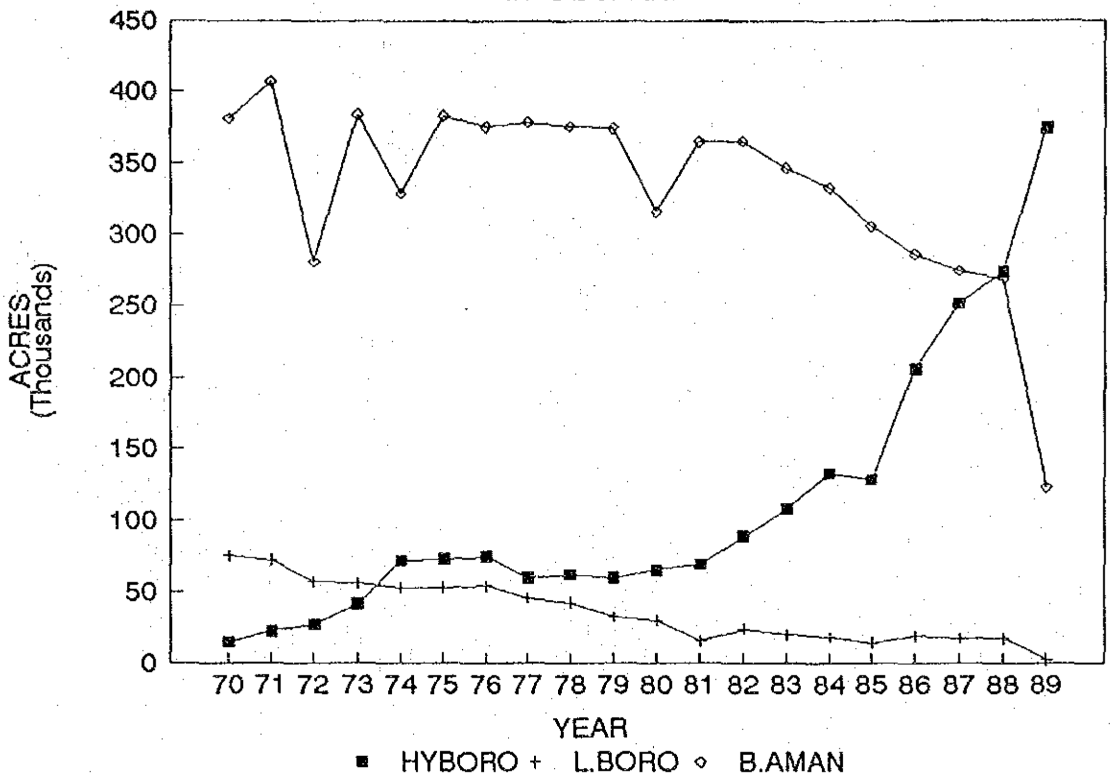


FIG. 2.26 AREA UNDER B.AMAN AND BORO VARIETIES

IN RANGPUR

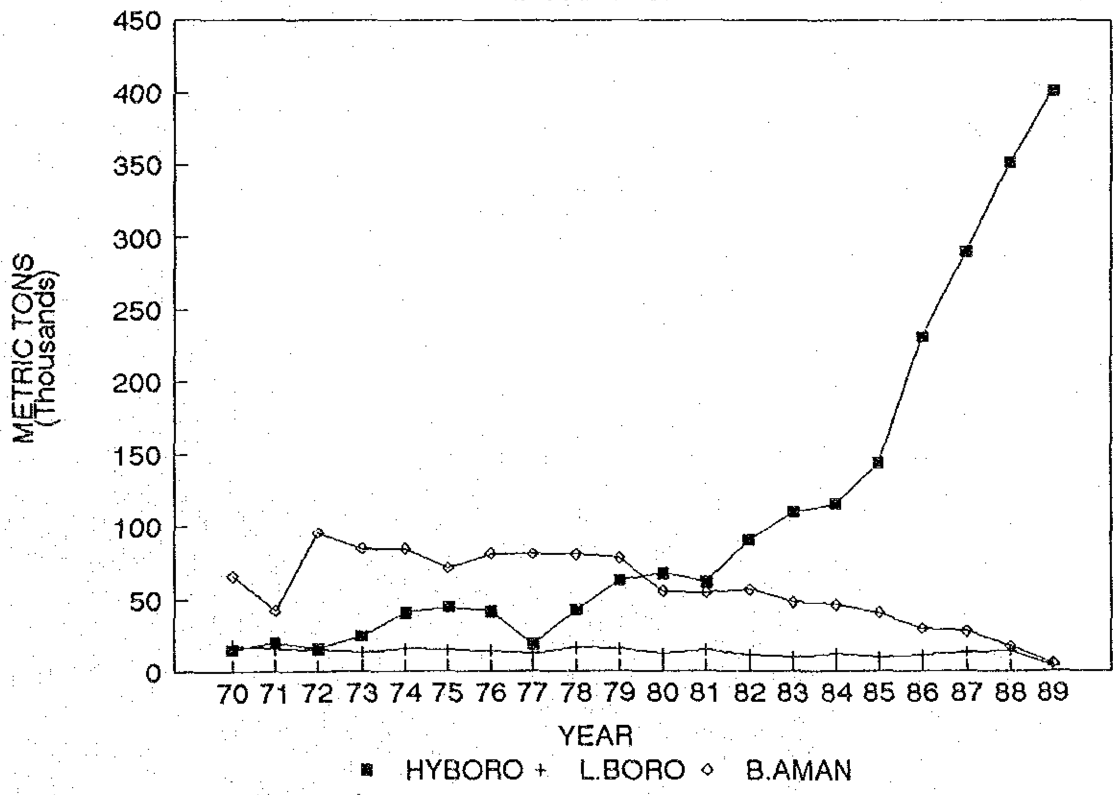


FIG. 2.27 PRODUCTION OF AMAN BY VARIETY
IN BOGRA

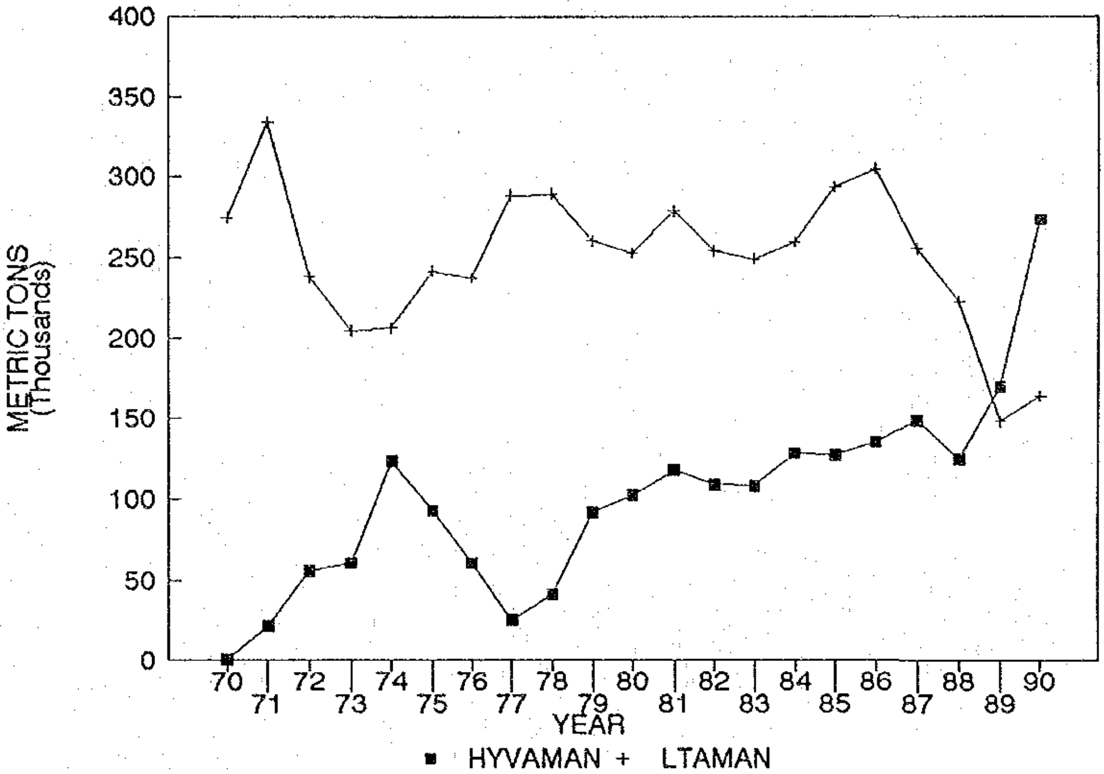


FIG. 2.28 AREA UNDER AMAN CROP BY VARIETIES
IN BOGRA

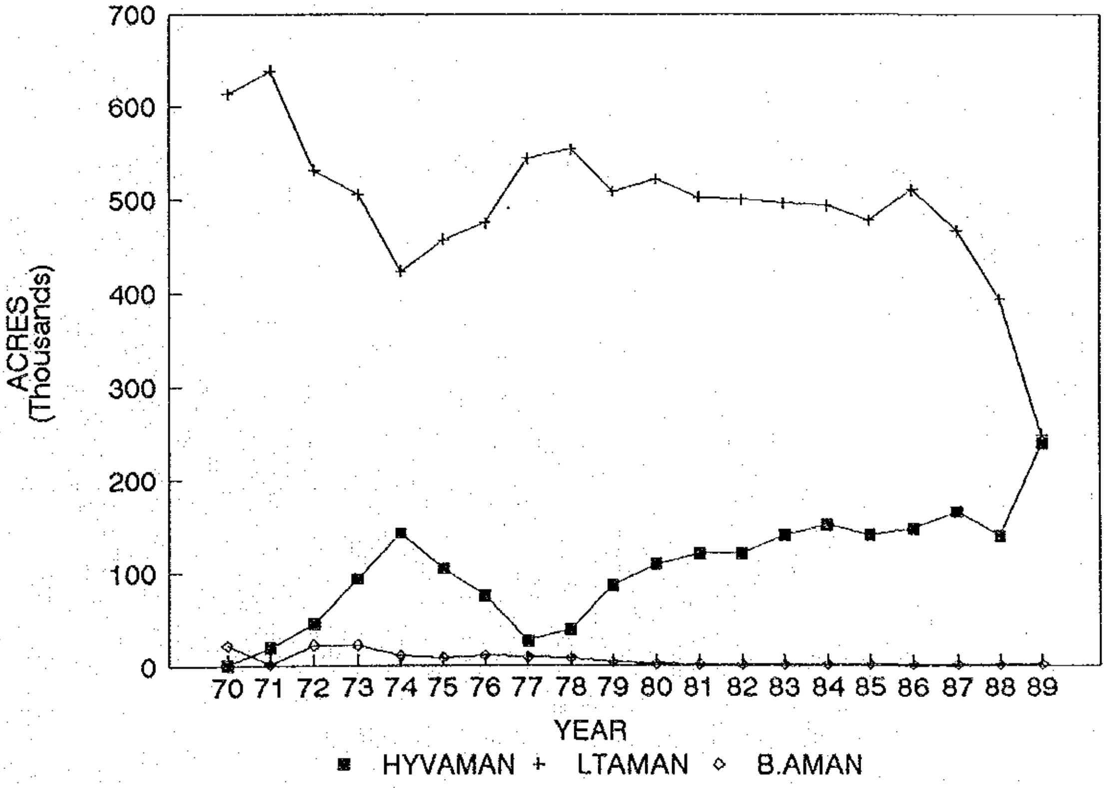


FIG. 2.29 AREA UNDER AMAN CROP BY VARIETIES

IN PABNA

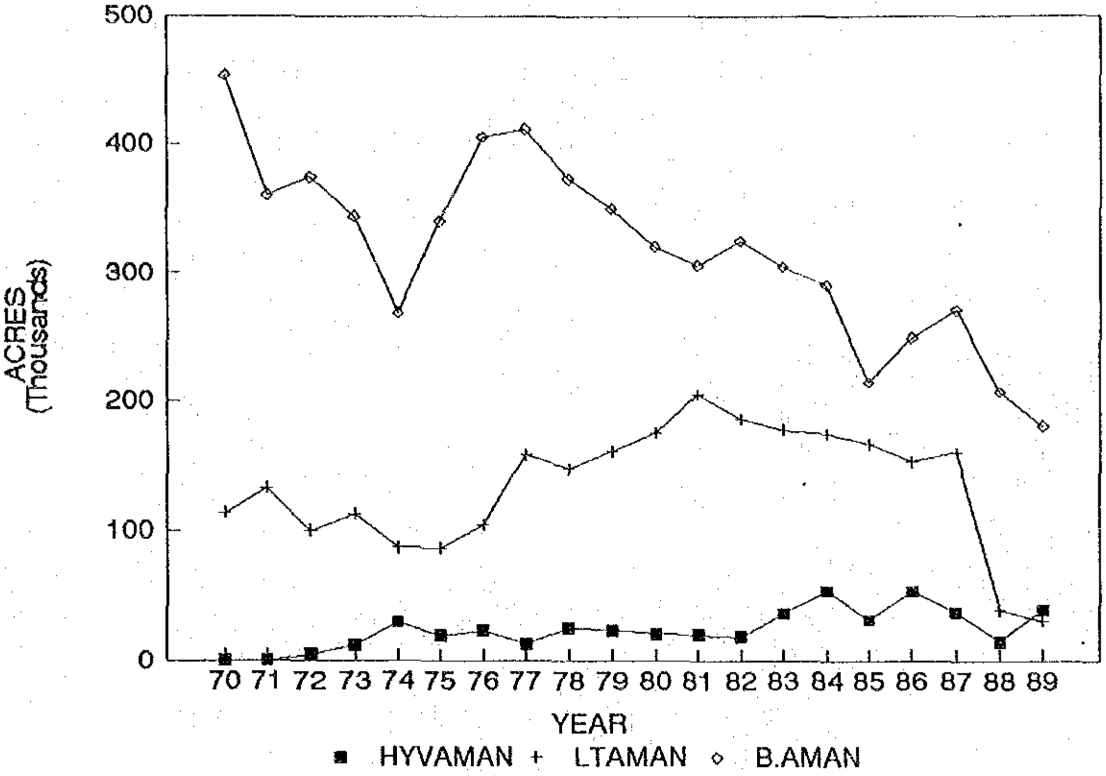


FIG. 2.30 AREA UNDER AMAN CROP BY VARIETIES

IN RAJSHAHI

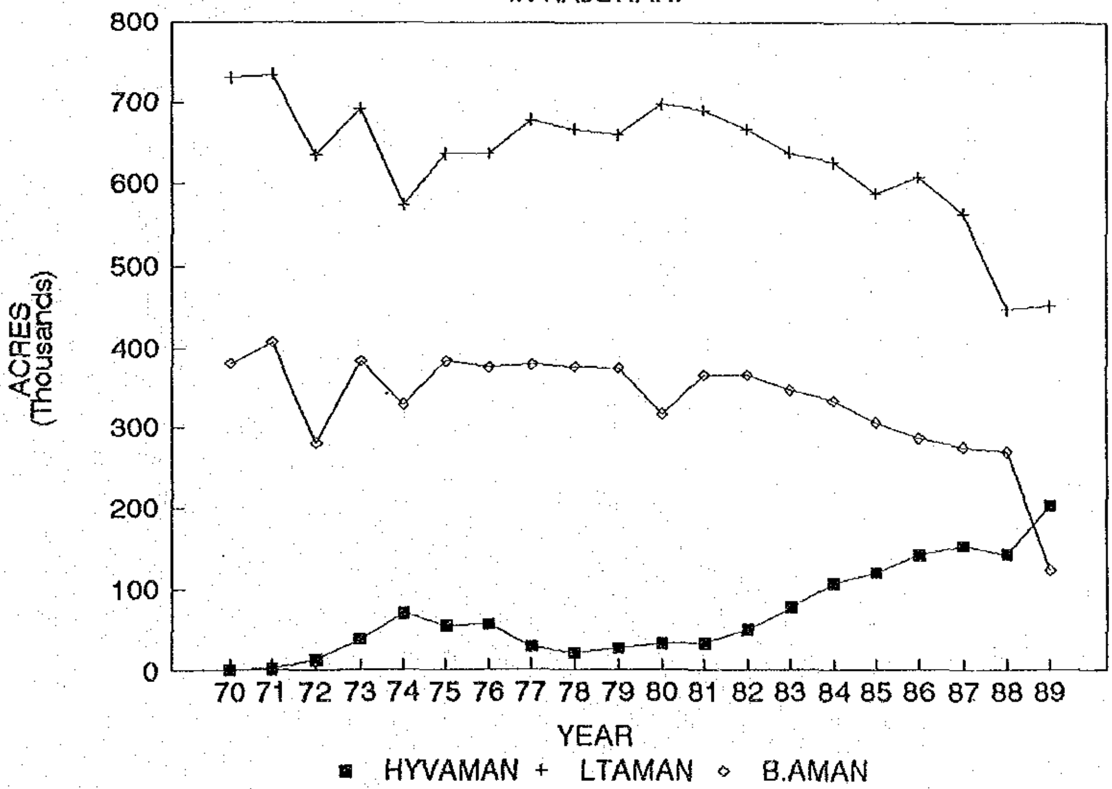


FIG. 2.31 AREA UNDER AMAN CROPS

IN RANGPUR

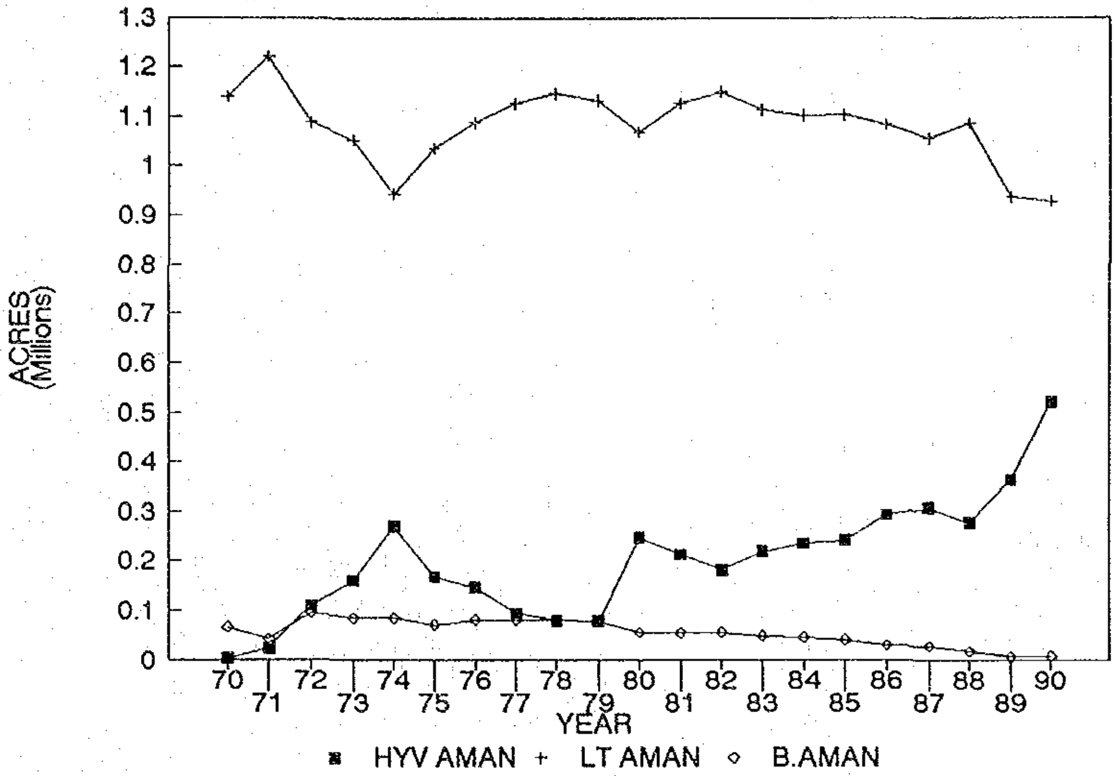


FIG. 2.32 AREA UNDER AMAN CROP BY VARIETIES

IN DINAJPUR

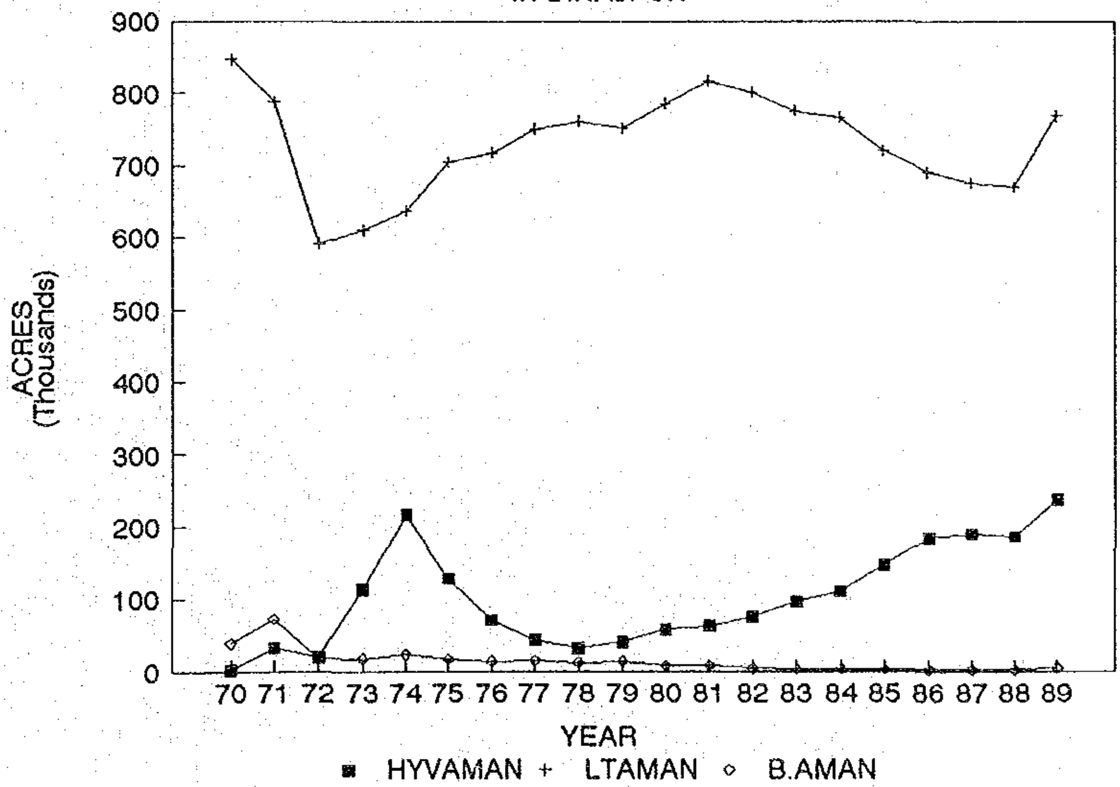


FIG. 2.33 AREA UNDER AUS VARIETIES

IN BOGRA

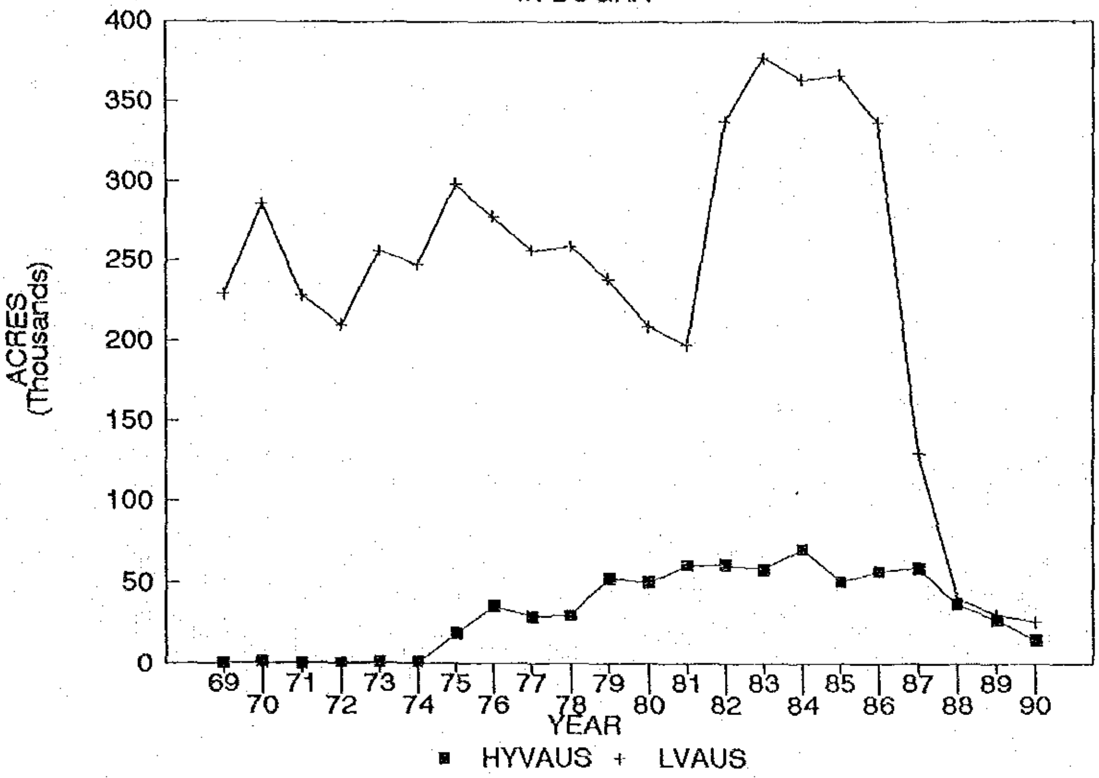
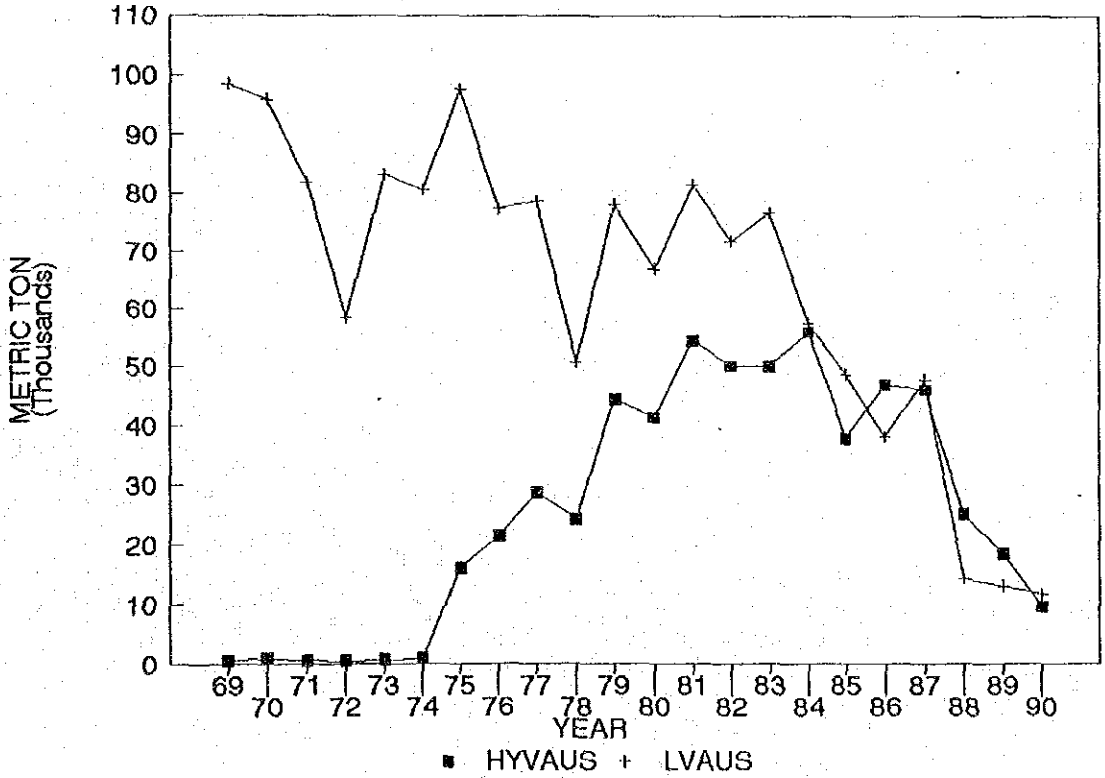


FIG. 2.34 PRODUCTION OF AUS RICE BY VARIETIES

IN BOGRA



2.2 Price and Wage Trends

Table 2.1. shows trends in real farm-gate prices of paddy and wheat in the NW Region. The trend is downwards, and this has major implications for future profitability, as well as for the economic pricing of different commodities in the analysis.

Table 2.2 shows nominal and real wage rates for the region. They show a fluctuation over the period but no clear trend. The fall in foodgrain prices gives some benefit to agricultural labourers however.

2.3 Policy Context of Regional Water Planning

The trends in output and prices discussed in the previous sections provide the context within which the FAP studies are taking place. It has been shown that foodgrains production is growing at a rate faster than population growth, and the potential for continued growth in the dry season is substantial. The downward trend in rice prices, and the expectation that this trend will intensify, appears to be the main factor which might reduce growth in paddy output, but this is not necessarily a negative trend if farmers start to diversify into more profitable crops (such a trend would require yield improvements for non-foodgrain crops).

The potential for growth from FCD projects appears to be less. This is recognised in national planning targets. The Fourth Five Year Plan (Draft, 1990) sets the following targets in the water resources sector:

	Benchmark (1989/90)		FFYP Target (1994/95)	
	mn ha	% of NCA	mn ha	% of NCA
Irrigation	3.1	32	4.81	50
FCD	3.24	34	3.64	38

The National Water Plan (1986) proposed that an additional 2.14 mn ha (22% of NCA) could be economically developed with FCD, but accepts that such an estimate may overstate the actual potential. The analysis by Gisselquist quoted earlier suggests a smaller potential in terms of actual impact on production. Some other studies seem to support the latter view. For example, the UNDP Flood Policy Study conducted in the wake of the 1988 floods estimated all the agricultural benefits to come from reduced crop damage, not from increases in crop production as such.

These views on the potential of and justifications for flood control projects need to be kept in mind when analysing specific options for flood control. The following sections discuss the scope of and approach to the analysis.

3. Options and Scenarios for Economic Analysis

The main focus of planning and analysis upto the interim report stage was an assessment of the feasibility of alternative Interceptor and Diversion Drains, and an assessment of conditions and possible measures (including the drains) in the Lower Atrai basin. Other possible measures elsewhere in the region were also analysed.

Table 2.1 Current and Real Farm-Gate Prices of Paddy and Wheat

NW Region, 1985/86 - 1991/92

A. Current Price	(Tk. per kg.)						
	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
HYV Aman	4.26	5.03	5.91	5.51	5.51	6.06	6.54
HYV Boro	4.58	5.13	4.58	5.25	5.16	5.88	5.74
Wheat	4.59	5.08	5.27	5.74	6.28	6.15	6.58

Source: BBS

Note: Directorate of Agricultural Marketing, based on average prices at 20 survey locations.

B. Real Price	(Tk. per kg.)						
	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
HYV Aman	4.26	4.57	4.84	4.21	3.91	4.09	4.11
HYV Boro	4.58	4.66	3.75	4.0	3.66	3.97	3.61
Wheat	4.59	4.62	4.32	4.38	4.45	4.16	4.14

Note: GDP deflator applied to current prices, 1985-86=100.

CRFGPPW

Table 2.2 Trends in Wages of Agricultural Labourers, NW Region

A. Nominal Wage (Tk. per day)

	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
NW Region	25.7	27	25.4	24.6	26.7	34.2	34.3

Source: BBS

Note: Annual average wage rate based on average of monthly data.
Monthly data incomplete for 1989-90(7 months) and 1990-91 (6 months).

B. Real Wage (Tk. per day)

	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
NW Region	25.7	24.1	21	19.2	19.6	23	21.7

Note: Nominal wage deflated by consumer price index for rural families,
Rajshahi Division, 1985-86=100

The interim report analysis found that both the Interceptor Drain and the Diversion Drain were clearly uneconomic. It also found that the option of a regulator on the Hurasagar outfall would not be effective, and that pump drainage as a general approach could not be economically justified. Analysis also showed that, in principle, full FCD in the Lower Atrai gave high returns, but in practice this was viewed as an inappropriate strategy for that area, in view of the serious confinement effect resulting from full FCD close to the rivers, and the consequent public cutting and breaching that occurred there.

The analysis in the subsequent stage has focussed particularly on three areas (although other areas have also been analysed): (i) the Lower Atrai/Lower Bangali basin, (ii) Gaibandha and the Teesta Right Bank (Gaibandha being the area selected for feasibility level work), and (iii) the Upper Karatoya and the associated proposal for the "Bangali Floodway", a form of shortened Interceptor Drain. Other areas for which pre-feasibility plans have been prepared and analysed are the Teesta Left Bank, Little Jamuna Right Bank, Hurasagar basin, and Mohananda basin.

With the exception of the Little Jamuna Right Bank proposal, all these options cover quite large areas (including impacted areas, the three main areas of focus cover well over 100,000 ha. each). The inclusion of impacted areas is important because it gives the study a genuine regional focus. However, the study has not in general examined small-scale water control projects although FAP 12 found that these tended to be the schemes with the highest rates of return. A number of projects already exist which develop such small-scale schemes (for example, EIP, SSFCDI), including many already completed in the NW Region, and the general approach of this study has been to develop a regional and sub-regional planning framework within which such smaller schemes can be developed.

Economic analysis has been used to select between alternatives in the same location, to appraise final options and scenarios (combinations of options), and to test proposals for sensitivity. Three measures of basic economic viability have been calculated for each option analysed:

- NPV
- EIRR
- NPVR(1).

The reason for including the NPVR(1) measure was explained earlier.

In contrast to the analysis at interim report stage, when each option was analysed for two individual years (a "normal" flood year and a "high" flood year), analyses were conducted for a single year selected, from hydrological analysis of the hydro-dynamic model outputs, to be representative of a 1:5 year water level. Analyses which were conducted to choose between alternatives at the same location were generally based on a 10 year model run, from which a 1:5 year was selected, while final analyses of selected options and scenarios were based on a 25 year model run.

The choice of a 1:5 year water level as the representative level for analysis is primarily intended to reflect farmers' decision-making behaviour in the flood season. It is a reasonable assumption that most farmers in Bangladesh plant crops in the monsoon season in the hope that, in most years, they will get a "normal" harvest, i.e. without serious flood damage. If the 1:5 year flood would damage crops, this still means that, on average, for 80% of the time farmers would get more or less normal yields. If it were assumed instead that farmers planned for the "average" flood, there would be a chance of serious damage every 2-3 years. It seems unlikely that most farmers are prepared to gamble to that extent. Equally, any water level greater than a 1:5 seems to be too conservative. Therefore it is assumed that farmers grow crops which can withstand water levels upto a 1:5 year flood. Discussion in the following sections will consider the implications of this assumption for the derivation of the cropping patterns used in analysis, as well as other components of the analysis (especially floodplain fisheries).

4. Methodology and Data for the Economic Analysis

4.1 Conceptual Approach and Link with Multi-Criteria Analysis

The following sections discuss the methodology and data sources used in the economic analysis. First, though, the conceptual approach to analysis is briefly discussed.

In line with the intentions expressed in the Guidelines for Project Assessment, the study has aimed to develop a broad assessment of project impacts, as well as adopting an approach to project design explicitly intended to pre-empt some of the problems that have arisen with conventional FCD approaches. These aims have been carried out to the extent possible within existing time and budgetary allocations, but there have been constraints which have limited the assessment to some extent. The scope of the study has been limited to flood alleviation rather than to a broader more integrated water resource management approach. In addition, the time available to conduct environmental and ecological assessments, while expanded considerably at the interim report stage, has still not been sufficient to allow detailed data collection of the type that might have allowed greater valuation of environmental impacts.

For the reasons given above, quantification of a large number of impacts has been limited to ranking of impacts on a scale of -5 to +5. It has not been possible to include valuation of such impacts in the economic analysis.

Nonetheless, the study has attempted to use a "modified" cost-benefit approach where possible. For example, fisheries output has been valued to take account of the depletion of the capture fisheries resource. The "green river" scenario in the Lower Atrai is by design an attempt to solve the problems of external and downstream impacts by a comprehensive approach which effectively internalises these problems. The resulting plan is then analysed as an interdependent system.

Also, the study places considerable emphasis on the importance of the multi-criteria analysis as a guide to policy-makers in the selection of projects. The results of the economic analysis are entered into the multi-criteria analysis (MCA) and should be considered in conjunction with the other indicators making up the MCA. Although the NPVR(1) has been used to rank projects in economic terms, other criteria in the MCA could be used to change the order of priorities in project selection. In fact, the study's own recommendations of priority projects do not follow the NPVR(1) ranking precisely.

Sensitivity analyses have also been carried out to assess impacts on soil fertility (as well as an analysis of navigation and a hazard analysis for the Gaibandha priority project area), but where valuation has not been possible, quantified impacts have been entered into the Environmental Impact Assessment (EIA) and important indicators from there have been included in the multi-criteria analysis. The MCA is therefore an important focus for policy-makers since it integrates the impacts which have been given monetary values and those which have not been.

4.2 Components of Economic Analysis

The main components entering into the economic analysis are:

A. Project costs

- construction and O & M costs
- economic cost of land acquisition.

B. Project benefits/disbenefits

- crop intensification benefits
- benefits of reduced damage to crops, property and infrastructure
- (dis) benefits for fisheries
- other ecological/environmental impacts.

The main ecological impact, at least in the short-term, is likely to be on floodplain fisheries, and this impact is analysed in some detail. The data on other ecological and environmental impacts are generally more approximate and attempts at valuation were not thought advisable at this stage. It should also be noted that at the regional planning stage detailed mitigation measures have not been proposed, since it is felt that these are more appropriately developed at the feasibility stage. Specific mitigation measures are therefore generally not included in the economic analysis. However, the Green River scenario in the Lower Atrai is itself in a sense a mitigation approach, since it aims to compensate for the negative impacts of the full FCD strategy hitherto attempted there. In another sense the Green River scenario is more than mitigation, being an alternative strategy to full FCD with a greater emphasis on sustainable development from a social and ecological viewpoint.

The following sections describe data sources and methodology used in developing the economic analysis.

4.3 Estimation of Agricultural Benefits

4.3.1 General

Direct agricultural benefits from flood control fall into two main categories:

- benefits due to agricultural intensification and shifts to higher value crops
- benefits due to reduced crop damage as a result of floods.

If significant increases in output of high yielding crops can be attained, such increases make the greatest contribution to project viability. However, experience from previous FCD projects (as documented, for example, in the FAP 12 study) shows that the increases that appear to be theoretically possible are in reality often unachievable, for a variety of reasons (e.g. disbenefits caused to outsiders which result in regular public cuts). Reductions in crop damage may then take on greater importance although they are rarely in themselves enough to justify a project.

These remarks emphasise the need for careful assessment of particular proposed schemes so that a realistic forecast of project benefits can be made.

4.3.2 Estimation of Incremental Crop Production Benefits

Estimation of Cropping Pattern Changes.

The estimation of the extent of changes in cropping patterns as a result of flood control projects is difficult and more open to doubt than the impact of, say, an irrigation project. This is primarily because it is difficult to derive an accurate estimate of the change in flood depth-areas that will occur

as a result of the project. Also, of course, that change is not fixed, since the degree of flooding will

vary every year, and even full FCD projects are vulnerable to variations in rainfall, as well as to the risk of breaches, public cuts etc.

Therefore, although the broad nature of the expected change may be clear, it is less obvious to what extent change will occur. This is particularly so where the main potential source of benefits is a switch from local t. aman to HYV t. aman. This switch might occur with an average reduction in water depths of a few centimetres, but such small differences cannot be reliably estimated at present.

The study has therefore spent much time in trying to develop a suitable approach to cropping pattern estimation in with- and without-project conditions. Since changes in cropped areas are fundamental to the economic viability of this type of project, the subject has justified the time spent on it.

Two main approaches have been considered. The first approach (described in detail in the Agriculture Annex, Volume 13) uses the hydro-dynamic model to predict water levels and flooded areas at 10-day intervals during the flood season, and then applies a set of rules to the output of flood depth-areas over time, in order to derive cropping patterns. The same system is used to derive without-project and with-project cropping patterns.

The second approach uses a "modified MPO" method, making use of the MPO (WARPO) system of land classification according to "normal" flood depth, deriving cropping patterns on the different land categories according to published data and a set of allocation rules, and then deriving with-project cropping patterns by applying the same set of rules to a prediction of the new land classification resulting from the project.

In principle the first approach is an advance on the second, since it incorporates the timing and duration of flooding into the selection of cropping patterns. However, a number of problems remain with the approach, including the following:

(i) the hydro-dynamic model developed for regional planning purposes is not developed to the level of accuracy that would allow distinctions between HYV t. aman and local t. aman, for example, to be made with any degree of confidence. Although the prediction of water levels along the river channel is quite accurate, these water levels then have to be transformed into flooded area-depth relationships on the basis of topographic data. These data however are at a rather coarse level in the regional planning stage;

(ii) the rules which are used to predict cropping patterns based on the model output tend to take on a precision which may be quite spurious. Again this appears to affect mostly the selection between HYV t. aman and local t. aman, where the selection criteria hinge on relatively minor differences in water levels towards the end of the flood season. In addition, the model- generated cropping patterns are the optimum cropping patterns on the basis of the criterion of water levels. Other factors which might influence crop selection are not included. These might include soil type and moisture, temperature, prices, availability of irrigation, other input constraints etc.

These limitations can be overcome to some extent in more detailed analysis (hence the use of this approach, with adjustments, in the Gaibandha analysis), but they restrict the use of the approach in regional planning. There are, then, two main directions in which the regional planning analysis can proceed:

(a) the model approach can be used to generate broader categories of crops (i.e. t. aman as a composite category), starting with a forecast of present condition cropping. If this output can be satisfactorily calibrated with existing data on cropped areas, then the model can be used with some confidence to predict with-project cropped areas, again using broader categories. The selection within categories (i.e. between HYV and local t. aman) would then be made on the grounds of judgement, previous experience of similar projects, etc.

(b) The modified MPO approach can be used.

This study has used the latter approach, which is described in more detail below.

The method used can be termed a modified MPO approach, since it follows to a large extent the approach developed by MPO (now WARPO) for the National Water Plan Phase I. MPO developed a classification of land according to depth of flooding (based on data originally collected by the SRDI). The MPO classification is:

	Flood depth	-	Land elevation
F0	0 - 0.3 m	-	Highland (flood free)
F1	0.3 - 0.9 m	-	Medium-highland (shallow flood)
F2	0.9 - 1.8 m	-	Medium-lowland (medium flood)
F3	1.8 - 3.6 m	-	Low land (deep flooded)
F4	>3.6 m.	-	Very low land (deep flooded)

This classification was applied on a Catchment Area and Planning Area basis to all land. Typical cropping patterns for a particular flood phase ("F") category were developed. The impact of a water control project was then analysed by assuming a shift in the flood phase distribution within the project area, e.g. some land previously classified as F2 would be changed to F1 and would as a result take on the cropping pattern associated with the new land classification. In this way overall changes in cropping patterns would be worked out.

This approach is appropriate for pre-feasibility level planning and has generally been followed in this study for regional planning analyses,but the approach has been modified in a way that should more accurately describe the expected transitions with-project.

Modifications have been made in at least two major respects:

(i) Cropping patterns on particular flood phases have been determined by allocating individual cropped areas to specific flood phases according to some basic rules discussed below. In this exercise the present-condition flood phasing for a particular project area was derived from MPO (WARPO) data, while the present-condition areas of individual crops were derived from BBS 1989 statistics, the most recent available.

(ii) The shift in flood phasing resulting under with-project conditions was derived, partly by using the FAP 2 model analysis and drainage analysis, and partly by applying judgement based on knowledge of the project areas and other sources such as FAP 12 studies. This approach allows for variations in the degree of transition between project area, whereas the MPO approach (described in MPO Technical Report No 26, March 1987), assumes a standard pattern of change for FCD projects, as follows:

(a) Irrigated land :

100% F1 to F0
75%F2 to F0
25%F2 to F1
20%F3 to F1
45%F3 to F2
35%F3 remains F3.

(b) Non-irrigated land:

100% to F0.

In some project areas, these assumed transitions are likely to overestimate the changes that are feasible.

In this analysis the MPO flood phase data and BBS data were both at thana level. In projects where only a portion of the thana fell within the project boundary, it was not always appropriate to assume that the thana-level flood phase distribution would apply within the project area. This is the case, for example, in the Bogra Polders, where thanas such as Adamdighi and Nandigram have a high proportion of F0-F1 land, but where the parts of these thanas falling inside the project areas were mostly F2-F4 land. It was generally not difficult to work out where such adjustments were needed.

The initial stage in deriving cropping patterns, then, was to match MPO flood phase data with BBS crop statistics. The following rules were used:

(i) The total irrigated area was assumed equal to the area of HYV boro + HYV aus (a cross-check was made with irrigated areas derived from the 1989 AST survey, and generally there was a good correspondence). The irrigated area was then allocated to different flood phases using the general principle that the proportion of irrigated land in a particular flood phase is generally higher on more low-lying areas (i.e. the highest densities were on F3 land, followed by F2 land etc.). This assumption is based on the historical experience of irrigation development using STWs, particularly in the Lower Atrai, where irrigation developed in the low-lying areas first in the substitution of HYV boro for broadcast aman (a form of flood response).

(ii) Cropping intensities were generally assumed to increase moving up the landscape, i.e. lowest cropping intensities are on F3 land. On F3 land in general the number of crops that can be grown apart from boro is limited, primarily to deepwater aman, some oilseeds and some pulses. In general the deepwater aman area was allocated, first to F3 land, then to F2 land, assuming that all non-irrigated land on those flood phases, plus 25% of the land growing boro, would grow deepwater aman. The latter assumption reflects the tendency for farmers to try to grow deepwater aman (especially transplanted) after growing boro, particularly in parts of the Lower Atrai basin where boro is harvested early.

(iii) Most of the remaining crops were allocated to F0 + F1 land. Transplanted aman was always allocated to that land, while non-irrigated crops such as b. aus, jute and rabi crops were allocated, first to F0 + F1 land, then, if the area of the crop was greater than the available land (or if cropping intensities appeared to be too high), the remainder of the crop was allocated to F2 land (with some oilseeds and pulses on F3 land).

It was encouraging to note that this method of allocation gave consistent and plausible results, even though it involved matching two different data sources. This consistency lends credibility to the assumed with-project changes.

The same allocation rules were retained when moving from present condition to future-without and future-with conditions. The main change between present and future-without is an increase in the irrigation percentage, without any changes in flood phasing. Since it was assumed that, under present conditions, irrigation occurred initially on lower land, the assumed increases in irrigation under without-project conditions occur to a greater extent on higher land, generally replacing b. aus. Therefore the main change in cropping patterns assumed between present and future-without conditions was the substitution of b. aus (and sometimes rabi crops) by HYV boro.

The shift between future-without and future-with involves a change in flood phasing without any further change in irrigated area (at least in the NW Region, where protection of the boro from floods is generally not needed). The assumed shifts in flood phasing were determined on the basis of FAP 2 hydraulic and drainage analyses and judgement.

It is worth noting that there is an overlap here with the first approach to developing cropping patterns. Comparison of MPO flood phase data with model-generated flood phase data indicates that, in many areas, the model predicted the F0 + F1 area reasonably well but tended to over-predict the F0 land. In addition, the model tended to show considerable reductions in F2-F4 land in deeply-flooded areas (especially the Lower Atrai) which experience has shown are not likely to be attainable to such a great extent. This gives confidence that the model can be used to give a broad prediction of the flood phase transition, but judgement should be used to make the finer distinctions between crops.

The flood phasing used in analysis was, then derived on the basis of comparing MPO flood phasing and the model-predicted flood phasing, and making adjustments based on judgement. The results of this approach can only be regarded as approximations of likely outcomes, but no better approach could be developed at this stage. Furthermore, the results in terms of cropping pattern shifts and economic viability seem intuitively reasonable.

The comparison between MPO and model-predicted flood phase data is given in Table 4.1 for selected areas and the adjusted flood phase distribution used in analysis is given in Table 4.2.

The changes in cropped areas resulting from the assumed shift in flood phasing were determined as follows:

(i) In general, it was assumed that cropping intensities would change little.

(ii) In most project areas with a significant amount of F3 land, this land generally declines, although not always by much (under the Green River scenario a major decline in F3 land is by definition ruled out). Where a decline does occur, it implies a decline in the area of deepwater aman, and sometimes in oilseeds where they were grown after deepwater aman. In "flow" areas of the Lower Atrai a small increase in deepwater aman was assumed to take place, reflecting the partial protection provided by the project.

(iii) Where F2 land is also assumed to decline, this also results in a decline in deepwater aman and sometimes in pulses and b. aus. Total jute areas were assumed generally to remain the same or decline slightly, but more of this jute would now be grown on F0 + F1 land.

Table 4.1 Comparison of MPO & Model predicted flood phase data: Selected Project

	%			
	F0	F1	F2	F3
A. TEESTA LEFT BANK				
MPO PRESENT	35	62	3	0
MODEL PRESENT/ FUTURE-WITHOUT	76	6	7	11
ASSUMED PRESENT/ FUTURE-WITHOUT	49	46	4	2
ASSUMED FUTURE WITH-PROJECT	56	41	2	1
B. CHALAN BEEL POLDER C				
CFD AREA				
MPO PRESENT	29	24	29	18
MODEL PRESENT/ FUTURE-WITHOUT	58	14	16	12
ASSUMED PRESENT/ FUTURE-WITHOUT	58	14	16	12
ASSUMED FUTURE WITH-PROJECT	66	11	14	9
C. CHALAN BEEL POLDER D				
CFD AREA				
MPO PRESENT	46	20	24	10
MODEL PRESENT/ FUTURE-WITHOUT	33	18	24	25
ASSUMED PRESENT/ FUTURE-WITHOUT	44	19	23	14
ASSUMED FUTURE WITH-PROJECT	58	22	12	8

Table 4.2 Flood Phase Distribution for Project Analysis

		F_o	F_1	F_2	F_3
A.	Teesta Left Bank				
	Future W/O	49	46	4	2
	Future With	56	41	2	1
B.	Mohananda				
	Future W/O	15	49	29	7
	Future With	48	10	10	2
C.	Upper Karatoya				
	Future W/O	44	39	13	4
	Future With	58	34	6	2
D.	Bogra Polder 2 CFD Area				
	Future W/O	32	13	16	38
	Future With	42	13	10	35
	Bogra Polder 2 Flow Area				
	Future W/O	0	0	51	49
	Future With	0	0	41	59
E.	Bogra Polder 3 CFD Area				
	Future W/O	69	10	11	10
	Future With	67	10	11	12
	Bogra Polder 3 Flow Area				
	Future W/O	0	0	71	29
	Future With	0	0	42	58
F.	Chalan Beel Polder A CFD Area				
	Future W/O	32	31	23	14
	Future With	37	31	17	14
	Chalan Beel Polder A Flow Area				
	Future W/O	0	0	40	60
	Future With	0	0	33	67
G.	Chalan Beel Polder B CFD Area				
	Future W/O	54	25	14	7
	Future With	71	19	6	4
	Chalan Beel Polder B Flow Area				
	Future W/O	0	0	45	55
	Future With	0	0	39	61

H.	Chalan Beel Polder C CFD Area				
	Future W/O	58	14	16	12
	Future With	66	11	14	9
	Chalan Beel Polder C Flow Area				
	Future W/O	22	12	19	47
	Future With	22	13	23	42
I.	Chalan Beel Polder D CFD Area				
	Future W/O	44	19	23	14
	Future With	54	20	16	10
	Chalan Beel Polder D Flow Area				
	Future W/O	10	27	33	30
	Future With	20	30	28	22
J.	SIRDP CFD Area				
	Future W/O	21	39	22	18
	Future With	30	42	15	13
	SIRDP Flow Area				
	Future W/O	0	0	29	71
	Future With	0	0	40	60
K.	Hurasagar North				
	Future W/O	50	38	8	4
	Future With	53	36	8	3
L.	Hurasagar South CFD				
	Future W/O	3	31	30	36
	Future With	40	29	17	14
	Hurasagar South Flow				
	Future W/O	3	31	30	36
	Future With	6	32	29	33

(iv) The main changes in flood phasing generally involve an increase in F0 land, and sometimes in F1 land. Although the overall area of HYV boro stays unchanged compared to without-project conditions, more of this boro is now grown on F0 + F1 land. In terms of actual changes in areas of individual crops, the main changes involve increases in HYV t. aman, shifts in either direction in the area of local t. aman, and sometimes further declines in the area of b. aus.

The cropping patterns used in analysis comprise 16 composite crops, as listed in Table 4.3. This again follows MPO practice. The main shifts in cropped areas as a result of flood control relate to paddy crops, but there are also some adjustments in areas of rabi crops. The principal shifts are:

A. Between present and future-without

Increased HYV boro and declining B. aus (and sometimes rabi crops)

B. Between future-without and future-with

Increased t. aman and declining b. aman (and sometimes rabi)
Increased t. aman and declining b. aus
Increased HYV t. aman and declining local t. aman
Increased b. aman ("Green River" areas).

An example of the approach used is given in Tables 4.4. to 4.6., which show present, future-without and future-with cropping patterns by flood phase for Bogra Polder 2.

The main source of incremental agricultural benefits is undoubtedly increased HYV t. aman production. However, a number of points need to be made with regard to the potential for increased HYV t. aman production as a result of flood control schemes:

(i) In the NW region HYV t. aman is already about as important as local t. aman in terms of cultivated area, and more important in terms of output, and this trend will continue even without flood control. Some farmers continue to grow local t. aman even on land where they could grow HYV t. aman, possibly because of lower input costs, or taste preferences etc. There is little doubt that most of these farmers will ultimately switch to HYV cultivation.

(ii) Possibly a greater constraint at present is the indirect impact of lack of irrigation. On some non-irrigated land farmers grow b. aus (perhaps preceded by rabi crops) and then find it difficult to follow b. aus by HYV t. aman, opting for local t. aman or fallow.

(iii) Farmers in parts of the Lower Atrai are emphatic in claiming that the HYV t. aman variety most commonly used in that area (BR21) is tolerant of quite high depths of flooding for a few days. It is therefore possible that the general view that local t. aman can withstand floods where HYV t. aman cannot is becoming, or will become, less important in future, thereby reducing one of the economic justifications for flood control.

In summary, not all the increase in HYV t. aman in future can be attributed to flood control. What can be said is that, where some land is converted to F0 from another flood phase, the potential for growing HYV t. aman has been increased. This is one of the principles adopted in this study in deriving future cropping patterns, where a proportion (usually 75-80%, depending on the starting condition) of the incremental F0 land is assumed to be cropped with HYV t. aman. The analysis has

Table 4.3 Composite Cropping Patterns

Broadcast(B) aus

Transplanted(T) aus, High Yielding Varieties(HYV) including Local transplanted(LT) aus

B aman

HYV aman

L T aman

L boro

HYV boro

Wheat

Potato

Jute

Sugarcane

Pulses(area weighted averages for masur, mung and mashkalai)

Ollseeds(mustard)

Spices (area weighted averages for chillies, onion and garlic)

Vegetables (area weighted averages for radis (mullah), tomatoes and brinjal)

Orchards (area weighted averages for pineapple, coconut, jackfruit, betel nut and banana)

Sourece: MPO

Table 4.4 Derived Present Condition cropping patterns by flood phase: Bogra Polder-2

LAND TYPE	AMOUNT(HA)	IRRIGATION BALANCE	
F0	14679	HYV BO	18252
F1	5990	WHEAT	0
TOTAL	20669	HYV AU	0
F2	7436		
F3	17214	TOTAL	18252
TOTAL	24650		
F4	0		
GTOYAL	45319		

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGAT AREA	NONIRR AREA	TOTAL AREA	% IRRIG
F0	3008	11671	14679	20
F1	1198	4792	5990	20
TOTAL	4206	16463	20669	20
F2	3718	3718	7436	50
F3	10328	6886	17214	60
TOTAL			24650	
F4			0	
TOTAL	18252	27067	45319	40

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	4206	B. AUS	1795	HYV TA	11383	SUGARC	206
WHEAT	1552	HYV AU	0	L.T. AM	4119	ORCHAR	14
POTATO	139	JUTE	596	VEGETA	78		
TOBACCO	170	OILSEEE	0	SPICES	0		
PULSES	1000	SPICES	0				
OILSEED	0	VEGETA	78				
SPICES	0						
VEGETABLES	156						
Sub-Total	7223	Sub-Total	2469	Sub-Total	15580	Sub-Total	220
TOTAL	25492						
CROPPING INTENSITY	123						

CROPS ON F2 LANDS

HYV BORO	3718
DW AMAN	4420
OILSEED	0
PULSES	615
JUTE	0
L.BORO	0
Sub-Total	8753
CROPPING INTENSITY	118

CROPS ON F3 LAND

HYV BORO	10328
LOCAL BORO	0
D.W.AMAN	9468
OILSEED	491
Sub-Total	20287
CROPPING INTENSITY	118

Table 4.5 Derived future-without cropping patterns by flood phase: Bogra Polder-2

LAND TYPE	AMOUNT(HA)	IRRIGATION BALANCE	
F0	14679	HYV BO	33491
F1	5990	WHEAT	0
TOTAL	20669	HYV AU	0
F2	7436		
F3	17214	TOTAL	33491
TOTAL	24650		
F4	0		
GTOYAL	45319		

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGAT AREA	NONIRR AREA	TOTAL AREA	% IRRIG
F0	8084	6595	14679	55
F1	3594	2396	5990	60
TOTAL	11678	8991	20669	56
F2	6321	1115	7436	85
F3	15493	1721	17214	90
TOTAL			24650	
F4			0	
TOTAL	33491	11828	45319	74

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	11677	B. AUS	0	HYV TA	11383	SUGARC	206
WHEAT	1552	HYV AU	0	L.T. AM	4119	ORCHAR	14
POTATO	139	JUTE	596	VEGETA	78		
TOBACCO	170	OILSEEE	0	SPICES	0		
PULSES	1000	SPICES	0				
OILSEED	0	VEGETA	78				
SPICES	0						
VEGETABLES	156						
Sub-Total	14694	Sub-Total	674	Sub-Total	15580	Sub-Total	220
TOTAL	31168						
CROPPING INTENS	151						

CROPS ON F2 LANDS

HYV BORO	6321
DW AMAN	2696
OILSEED	0
PULSES	0
JUTE	0
L.BORO	0
Sub-Total	9017
CROPPING PATTE	121

CROPS ON F3 LAND

HYV BORO	15493
LOCAL BORO	0
D.W.AMAN	5595
OILSEED	0
Sub-Total	21088
CROPPING INTENS	123

Table 4.6 Derived future-with cropping patterns by flood phase: Bogra Polder 2

LAND TYPE	AMOUNT(HA)		IRRIGATION BALANCE	
F0	19034	4355	HYV BO	33491
F1	5891		WHEAT	0
TOTAL	24925		HYV AU	0
F2	4532			
F3	15862		TOTAL	33491
TOTAL	20394			
F4	0			
GTOYAL	45319			

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGAT AREA	NONIRR AREA	TOTAL AREA	% IRRIG
F0	11534	7500	19034	61
F1	3829	2062	5891	65
TOTAL	15363	9562	24925	62
F2	3852	680	4532	85
F3	14276	1586	15862	90
TOTAL	18128	2266	20394	
F4			0	
TOTAL	33491	11828	45319	74

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	15363	B. AUS	0	HYV TA	14867	SUGARC	206
WHEAT	1552	HYV AU	0	L.T. AM	4119	ORCHAR	14
POTATO	139	JUTE	596	VEGETA	78		
TOBACCO	170	OILSEEE	0	SPICES	0		
PULSES	100	SPICES	0				
OILSEED	871	VEGETA	78				
SPICES	0						
VEGETABLES	156						
Sub-Total	18351	Sub-Total	674	Sub-Total	19064	Sub-Total	220
TOTAL	38309						
CROPPING INTENS	154						

CROPS ON F2 LANDS	
HYV BORO	3852
DW AMAN	1643
OILSEED	0
PULSES	0
JUTE	0
L.BORO	0
TOTAL	5495
CROPPING INTENS	121

CROPS ON F3 LAND	
HYV BORO	14276
LOCAL BORO	0
D.W.AMAN	5155
OILSEED	0
TOTAL	19431
CROPPING INTENS	123

also been able to distinguish between increases in HYV t. aman that could be due to flood control and those due to irrigation-induced shifts in cropping patterns, by holding irrigation constant in future-without and future-with conditions.

Other points to note in regard to cropping pattern analysis are:

(a) HYV boro areas are taken to be the same in future-without and future-with conditions. Flood waters generally rise relatively late in the region and in most years will not affect HYV boro, certainly not preventing it from being planted. Any occasional effect of floods on boro is accounted for in the crop damage analysis.

(b) Cropping intensities barely increase and may even decrease with project. Incremental HYV t. aman cultivation, for example, generally replaces another paddy crop (local t. aman, b. aus or b. aman) and, if the cropping pattern HYV boro - HYV t. aman replaces rabi - b. aus - local t. aman, cropping intensities decline.

(c) In the Lower Atrai, some benefits can be gained from regulating the rise of water to allow deepwater aman to become established. Some farmers try to transplant deepwater aman after harvesting boro, but rising floods may wash away the plant before it has developed. Modest benefits have been assumed to accrue in "flow" areas of the Lower Atrai as a result of partial protection provided there.

It is felt that the approach outlined above allows a generally realistic forecast to be made of shifts which are genuinely the result of flood control and not of other simultaneous changes such as irrigation development. If the resulting forecasts are more conservative than some predictions made in the past, it is felt that such an outcome is nonetheless realistic.

This approach as described above could be usefully developed in future. One of the strengths of the MPO approach is that it provides a logical framework for land classification which is practical for agricultural development planning. However the assumption of a standard transition is limiting, and in that sense the hydro-dynamic model provides great potential for making more accurate and project-specific assessments of likely shifts, as well as allowing more detailed analysis of the timing and duration of flooding for floods of different magnitudes.

Crop Input Use

Crop input-output data were compiled for the crops listed above. Data were derived from the following secondary sources:

- MPO Technical Report No. 14: Agricultural Production Systems
- Agro-Economics Research Costs and Returns Reports for selected years, 1982-83 to 1988-89
- IFDC Farm-Level Fertiliser Use Surveys for 1989-90 and 1990-91
- World Bank: Selected Issues in Rural Employment (1983).

The agricultural survey conducted by the study in 1991 gave further information on input use and yields.

Most data sources on input use tend to show broad agreement on the quantities used. Therefore at the regional planning level the estimates derived can be regarded as reasonably accurate.

These data sources were combined to get a composite data set for input use and yields. These data are shown in Tables 4.7. and 4.8. for present and future conditions.

Crop Yields

Comparing different data sources, there tends to be greater variability in yield estimates compared to estimates of input requirements. This is important since assumptions on yields have a significant impact on potential project viability. MPO "future" yields, for example, tend to be significantly higher than those given by other sources.

There also appears to be some intra-regional variability in yields, with parts of the Lower Atrai having particularly high HYV boro yields. In this study, however, no such variability has been considered, on the assumption that other areas would tend to close the gap over time.

There is no consistent evidence that flood control projects in themselves result in yield increases, although in principle the increased security that such projects should provide could be expected to encourage farmers to intensify production and increase yields. In this study no such increase has been considered. The difference between without- and with-project conditions in terms of reduced crop damage is accounted for separately in crop damage estimates.

However, it has been assumed that yields will increase in future, (i.e. in both without- and with-project conditions), particularly of HYVs. Available data tend to show rather flat yields, even of HYVs, in recent years, with overall yield increases being achieved by substitution of HYVs for local varieties.

Nonetheless, it is likely that, during the life of FAP projects, yield increases will occur due to further varietal improvement. Such yield increases will affect project viability, even though the higher yields will also apply to future-without conditions, as long as with-project cropping patterns show increased areas planted to the higher yielding crops. The assumed yield increases are 1% per annum over 15 years for HYVs (until the year 2007, which has been taken as the reference year for analysis), and 0.3 % per annum for other crops.

Yields under present and future conditions are shown in Tables 4.7. and 4.8.

Crop Residues and Livestock Benefits

The FAP 12 studies showed that some flood control projects resulted in significant loss of grazing land as cropped areas increased. Any loss of grazing land would further weaken the already under-nourished livestock used for land preparation and thereby could adversely affect production. Conversely, increased crop production results in increased crop residues which can be used as fodder (despite the lower nutrient value of HYV straw compared with an equivalent weight of local paddy straw).

As a simplifying assumption, it has been assumed that the gains and losses to livestock balance out and that the overall impact of flood control projects on livestock is neutral. In the economic analysis this is accounted for by removing the value of crop residues from the value of both future-with and future-without crop production.

Table 4.7 Present condition input use and yields

Crop	Labour (man days)	Draft Animal (pair days)	Seed (kg)	Urea (kg)	Fertiliser TSP (kg)	MP (kg)	Manure (kg)	Pesticide (kg)	Production Main Crop (mt/ha)	(mt/ha) By-Product
HYV Boro	215	50	30	186	123	41	0	0.5	4.5	4.5
Local Boro	160	40	30	62	41	14	0	0	2.5	2.5
HYV Aus	205	50	30	130	90	30	0	0.5	3.75	3.75
Local B.Aus	160	45	80	50	0	0	1300	0	1.6	1.6
HYV T.Aman	190	50	30	130	90	30	0	0.5	3.75	3.75
Local T.Aman	140	44	30	45	30	10	1300	0	2.25	2.25
DW Aman	115	45	30	50	0	0	660	0	1.6	2.4
Wheat	120	40	140	75	25	0	0	0.25	1.7	1.7
Jute	230	48	7	60	20	15	0	0	1.7	3.4
Sugarcane I	260	65	5000	175	70	105	1400	0.75	42	
Sugarcane II	230	65	5000	50	20	30	1400	0	20	
Potato	190	45	1000	75	50	75	1500	0.5	10	
Pulse	50	30	30	30	0	0	0	0	0.8	1
Oilseeds	75	36	10	75	75	30	700	0.5	0.7	1
Onion	150	40	6.2	55	37	55	0	0	8	
Vegetable (Brinjal)	270	50	0.3	60	40	60	0	0	15	
Tobacco	260	60	0.1	0	25	25	2600	0.5	1	
Banana										

SOURCES:

(1)MPO Technical Report No.14.

(2)World Bank:Bangladesh:Selected Issues in Rural Employment (1983).

(3)Agro-Economics Research,MoA:Costs and Returns for years 1982-83 to 1988-89.

(4)IFDC Farm-Level Fertiliser Use Surveys for 1989/90 Rabi/Boro and Aman Seasons.

(5)Consultants' field survey data.

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Table 4.8 Future condition input use and yields.

Present Crop	Labour (man days)	Draft Animal (pair days)	Seed (kg)	Fertiliser Urea (kg)	TSP (kg)	MP (kg)	anure (kg)	Pesticide (kg)	Production(mt/ha) Main Crop	By-Product
HYV Boro	215	50	30	210	139	46	0	0.5	5.175	5.175
Local Boro	160	40	30	63	42	14	0	0	2.625	2.625
HYV Aus	205	50	30	149	103	34	0	0.5	4.3125	4.3125
Local B.Aus	160	45	80	55	0	0	1300	0	1.68	1.68
HYV T.Aman	190	50	30	149	103	34	0	0.5	4.3125	4.3125
Local T.Ama	140	44	30	49	33	11	1300	0	2.3625	2.3625
DW Aman	115	45	30	55	0	0	660	0	1.68	2.52
Wheat	120	40	140	80	26	0	0	0.25	1.785	1.785
Jute	230	48	7	64	21	16	0	0	1.785	3.57
Sugarcane I	260	65	5000	187	75	112	1400	0.75	44.1	
Sugarcane II	230	65	5000	50	20	30	1400	0	20	
Potato	190	45	1000	79	53	79	1500	0.5	10.5	
Pulse	50	30	30	31	0	0	0	0	0.84	1.05
Oilseeds	75	36	10	79	79	32	700	0.5	0.735	1.05
Onion	150	40	6.2	58	39	58	0	0	8.4	
Vegetable (Brinjal)	270	50	0.3	66	44	66	0	0	15.75	
Tobacco	260	60	0.1	0	26	26	2600	0.5	1.05	
Banana										

SOURCES:

(1)MPO Technical Report No.14.

(2)World Bank:Bangladesh:Selected Issues in Rural Employment (1983).

(3)Agro-Economics Research,MoA:Costs and Returns for years 1982-83 to 1988-89.

(4)IFDC Farm-Level Fertiliser Use Surveys for 1989/90 Rabi/Boro and Aman Seasons.

(5)Consultants' field survey data.

This assumption does not apply to jute since the jute residues have no value for livestock. They do, however, have a considerable and perhaps growing value for fuel and housing, reflected in the fact that (in economic terms) the value of jute crop residues is almost 50% of the gross value of the crop itself.

Minor Irrigation

The dramatic increase in minor irrigation throughout much of the region has been the main source of growth in agricultural output in the last decade. Most of this increase has been due to the spread of shallow tubewells (STWs) which from a water management viewpoint are well suited to Bangladesh' agrarian structure. Most of the additional irrigation capacity is used for HYV boro cultivation, and to a much smaller extent for supplementary irrigation of HYV t. aman post-monsoon.

The growth of minor irrigation in the region has been independent of flood control and will basically continue to be so. Nonetheless availability or non-availability of irrigation is a major determinant of without-project cropping patterns and therefore has an indirect influence on the types of cropping pattern changes that might occur with flood control.

The approach used here has been, for each area, to project forward the likely coverage of irrigation by the year 2007, and to use the projected irrigation rate as an estimate of the HYV boro area in future-without and future-with conditions. The change in projected boro area is the main cause of shift between present and assumed future-without cropping patterns: for example it affects areas of aus, deepwater aman and in some cases rabi crops, all of which are likely to decline between present and future-without conditions.

In the cropping pattern analyses the HYV boro area has been allocated to flood phases on the assumption that a higher percentage of area irrigated is normally found on the lower-lying areas. The assumption has been made on the basis of historical experience in the Lower Atrai, where STWs were used on land normally planted to b. aman, to replace b. aman with HYV boro. In future, this pattern is likely to change as the low land becomes fully used up and irrigation will have to take place on higher land. The shift may also require use of a different technology.

Costs of minor irrigation enter into the analysis as an annualised cost included in crop production costs. The derivation of these costs by type of irrigation equipment is shown in Table 4.9. For the analysis, the annualised cost of STW irrigation was used throughout.

Financial Prices of Crops and Inputs

Financial prices for crops were derived from the farmgate price data collected at twenty survey locations in the region by the Directorate of Agricultural Marketing. There was a high degree of uniformity in prices between locations so a simple average of prices at the twenty locations was used as a basis for calculating financial prices. Price data were collected for the last seven years (1985-86 to 1991-92) for the months for which they were available (generally the three months immediately post-harvest). The average prices for the last three years were then converted to 1991-92 prices using the GDP deflator, and the average of those three years was taken as the relevant financial price.

Input price data were collected from different sources. Labour wage rates and draught power rents were collected during field surveys. The wage rate data were also checked against BBS data. In comparison with other regions, the wages and draught power rents appear to be rather low in the NW region.

Table 4.9 Cost of minor irrigation

A. ESTIMATE CAPITAL COSTS FOR 0.5 CUSEC SHALLOW TUBEWELL

Item	Financial Prices (Tk)				Conversion Factor	Economic prices(Tk)				Interest Rate 12% Annual Cost	
	Local	Foreign	Duty/ Surcharges	Total		Local	Foreign	Total	Life (yrs)	Financial	Economic
Pump(centrifugal)	3000	1000	420	4420	0.62	1860	1000	2860	5	1226.152	793.3926
Engine(diesel 12hp)	1000	8000		9000	0.62	620	8000	8620	5	2496.69	2391.2742
Accessories	500	100	42	642	0.62	310	100	410	5	178.0972	113.7381
Pipes etc	3000	1000	420	4420	0.62	1860	1000	2860	5	1226.152	793.3926
Drilling/installation											
Skilled labour	1000	0		1000	0.87	820		820	5	277.41	227.4762
Unskilled labour	1000	0		1000	0.65	710		710	5	277.41	196.9611
Canal system											
Unskilled labour	1782	0		1782	0.65	1265		1265	5	494.3446	350.92365
TOTAL	11282	10100	882	22264		7445	10100	17545		6176.256	4867.1584

B. ESTIMATED CAPITAL COSTS FOR 2.0 CUSEC DEEP TUBEWELL
(1991 prices)

Item	Financial Prices(Tk)				Conversion Factor	Economic prices(Tk)				Interest Rate 12% Annual Cost	
	Local	Foreign	Duty/ Surcharges	Total		Local	Foreign	Total	Life (yrs)	Financial	Economic
Pump,shaft	6063	28200	32430	66693	0.62	3759.06	28200	31959.0	15	9791.866	4692.2291
Gear box	1226	5700	6555	13481	0.62	760.12	5700	6460.12	15	1979.280	948.47481
Engine(31 hp diesel)	15480	72000	82800	170280	0.62	9597.6	72000	81597.6	10	30136.15	14441.143
Pump house and base	10000	0		10000	0.87	8200		8200	20	1338.8	1097.816
Pipes - 48m UWC	38000	10000	11500	59500	0.61	23180	10000	33180	20	7965.86	4442.1384
Screen - 36m SS	14405	67000	77050	158455	0.61	8787.05	40870	49657.0	20	21213.95	6648.0858
Reducers,bail plug	1500	1000	1150	3650	0.61	915	1000	1915	20	488.662	256.3802
Installation											
Skilled Labour	28746	0		28746	0.87	25009.0		23572	20	3848.514	3155.8193
Unskilled Labour	6844	0		6844	0.65	4448.6		4859	20	916.2747	650.52292
Materials	5475	0		5475	0.87	4763.25		4490	20	732.993	601.1212
Test boring	4103	0		4103	0.87	3569.61		3364	20	549.3096	450.37232
Well shrouding	20590	0		20590	0.87	17913.3		16884	20	2756.589	2260.4299
Transport etc	34241	0		34241	0.68	23283.8		28078	20	4584.185	3759.0826
Canal System											
Earth work											
Skilled Labour	1149	0		1149	0.87	999.63		942	20	153.8281	126.11496
Unskilled Labour	10341	0		10341	0.65	6721.65		7342	20	1384.453	982.94696
Structure											
Materials	5030	1105		6135	0.87	4376.1	1105	5031	20	821.3538	673.55028
Skilled Labour	1840	0		1840	0.87	1600.8		1509	20	246.3392	202.02492
Unskilled Labour	4294	0		4294	0.65	2791.1		3049	20	574.8807	408.20012
TOTAL	209327	185005	211485	605817		150675.	158875	312088.		89483.29	45796.453

C. ESTIMATED CAPITAL COSTS OF 1 CUSEC LOW LIFT PUMP
(1991 prices)

Item	*Financial Prices(Tk)*				*Conversion* Factor	Economic Prices(Tk)				Interest Rate 12%	
	Local	Foreign	Tax	Total		Local	Foreign	Total	Life (yrs)	Financial	Economic
Pump(centrifugal)	3000	1000	420	4420	0.62	1860	1000	2860	5	1226.152	793.3926
Engine(diesel)	1000	8000		9000	0.62	620	8000	8620	5	2496.69	2391.2742
Accessories	500	100	42	642	0.62	310	100	410	5	178.0972	113.7381
Pipes etc.	500	100	42	642	0.61	305	100	405	5	178.0972	112.35105
Canal System											
Earth work											
Skilled Labour	693	0		693	0.87	602.91		568	5	192.2451	157.56888
Unskilled Labour	6237	0		6237	0.65	4054.05		4428	5	1730.206	1228.3714
TOTAL	11930	9200	504	21634		7751.96	9200	17291		6001.487	4796.6963

TWCOST

D. ESTIMATED CAPITAL COSTS OF 0.5 CUSEC DEEPSET SHALLOW TUBEWELL
(1991 prices)

Item	Financial Prices(Tk) Local	Foreign	Tax	Total	Conversion Factor	Economic Prices(Tk) Local	Foreign	Total	Life (yrs)	Interest Rate 12% Annual Cost Financial	Economic
Pump(centrifugal)	3000	1000	420	4420	0.62	1860	1000	2860	5	1226.152	793.3926
Engine(diesel 12hp)	1000	8000		9000	0.62	620	8000	8620	5	2496.69	2391.2742
Accessories	500	100	42	642	0.62	310	100	410	5	178.0972	113.7381
Pipes etc.	3000	1000	420	4420	0.61	1830	1000	2830	5	1226.152	785.0703
Drilling/installation											
Skilled labour	1000	0		1000	0.87	870	0	870	5	277.41	241.3467
Unskilled labour	1000	0		1000	0.65	650	0	650	5	277.41	180.3165
Pit:unlined 2m:											
Unskilled labour	750	0		750	0.65	487.5	0	487.5	5	208.0575	135.23737
Canal System											
Unskilled Labour	1782	0		1782	0.65	1158.3	0	1158.3	5	494.3446	321.32400
										6384.313	4961.6997
TOTAL	12032	10100	882	23014		7785.8	10100	17885.8			

A.ANNUAL CAPITAL COSTS(T

	Financial	Economic
STW	6176	4867
DTW	89483	45797
LLP	6002	4797
DSSTW	6384	4962

B.ANNUAL O&M COSTS(Tk)

STW	20269	14077
DTW	95557	63419
LLP	13119	9679
DSSTW	22910	15764

C.TOTAL ANNUAL COST(Tk)

STW	26445	18944
DTW	217695	133052
LLP	19121	14476
DSSTW	29294	20726

D.ANNUAL COST/HECTARE(T

Av. Command Area(ha)			
4	STW	6611.25	4736
20	DTW	10884.75	6652.6
7	LLP	2731.571	2068
4	DSSTW	7323.5	5181.5

Fertiliser prices were collected from 1991-92 regional data provided by IFDC. These data showed a considerable reduction in the extent of subsidy on TSP and MP during 1991-92, which brought the financial prices of these inputs more in line with world prices.

Seed prices were collected from the Directorate of Agricultural Marketing where available, and otherwise, in the case of grain crops, by applying a ratio of 1.5 to the respective crop output price. In the case of other crops seed prices quoted in the FAP Guidelines for Project Assessment were used.

Other input costs (organic manure, pesticides) were collected in field surveys.

The conversion of financial prices to economic prices generally followed the recommendations in the FAP Guidelines for Project Assessment. In this respect the decision to recommend a conversion factor for paddy based on the average of import and export parity prices is supported by this study. However, if production increases fall off such that import parity pricing is clearly relevant, calculation of the conversion factor suggests it should be 1.19, not 1.02 as proposed in the Guidelines. With a conversion factor for paddy of 1.19, the analysis of outcomes could differ significantly. Sensitivity analyses testing the impact of such price shifts are described later.

The conversion factors for fertiliser given in the Guidelines were superceded by the reductions in subsidies during 1992. The border price based on the world market price was therefore recalculated and used as the economic price in analysis.

The resulting financial and economic prices for inputs are given in Table 4.10., and for crops in Table 4.11.

Crop Budgets

Crop budgets were derived in economic prices from the physical input-output data and the economic price data. A number of adjustments were made to the crop budgets before they could be used in analysis:

- exclusion of crop residues (except jute) to account for livestock impacts
- inclusion of irrigation costs (mostly for HYV boro production)
- inclusion of the cost of credit, equivalent to 80% of cash production costs for six months, at a rate of interest of 12% reflecting the opportunity cost of capital
- inclusion of an additional 10% of total production costs to reflect miscellaneous costs.

The last two adjustments are based on recommendations of an earlier version of the FAP Guidelines.

The basic crop budgets are shown in Table 4.12., and the adjusted budgets in Table 4.13.

Timing of Crop Production Benefits

The basic assumptions with regard to timing of the flow of benefits are that no benefits accrue until a project is completed, and that there is a five-year build-up to full development. The year 2007 has

Table 4.10
Financial and Economic Prices for Inputs,NW Region,mid 1991-92

Input	Financial Price (Tk)	Conversion Factor	Economic Price (Tk)
Labour(m-d)	31.67	0.75	23.75
Draft power (pair-days)	25.00	0.87	21.75
Urea(kg)	5.12	1.17	5.99
TSP(kg)	6.60	1.34	8.84
MP(kg)	5.55	1.45	8.05
Manure(kg)	5.00	0.87	4.35
Pesticide (kg)	504.00	0.87	438.48
LLP(ha)	2732.00		2068.00
STW(ha)	6611.00		4736.00
DSSTW(ha)	7324.00		5182.00
DTW(ha)	10883.00		6653.00
SEEDS: HYV Boro	9.92	0.88	8.73
Local Boro	9.92	0.88	8.73
HYV Aus	8.76	0.88	7.71
Local B.Aus	8.76	0.88	7.71
HYV T.Aman	9.60	0.88	8.45
Local T.Aman	9.48	0.88	8.34
B.Aman	9.48	0.88	8.34
L.I.Aman (Paijam)	9.48	0.88	8.34
Wheat	10.11	1.29	13.04
Jute	25.71	1.06	27.25
Sugarcane		0.95	
Potato		0.87	
Pulse	24.50	0.87	21.32
Mustard/ Rape	19.89	0.88	17.50
Onion		0.87	
Vegetable (Brinjal)		0.87	
Tobacco		0.87	

inprice

Table 4.11

Financial and Economic Prices for Crops,NW Region, 1991-92

Crop	Financial Price (Tk/kg)	Conversion Factor	Economic Price (Tk/kg)
HYV Boro	6.61	0.88	5.82
Local Boro	6.61	0.88	5.82
HYV Aus	5.84	0.88	5.14
Local B.Aus	5.84	0.88	5.14
HYV T.Aman	6.40	0.88	5.63
Local T.Aman	6.32	0.88	5.56
B.Aman	6.32	0.88	5.56
L.I.Aman (Paijam)	6.32	0.88	5.56
Wheat	6.74	1.29	8.69
Jute	8.57	1.06	9.08
Sugarcane		0.95	
Potato		0.87	
Pulse	16.33	0.87	14.21
Mustard/ Rape	13.26	0.88	11.67
Onion		0.87	
Vegetable (Brinjal)		0.87	
Tobacco		0.87	
Rice Straw HYV	0.70	0.87	0.61
Local	0.93	0.87	0.81
Jute Sticks	2.73	0.87	2.38

Table 4.12 Basic Crop Budgets

Present Crop	Gross Returns Main Crop	By-Product	Total	Labour	Production Costs Draught Power	Seed	Urea	TSP	MP	Manure	Pest-icide	Total Costs	Net Benefit	Net Benefit (excl.crop residues)
HYV Boro	30118.5	3156.75	33275.25	5106.25	1087.5	261.9	1257.9	1228.76	370.3	0	219.25	9531.86	23743.39	20586.64
Local Boro	15277.5	2126.25	17403.75	3800	870	261.9	377.37	371.28	112.7	0	0	5793.25	11610.5	9484.25
HYV Aus	22168.82	2630.93	24799.75	4868.75	1087.5	231.3	892.51	910.52	273.7	0	219.25	8483.53	16316.22	13685.29
Local B.Aus	8635.2	1360.8	9996	3800	978.75	616.8	329.45	0	0	143	0	5868	4128	2767.2
HYV T.Aman	24282.19	2630.93	26913.12	4512.5	1087.5	253.5	892.51	910.52	273.7	0	219.25	8149.48	18763.64	16132.71
Local T.Ama	13138.28	1914.03	15052.31	3325	957	250.2	293.51	291.72	88.55	143	0	5348.98	9703.33	7789.3
B.Aman	9525.6	2041.2	11566.8	2731.25	978.75	250.2	329.45	0	0	72.6	0	4362.25	7204.55	5163.35
Wheat	15511.65	1088.85	16600.5	2850	870	1825.6	479.2	229.84	0	0	109.625	6364.265	10236.23	9147.385
Jute	16207.8	8496.6	24704.4	5462.5	1044	190.75	383.36	185.64	128.8	0	0	7395.05	17309.35	8812.75
Sugarcane I	42380.1	0	42380.1	6175	1413.75	4750	1120.13	663	901.6	154	328.875	15506.35	26873.74	26873.74
Sugarcane II	19220	0	19220	5462.5	1413.75	4750	299.5	176.8	241.5	154	0	12498.05	6721.95	6721.95
Potato	41790	0	41790	4512.5	978.75	7400	473.21	468.52	635.95	165	219.25	14853.18	26936.82	26936.82
Pulse	11936.4	1281	13217.4	1187.5	652.5	639.6	185.69	0	0	0	0	2665.29	10552.11	9271.11
Mustard	8577.45	273	8850.45	1781.25	783	175	473.21	698.36	257.6	77	219.25	4464.67	4385.78	4112.78
Onion	66108	0	66108	3562.5	870	3236.4	347.42	344.76	466.9	0	0	8827.98	57280.02	57280.02
Vegetable (Brinjal)	62685	0	62685	6412.5	1087.5	150	395.34	388.96	531.3	0	0	8965.6	53719.4	53719.4
Tobacco	22639.05	0	22639.05	6175	1305	3.48	0	229.84	229.84	286	219.25	8448.41	14190.64	14190.64

TABLE 4.13 ADJUSTED CROP BUDGETS (ECONOMIC PRICES)

(Tk., 1991-92 prices)

Per ha. RETURNS

CROPS	GROSS RETURN (excl.crop residues)	COST OF INPUTS	RRIGATION COST	COST OF CREDIT (12%)	MISCELL. COSTS (10%)	TOTAL PRODUCTION COST	NET RETURN
HYV Boro	30119.00	9532.00	4262.00	662.11	1445.61	15901.72	14217.28
HYV T.Aman	24282.00	8149.00	474.00	413.90	903.69	9940.59	14341.41
DW Aman	9526.00	4362.00	0.00	209.38	457.14	5028.51	4497.49
L.T.Aman	13138.00	5349.00	0.00	256.75	560.58	6166.33	6971.67
B.Aus	8635.00	5868.00	0.00	281.66	614.97	6764.63	1870.37
HYV Aus	24282.00	8149.00	1705.00	472.99	1032.70	11359.69	12922.31
Jute	24704.00	7395.00	0.00	355.00	775.00	8525.00	16179.00
Pulse	11936.00	2665.00	0.00	127.92	279.29	3072.21	8863.79
Oilseed	8577.00	4465.00	0.00	214.32	467.93	5147.25	3429.75
Wheat	15512.00	6364.00	0.00	305.47	666.95	7336.42	8175.58
Potato	41790.00	14853.00	0.00	712.94	1556.59	17122.54	24667.46
Veg/Spices	66108.00	8828.00	0.00	423.74	925.17	10176.92	55931.08
Tobacco	22639.00	8448.00	0.00	405.50	885.35	9738.85	12900.15
Sugarcane	42380.00	15506.00	0.00	744.29	1625.03	17875.32	24504.68

N.B. Crop residues not excluded from jute since not used for fodder.

been taken as the reference year for the analysis, assuming on average that full development could be reached by that year (some projects will reach full development earlier): the choice of reference year mostly affects projections of the irrigated area and of future yields.

The analysis is conducted using 1991-92 constant prices.

4.3.2 Reduced Crop Damage

The second agricultural benefit from flood control is reduction in crop damage caused by floods: the value of crop damage averted is then added to the benefit side of the analysis. In some parts of the region the major flood "problem" appears to be crop damage, rather than inability to intensify production because of water constraints. This is the case for example in the Thakurgaon and Dinajpur areas where monsoon cultivation of t. aman predominates but where flash floods, particularly in recent years, have caused localised damage. It is probably also the case in the Lower Atrai, where farmers are especially concerned about losing existing crops as a result of public cuts, and in the Upper Karatoya.

Therefore, although the highest returns come in theory from changes in cropping patterns, in practice reduced crop damage is also of great concern to farmers living within project areas.

The methodology used to assess crop damage involved deriving the expected annual crop damage by developing a crop flood damage - frequency curve. The data to enable the crop damage - frequency curve to be derived only exist at Old District level. These data comprise figures for area damaged (in fully damaged area equivalents) and production lost. Table 4.14. shows crop flood damage for major crops in the Old Districts of the region in terms of the % of area under a specific crop which was fully damaged, on average over the period 1971-88.

The value of production lost was calculated by Old District for each year for the period 1971-88, using constant 1988 prices. These data were then used to derive damage frequency curves. The first output of the analysis was therefore a frequency curve for each of the five Old Districts, from which the expected annual crop damage was calculated for each Old District. The calculations are shown in Table 4.15. It should be emphasised that there are very wide confidence limits attached to these calculations, but the resulting per hectare damage figures appear to be reasonable.

The next step in the analysis involved distributing the Old District-level figure for expected annual crop damage according to the severity of damage within each Old District. The only disaggregated data that allowed such a distribution to be made were the thana-level damage figures for 1987 and 1991 (collected by the DAE). These years were both years of high flooding. The crop damage data for these years were used to give a weight to each thana by which the Old District data could be distributed. The weight used was as follows: (1987 t. aman fully damaged area + 0.5 1987 b. aman fully damaged area + 1991 t. aman fully damaged area + 0.5 1991 b. aman fully damaged area)/2. Basically this means the average of damage in the two years, taking into account the higher value of t. aman compared to b. aman. A sample output from this analysis is given in Table 4.16. for the Middle Bangali area which is one of the parts of the region most seriously prone to flood damage, particularly through breaches in the BRE.

Clearly the above method provides only an approximation, but it appears to be the best that can be made with the available data, and it clearly picks out the thanas where it is known that crop damage is significant and persistent.

Table 4.14 Crop Flood Damage in NW Region, 1971-88

(Area of Total damage as % of total area under major crops)

Crop	Pabna	Rangpur	Rajshahi	Bogra	Dinajpur
L. Aus	6.9 (1)	2.9 (2)	1.8 (4)	2.1 (3)	0.6 (5)
HYV Aus	2.4 (4)	1.6 (5)	2.7 (3)	5.0 (1)	4.1 (2)
B. Aman	13.7 (1)	7.0 (3)	8.3 (2)	3.3 (4)	0.9 (5)
L. T.Aman	4.7 (1)	2.4 (4)	2.7 (3)	3.0 (2)	1.6 (5)
HYV T.Aman	7.5 (1)	5.7 (2)	2.6 (4)	2.9 (3)	2.4 (5)

Note: Figures in parentheses show rank order of % damage in each District for each crop.

Source: Yearbook of Agricultural Statistics

crpdam

Table 4.15 Estimated average annual crop damage by old district

A. BOGRA DISTRICT

Frequency (non-exceed-ence)	Return Period (yr)	Estimated damage (Tk mn, 1988 prices)	Cost & frequency differ-ential (Tk mn)	Cumulated costs (Tk mn)
0	0	0		
			0	0
0.09	1.11	0		
			0	0
0.2	1.25	0		
			23.25	23.25
0.5	2	155		
			43.2	66.45
0.8	5	443		
			9.5	75.95
0.9	10	633		
			4.55	80.5
0.95	20	815		
			3.54	84.04
0.98	50	1051		
			0.885	84.925
0.99	100	1228		

Average annual damage avoided by protection
upto specified return period d(Tk mn,1988 prices)

	1:5	1:10	1:20	1:50	1:100
Total	66.45	75.95	80.5	84.04	84.925
Tk per ha NCA	192.6	220.2	233.3	243.6	246.2

Convert to 1991-92 prices using GDP deflator:

	1:5	1:10	1:20	1:50	1:100
Total	80.4045	91.8995	97.405	101.6884	102.7592
Tk per ha NCA	233.046	266.442	282.293	294.756	297.902

B. DINAJPUR DISTRICT

Frequency (non-exceed-ence)	Return Period (yr)	Estimated damage (Tk mn, 1988 prices)	Cost & frequency differ-ential (Tk mn)	Cumulated costs (Tk mn)
0	0	0		
			0	0
0.09	1.11	0		
			0	0
0.2	1.25	0		
			9.15	9.15
0.5	2	61		
			16.95	26.1
0.8	5	174		
			3.7	29.8
0.9	10	248		
			1.8	31.6
0.95	20	320		
			1.38	32.98
0.98	50	412		
			0.345	33.325
0.99	100	481		

Average annual damage avoided by protection upto specified return period d (Tk mn)

	1:5	1:10	1:20	1:50	1:100
Total	26.1	29.8	31.6	32.98	33.33
Tk per ha NCA	43.1	49.2	52.2	54.5	55.1

Convert to 1991-92 prices using GDP deflator:

	1:5	1:10	1:20	1:50	1:100
Total	31.581	36.058	38.236	39.9058	40.3293
Tk per ha NCA	52.151	59.532	63.162	65.945	66.671

C. PABNA DISTRICT

Frequency (non-exceed-ence)	Return Period (yr)	Estimated damage (Tk mn, 1988 prices)	Cost & frequency differ-ential (Tk mn)	Cumulated costs (Tk mn)
0	0	0		
			6.12	6.12
0.09	1.11	136		
			3.575	9.695
0.2	1.25	201		
			22.95	32.645
0.5	2	354		
			30.9	63.545
0.8	5	560		
			6.8	70.345
0.9	10	696		
			3.275	73.62
0.95	20	827		
			2.535	76.155
0.98	50	996		
			0.635	76.79
0.99	100	1123		

Average annual damage avoided by protection
upto specified return period d (Tk mn)

	1:5	1:10	1:20	1:50	1:100
Total	63.55	70.35	73.62	76.16	76.79
Tk per ha NCA	167.9	185.9	194.5	201.2	202.9

Convert to 1991-92 prices using GDP deflator:

	1:5	1:10	1:20	1:50	1:100
Total	76.8955	85.1235	89.0802	92.1536	92.9159
Tk per ha NCA	203.159	224.939	235.345	243.452	245.509

D. RAJSHAHI DISTRICT

Frequency (non-exceed-ence)	Return Period (yr)	Estimated damage (Tk mn, 1988 prices)	Cost & frequency differ-ential (Tk mn)	Cumulated costs (Tk mn)
0	0	0		
			0.09	0.09
0.09	1.11	2		
			5.225	5.315
0.2	1.25	97		
			33.45	38.765
0.5	2	320		
			45	83.765
0.8	5	620		
			9.9	93.665
0.9	10	818		
			4.775	98.44
0.95	20	1009		
			3.705	102.145
0.98	50	1256		
			0.92	103.065
0.99	100	1440		

Average annual damage avoided by protection upto specified return period d (Tk mn)

	1:5	1:10	1:20	1:50	1:100
Total	83.77	93.67	98.44	102.15	103.07
Tk per ha NCA	95	106.3	111.7	115.9	116.9

Convert to 1991-92 prices using GDP deflator:

	1:5	1:10	1:20	1:50	1:100
Total	101.3617	113.3407	119.1124	123.6015	124.7147
Tk per ha NCA	114.95	128.623	135.157	140.239	141.449

E. RANGPUR DISTRICT

Frequency (non-exceed-ence)	Return Period (yr)	Estimated damage (Tk mn, 1988 prices)	Cost & frequency differ-ential (Tk mn)	Cumulated costs (Tk mn)
0	0	0		
			4.0923	4.09
0.09	1.11	90.93		
			6.5197	10.6097
0.2	1.25	209.47		
			41.79	52.3997
0.5	2	488		
			56.25	108.6497
0.8	5	863		
			12.45	121.0997
0.9	10	1112		
			5.95	127.0497
0.95	20	1350		
			4.62	131.6697
0.98	50	1658		
			1.155	132.8247
0.99	100	1889		

Average annual damage avoided by protection upto specified return period d (Tk mn)

	1:5	1:10	1:20	1:50	1:100
Total	108.65	121.1	127.05	131.67	132.82
Tk per ha NCA	132.5	147.7	155	160.6	162

Convert to 1991-92 prices using GDP deflator:

	1:5	1:10	1:20	1:50	1:100
Total	131.4665	146.531	153.7305	159.3207	160.7122
Tk per ha NCA	160.325	178.717	187.55	194.326	196.02

Table 4.16: Annual Average Crop Damage Middle Bangali Planning Unit

Thana	NCA (ha)	GCA (ha)	Damage of Taman and Baman (ha)	Percentage on Old District	Value of Damage (Tk.m)
Bogra	12873	15140	1845	3.83	3.73
Dhunat	20925	24609	7219	14.98	14.58
Gabtali	20506	24116	5965	12.38	12.05
Sariakandi	17357	20413	1335	2.77	2.70
Sonatala (Bogra)	8127	9558	3120	6.47	6.31
Sherpur	5056	5946	856	1.78	1.73
Shibganj (Bogra)	4236	4982	787	1.63	1.59
Kamarkanda	1101	1295	63	0.34	0.30
Kazipur	24476	28785	2449	13.15	11.72
Raiganj	8581	10092	2262	12.15	10.83
Sirajganj	16135	18976	1457	7.83	6.98
Gobindhaganj	721	848	152	0.14	0.21
Saghatta	12399	14582	4067	3.75	5.76
Total:	152493	179342	31577	81.20	78.49