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Impact of Reforms in Agricultural Input Markets on Crop Sector Profitability in Bangladesh

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Chapter 1
Introduction

After the Independence, most of the organized activities in Bangladesh economy were owned and operated by the public sector through various public agencies. Such a state of ownership was partly rooted in the past policy regimes and was partly a *de facto* outcome due to absence of the previous entrepreneurs and institutions. Since the late 1970's, reforms in the food and agriculture sector were initiated to gradually limit the space of the public sector. These reforms remained at sectoral level, until being packaged under the Structural Adjustment Policies (SAP) during the second half of the 1980's. While policy reforms continued into the 1990's, some of the major reforms in the agricultural input markets came about in the 1980's. Two important elements of these reforms were perceived to include, reduction of subsidy, and increasing the participation of private sector in the procurement and distribution of inputs. From such perspective, effects of reforms on the crop sector profitability in general, and farm-level profitability in particular, were expected to be mixed. Reduction of subsidy was expected to reduce farmers' profit (net income) and adversely affect crop sector growth. On the contrary, increased competition in the input market due to private sector participation was expected to lower input prices and raise farm-level profitability. With these *a priors*, the present study reviews the policy reforms pertaining to the (chemical) fertilizer and irrigation markets, and provides estimates on changes in crop sector profitability over the reform period. Strictly speaking, methodological problems restrict us from establishing causality and from rigorous estimation of the effect of reforms. Thus, attempts have been made to conjecture on the effects through association of events and outcomes.

The study is based on secondary sources, and therefore, limited by the availability of data. The Government of Bangladesh (GOB) and the World Bank (WB) document and research materials have been consulted for reviewing the policy reforms undertaken during the 1980's. Published and unpublished data from (International Fertilizer Development Center - IFDC), as well as published data from other studies, have been analyzed and used for the present study. Some of the technical aspects and more rigorous statistical analyses have been relegated to appendix.

Policy reforms are reviewed in the following chapter, while chapter 3 outlines the methods and issues dealt with in chapter 4. The latter describes the changes in the input markets, presents findings on input prices, crop choice and crop sector profitability. The concluding chapter discusses some of the emerging issues that may be rooted in the dynamics unleashed by policy reforms.

Chapter 2
Review of Policy Reforms

Tracing policy changes with a view to assess their impacts on a sub-sector of an economy is always difficult. One obvious difficulty is in defining the scope, that is, in identifying the relevant policy areas. Additional difficulty arises in identifying the policy instruments, whose changes need to be traced. In assessing changes in profitability of the crop sector, we conveniently group policies in terms of the area they are expected to impact upon. The latter may be broadly categorized into three: domestic output market, input market and trade & exchange rate policies. Conventional policy types, such as, pricing, fiscal, monetary and institutional reforms may each have bearings on both output and input markets. While the present chapter briefly touches upon various policy reforms that had implications for the input and output markets pertaining to the crop sector in Bangladesh, the primary focus will be on those addressing the chemical fertilizer and mechanized irrigation markets. In reviewing the policy reforms, we draw upon various government and World Bank documents to highlight on how these reforms came about.

Policy Perspectives in 1982

While policy changes is a continual process, and it is often difficult to draw a time-line for pre-post comparison, we pick on the 1982 World Bank document (Bangladesh: Foodgrain Self-Sufficiency and Crop Diversification) to represent the set of ideas prior to the onset of numerous policy changes during the 1980's, in both input and output markets.[1] The WB document notes that "Bangladesh's agricultural strategy clearly must continue to place strong emphasis on raising foodgrain production" (p. 2). It also notes that the central thrust of the medium term food production plan (MTFPP) should be on "the provision of additional

[1] Another document consulted in later part of this report is the "Bangladesh Minor Irrigation: A Joint Review by Government and the World Bank", published in December 1992 (GoB 1992).

irrigation, drainage and flood control facilities" (p. 4) and "the complementary use of other modern inputs, such as fertilizers and HYV seeds, must continue to be increased simultaneously if the full potential of improved water management is to be realized" (p. 4).

As far back in 1982, there is recognition that GOB had "initiated a policy shift towards greater reliance on private financial and managerial resources" (p. 5). The WB document recommends vigorous pursuit of such policy, "particularly in the areas if minor irrigation and of recurrent input supply and distribution" (p. 5). More specifically, it mentions of "handing over responsibility for the procurement, marketing, servicing and management of minor irrigation equipment to the private sector, direct sale of pumps and tubewells to farmers and cooperatives, phasing out of seasonal equipment rentals, movement towards full-cost pricing for agricultural production assets and inputs, and vigorous extension training to improve farmer ability to extract the full potential from modern inputs" (p. 5). As a matter of fact, by 1982, the GOB had already taken measures to switch from the rental programs for minor irrigation equipment to a sales program, and had decided to subsequently move towards full-cost sales pricing (for STWs and LLPs).

While continued effort towards reduction of subsidy on fertilizer is noted, the document had a narrow focus on its distribution. The reason lies in the fact that by the end of 1982, fertilizer marketing was predominantly in the private sector at the retail level, and was being "reorganized from a BADC monopoly to extensive private involvement in wholesale distribution at the thana level" (pp. 28-29). The report was critical of the practice of officially fixing both wholesale and retail prices for private dealers, and recommended an interim strategy "to fix the wholesale price, to ensure adequate supply at the wholesale level, and to allow market forces and dealer competition to take care of the rest" (p. 29).

Two other important inputs in the crop sector production are seeds and pesticides. Subsidies on pesticides were eliminated in 1980 with the transfer of responsibility for the import and distribution of this input from the Ministry of Agriculture to the private sector. Subsidy on seeds continued, and the WB document of 1982 mentions of a GOB decision to eliminate this subsidy over a period of three years (from 1982).

Government interventions in the output market, in the forms of procurement and offtakes at given prices, were generally considered to be in line with what the WB thought to be appropriate during that period. This is partly reflected in the following statement made in the report: “In recent years, grain procurement prices have been set primarily in accordance with considerations of maintaining producer incentives in the face of rising input costs. The available evidence suggests that this has been successfully accomplished … . In the medium run, the present procurement prices should be roughly maintained in real terms through periodic adjustments necessitated by both domestic inflation and exchange rate movements.” (pp. 9-10) The WB document is however more emphatic in the area of public food distribution. It reiterates previous recommendations to reduce subsidy element in the ration system, direct a greater proportion of the ration distribution to the poor, and to make use of open market sales (of government stock) to reduce seasonal and annual market price fluctuations.

Some Facts on Government Intervention in Input and Output Market till 1982

Input subsidies on fertilizer and irrigation amounted to about 15 percent of GOB’s tax revenue in FY1981. Subsidy on fertilizer amounted to Tk. 1.2 billion in FY1981, even though subsidy in unit terms was reduced from 50 percent of BADC’s cost in FY1979, to 42 percent in FY1980, 32 percent in FY1981, and an

estimated 21 percent in FY1982 (WB:1982; 47).[2] A rough estimate suggested that subsidy on minor irrigation (accounting for amortization of equipments) amounted to Tk. 600 million in FY1982. The major portion of this subsidy was due to rental of LLP and DTW by the BADC and BWDB at concessional terms. As of 1982, substantial subsidies continued to be provided for the use of major irrigation – i.e., of large-scale gravity and canal irrigation schemes. Water charges assessed for the large-scale irrigation schemes were fairly modest; and yet, one estimate suggests that only 5.7 percent of these were actually realized during 1984-91 period.[3]

Distribution of benefits (arising from subsidy on fertilizer and irrigation) to various groups of farming households may be indirectly captured from Table 1, reproduced from Osmani and Quasem (1990). Even though the intensity of fertilizer use and percentage of land irrigated were consistently higher for the small farmers, due to difference in landownership, the large farmers appropriated a larger share of subsidies on all major ingredients of modern technology – fertilizer, irrigation and credit.

Table 1
Share of Different Farm Size Groups in
Consumption of Modern Inputs: 1981-82

Size of Farm (acre)	Percentage of farms	Percentage of land operated	Share of fertilizer	Share of irrigated land	Share of institutional credit
Upto 1.00	31.5	12.6	15.6	16.7	3.2
1.01-2.50	32.8	22.0	23.2	25.1	21.9
2.51-5.00	21.9	27.5	28.8	27.9	35.7
Above 5.00	13.8	37.9	32.4	30.2	39.2

Source: Table II. 11, p. 25, Osmani and Quasem (1990).

The discussion so far indicates that periodizing policy reforms in the agricultural sector is quite difficult. In the context of chemical fertilizer, the policy of heavy

[2] Rates of budgetary subsidy on fertilizer, as reported in Osmani and Quasem (1990), were 48 percent in FY1979, 40 percent in FY1980, 15 percent in FY1981 and 23 percent in FY1982.

subsidy had been gradually reversed since the 1970's; and reduction in subsidy had brought about a 15-fold increase in the nominal price of fertilizer in the period between 1971-72 and 1983-84. Since the growers' price of paddy did not rise as much, fertilizer/paddy price ratio shot up from 0.74 in 1971-72 to 2.03 in 1983-84 (see Osmani and Quasem 1990). It is however important to note that major shift in the policy on fertilizer distribution came about during the early 1980's, which had subsequent influence on availability and actual use of fertilizer for crop production. Similarly, the policies to liberalize markets for irrigation equipments and irrigation water came about gradually, even though 1980 may be considered to be the beginning of such policy initiatives.

Policy Reforms since 1982

A chronology of policy reforms towards liberalizing the agricultural input markets in Bangladesh is presented in Table 1. It is quite evident that some of the major policy reforms came about during the 1980s. More important among these are: (i) deregulation of fertilizer prices with private dealers procuring directly from the factories; (ii) transfer of ownership of tubewells from BADC to private hands[4], and most importantly, (iii) withdrawal of restriction on import of engines and pumps along with withdrawal of standardization restriction that previously limited the choice of makes and models. It is commonly perceived that the last set of policies liberalizing the restrictions on irrigation equipment and allowing private sector import, had the most impact on the crop sector production in Bangladesh.

The 1990's experienced further liberalization, especially in the trade sector, having important implications for the crop production. The Rural Rationing was withdrawn in 1991, largely restricting public offtakes of foodgrains through non-monetised channels and open market sales. Import of fertilizer by the private sector was allowed in 1992, with special credit support provided to the

[3] See Hossain and Dhaly (1991).
[4] This included cooperatives, informal groups and individuals.

importers.[5] During the same time, private sector participation in import of foodgrains was also opened up. The latter is believed to have reduced budgetary burden of the GOB and helped in stabilizing prices during shortfalls in domestic production. The 1990's is also marked by significant increase in mechanization of crop production, largely facilitated by the liberal policy towards importation of farm machinery and farm credit to support it.

[5] Private sector was also allowed to import urea during 1994, which was discontinued after the crisis in fertilizer market during 1995.

Table 1
Liberalization of Agricultural Input Markets: a chronology

Actions	Time Span	Remarks
Fertilizer Market		
1. BADC withdrew from retail and wholesale markets at thana levels, the primary distribution points	1978-83	Done first at Chittagong division, with vigorous response from traders
2. Licensing requirement was abolished and restriction on movement removed (except for eight-kilometer border zones with India)	1982-83	
3. Deregulation of fertilizer price took place	1982-84	Beginning of real competition
4. Private traders directly purchased from factory gates and port points	1987	Vigorous response from traders
5. Free import from world market began	1992	Good response but persistent fear of oligopoly
6. Fertilizer crisis took place, with partial reversal of reform	1994-95	
Irrigation devices		
1. BADC sale of low-lift pumps and tubewells to private parties (individuals, informal groups and KSS) backed by special credit arrangement for purchasers	1980-85	Good response from farmers
2. Restriction on import of engines and pumps was withdrawn; private sector was allowed to import	1987	Drastic fall in prices of engines
3. Standardization restrictions limiting makes and models were removed	1988	Drastic fall n prices of engines
Power tillers, Pesticides and Seeds		
1. Restriction on power tiller import and the standardization requirement were removed	1989	Modest response
2. Import of power tiller/tractor was made duty-free, along with credit support for purchase of these machineries	1995	Vigorous response
3. Restriction on import by brand names was liberalized for pesticides	±1989	Modest response
4. New seed policy proposed, even though restrictions remain on import of rice, wheat, potato, jute and onion seeds	1990	Further revisions made in 1998 & 1999. Upon certification, private sector may import hybrid seeds

Source: Table 3.1 in Ahmed (2000), with some important revisions.

Chapter 3
Issues and Methods

The primary objective of the study is to assess the changes in profitability in crop production at the farm level as a consequence of the policy reform in the agricultural input markets in Bangladesh. Two markets under consideration are chemical fertilizer and mechanized irrigation. There are two different sets of issues: identification of the timing of the reforms so that time series data on the real economy may be mapped on it for empirical assessment of the impact; and the second set of issues relate to linking individual policy reforms with final outcomes affecting crop sector profitability. We discuss these issues briefly and outline the methods adopted.

As noted in the previous chapter, reforms in food and agricultural sectors commenced since the 1970's; and the process had been quite gradual. Even though government intervention in the foodgrain market continues, it had gone through phases of rationalizing procurement prices, reduction of subsidy on ration distribution with subsequent phasing out of urban and (later) rural rationing. In the area of input markets, there are two important dimensions in policy packaging. The first involves the amount/extent of subsidy provided, and the other relates to transfer of ownership/activities to private sector (from public agencies).[6] It has already been noted that subsidy reduction on inputs had been a gradual process, and one is unable to identify a single year to demarcate between pre- and post-policy periods. However, with regards to deregulation and privatization of procurement/import and distribution of inputs, one is able to identify certain time-specific policies. Deregulation in fertilizer prices took place during 1982-84, with private traders subsequently allowed to procure from factory gates and port since 1987. Similarly, ownership of public-owned irrigation equipments was transferred to private hands during 1980-85 (which continued beyond this period); while the private sector was allowed to import makes and

[6] Note that an activity may be transferred to private sector and yet subsidy may continue.

brands of own choice since 1987. This was followed by the policy on removal of siting restriction following the 1987-88 flood. Under the circumstance, one may consider the whole of 1980's as the decade of policy changes; and compare performance of the economy (discounting for the autonomous changes) during the beginning and the end of the decade. This is what we have done in the following section, being fully aware about the limitation that such comparisons do not allow us to associate changes with any individual policy reform.

On an *a priori* basis, it is however possible to identify a number of policies along with expected effects of these policies. Following Ahmed (2000), these are summarized in Table 2 below.

Table 2
Policy-Outcome Linkages

Policy	Meso-level effects	Effects on input use and crop choice	Direction of profit
Reduction of subsidy on fertilizer	Increase in fertilizer prices	Reduced fertilizer consumption	Decrease
Privatization of fertilizer distribution	Lowering of retail prices due to increased competition	Increase in fertilizer consumption	Increase
	Increase in price instability due to alleged oligopoly at dealers' level	Sub-optimal choice of crops	Decrease
Reduction of subsidy on irrigation	Increase in the price of irrigation water	Shift away from irrigated crop	Decrease
Withdrawal of restriction on private sector import, and on brands/makes	Wider choice and increased competition, leading to increased investment in irrigation and decrease in price of irrigation water	Wider choice of crops, especially HYV rice	Increase
		Expansion in irrigated area, leading to wider choice of cropping pattern	Increase

Note: If one accounts for the complementarities in use of inputs, increase in irrigated area is expected to facilitate crop production, which subsequently leads to increased consumption of chemical fertilizer.

The above description in Table 2 suggests that impacts of policy reforms need to be traced through changes in meso-level variables (i.e., prices), with subsequent impacts on crop and inputs choice, which subsequently influenced crop-sector

profitability. While the major part of chapter 4 deals with these issues, we also critically examine the findings presented in Ahmed (2000), based on SUR (Seemingly Unrelated Regression) estimates of a system of equations.

Chapter 4
Changes in Crop Sector Profitability

Introduction

This chapter compares state of market prices, choice of crops and crop-sector profitability at two different periods; average of 1978-79 to 1980-81 and average of 1990-91 to 1991-92. The last period precedes the policy on import liberalization, which included private imports of fertilizer and foodgrains. On occasions, we will inform the readers on more recent data to highlight on subsequent changes. The last part of the chapter makes an attempt to summarize the impacts of policy reforms, where the findings in Ahmed (2000) are also highlighted.

Changes in the Fertilizer Market

Since nominal prices are not always comparable over time and the Bangladesh crop economy is dominated by rice production, it is meaningful to express fertilizer prices as ratios of rice prices. This is done in Table 3 for two major rice seasons in three different periods. The figures compiled are based on various sample surveys and prices are those received or paid by farmers.

Table 3
Ratio of Fertilizer Prices to Paddy Prices

Inputs	HYV Aman			HYV Boro		
	1979-81	1990-92	1997-99	1979-81	1990-92	1997-99
Urea	1.09	0.82	0.75	1.13	0.90	0.91
TSP	0.98	0.98	1.77	1.02	1.18	2.15
MoP	0.76	0.81	1.11	0.78	0.99	1.35
Paddy Price (Tk/kg)	3.24	6.06	7.17	3.17	5.59	5.91

Source: BBS, IFDC, Zohir (1993) and unpublished data from BIDS study on PKSF's MES.
Note: Same input prices were considered for both Aman and Boro during 1997-99.

Since subsidy on BADC-imported TSP and MoP continued till the end of 1991, and there was allegedly implicit subsidy on urea through administered factory-gate urea prices, real price of fertilizer had effectively declined in real terms over the decade of policy reforms under consideration. While administered factory-gate urea prices continued into the 1990's, subsidies on TSP and MoP were eliminated; and the latter prices kept par with international prices. Thus, fertilizer-paddy price ratios with respect to these two chemical fertilizers increased dramatically during the 1990's (see Table 3).

There are three other sets of price summaries, all based on data collected by the IFDC at different stages of their involvement in Bangladesh. Analysis on spatial price integration of the fertilizer market was only feasible for 1995-99 period due to data limitation, details of which are presented in Appendix A. The analysis suggests that the market is competitive and the retail prices in different regions of the country are well integrated. Since the data on fertilizer prices was incomplete, a second set of analysis compares price deviations in a number of districts (from Dhaka prices) during the early 1980's and during the 1990's. Summary of the findings is presented in Table 4 below. The findings suggest that spatial price differences have increased in the case of urea for a number of districts, particularly in the north-west region. In contrast, price differences in MoP have declined for most districts during the 1990's, when compared with early 1980's.[7] It needs mentioning that the figures on 1990's capture the effects of trade liberalization on fertilizer imports and private sector participation in such imports.

The final set of price statistics are based on monthly price data (national averages) and try to capture the price volatility at the farm level arising due to non-availability of fertilizer during the peak periods. We assume February, March and April to constitute the period of peak demand for fertilizer. Thus, average price for these three months is expressed as percentage of average price in a fiscal year in Table 5. Price deviations during the peak period are found to have

[7] No clear trend is observed for price differences in TSP.

declined after the initial introduction of private dealership at the retail level; and the deviations remained quite low until the introduction of private import of fertilizer. Since then price volatility had increased, allegedly due to presence of oligopoly. However, strict monitoring to regulate the operations of the dealers

Table 4 Percentage Deviations of Fertilizer Prices (from Dhaka Prices)

Fertilizer Type	Year/Districts	1980-83	1984	1995-97	1998-99
UREA	Chittagong	-2.19	2.26	1.10	-0.12
	Noakhali	0.48	2.65	2.05	1.12
	Comilla	-0.01	-1.72	-0.92	-2.08
	Kishoreganj		0.79	-1.17	-1.06
	Mymensingh		-1.54	2.18	-1.45
	Jamalpur		1.91	-0.12	-2.23
	Tangail	-1.66	1.80	1.59	-0.28
	Faridpur	3.79	6.55	1.95	3.34
	Rajshahi	0.98	-0.20	7.01	1.47
	Dinajpur		-2.79	3.08	3.33
	Bogra	-0.89	-0.31	6.85	0.86
	Rangpur		-1.72	5.91	3.63
	Pabna	1.49	1.50	4.77	2.73
	Khulna		-0.59	4.68	5.40
	Kushtia	-0.66	2.48	2.38	1.36
	Jessore		-1.13	2.62	2.30
TSP	Chittagong		-5.27	-6.18	-7.74
	Comilla	-5.14	-0.70	-6.70	-5.99
	Faridpur	-2.33	11.86	0.00	-1.97
	Bogra	-7.12	9.94	-3.56	-3.70
	Jessore		3.46	-1.60	-4.96
MoP	Chittagong		11.66	-1.40	-6.44
	Noakhali		7.70	1.45	-3.50
	Comilla	-3.34	-6.57	-6.00	-7.27
	Kishoreganj		-2.55	-2.20	-1.77
	Mymensingh		0.57	-1.43	-2.70
	Jamalpur		-1.56	-4.39	-5.42
	Faridpur	2.47	10.07	-2.11	-6.21
	Rajshahi	-4.46	-6.39	-1.34	-5.03
	Dinazpur		-6.78	-3.36	-5.04
	Bogra	-4.65	-4.57	-3.46	-4.60
	Rangpur		-7.30	-3.40	-4.61
	Pabna	-3.42	-2.07	-4.14	-9.77
	Kushtia	-6.51	1.76	-5.64	-10.37
	Jessore		-3.23	-6.11	-8.34

Source: Author's Calculation from unpublished IFDC data.

appear to have ensured lower price deviations for urea since FY1997. Since such monitoring is not in place for imported fertilizer, and due to variations in world prices, price volatility has increased for TSP and MoP.

Table 5: Deviations of February-April Prices from Annual Average Prices

Year	Absolute Deviation (Tk/50Kg)			Percentage Deviation		
	Urea	TSP	MoP	Urea	TSP	MoP
1980-81	3.82	4.19	3.14	2.62	3.43	3.32
1981-82	3.04	10.02	7.97	1.70	6.45	6.85
1982-83	0.09	-2.58	0.01	0.05	-1.38	0.01
1983-84	0.26	1.26	1.16	0.13	0.67	0.75
1984-85	6.92	-2.53	8.61	2.91	-1.05	4.64
1985-86	2.13	4.63	7.93	0.85	1.87	3.86
1986-87	-0.24	-0.49	6.56	-0.10	-0.19	3.03
1987-88	2.48	2.50	1.50	1.00	0.96	0.68
1988-89	2.93	0.83	2.94	1.18	0.32	1.33
1989-90	-2.28	-0.49	2.68	-0.98	-0.20	1.26
1990-91	6.88	-4.69	-0.07	2.91	-1.75	-0.03
1991-92	7.74	11.88	18.34	3.09	3.81	7.15
1992-93	15.97	8.98	10.51	5.91	2.32	3.09
1993-94	4.37	5.74	21.60	1.84	1.41	5.70
1994-95	33.40	-6.80	-9.20	11.53	-1.51	-2.68
1995-96	17.67	14.17	2.42	6.98	2.64	0.64
1996-97	-2.83	38.75	-13.58	-1.15	6.27	-3.77
1997-98	3.50	-25.17	8.75	1.27	-3.86	2.23
1998-99	7.17	5.33	29.08	2.55	0.84	6.59

Source: Author's calculation from monthly reports of FDI-II & ATDP, IFDC, Dhaka

Market for Irrigation

Systematic data on prices of irrigation water and prices of irrigation equipments is not available. The task of compiling such data is made more difficult due to presence of numerous modes of irrigation and wide variation in pricing arrangements and prices across regions and seasons. In spite of these limitations, we try to describe the irrigation market during the late 1970's and

early 1980's, and present information pertaining to irrigation prices, compiled from secondary sources.

By 1980, three modern minor irrigation technologies – Low Lift Pumps (LLP), Deep Tubewells (DTW) and Shallow Tubewells (STW) – were available through BADC. During the early 1980's, these were either purchased or rented from BADC; and were managed either by KSS groups, informal pump groups related directly to BADC, private owners who may be individuals or groups, or landless groups (Palmer-Jones and Mandal 1987). Some aspects of the supply side of STW irrigation are described in Box 1.

Box 1: Irrigation market in the Early 1980's

A study on IDA-STW project in the north-west (Hamid 1984) provides some interesting insights into irrigation market during the early 1980's. Some of the salient features of the market are mentioned below.

1. STWs were to be sold through 3 different channels; (i) cash sales to individuals, (ii) sales to BRDB groups on credit from commercial banks, and (iii) sales to individuals or group of individuals on credit from commercial banks. For obtaining a STW, an applicant was required to fulfill a number of conditions, which included 70 percent down payment for non-BRDB upazilas and 20 percent for BRDB upazilas, security in the form of land (initially 3 acres, which was later reduced to half an acre) and submission of various land documents and other certificates. Sales to individuals essentially went to rich; while in the case of BRDB groups, the persons, designated as managers, bearing the land security, became the owners of the STWs.
2. There were several restrictions in place with regards to siting and sinking of STWs. It was necessary on the part of the users to identify a location and show it in the STW scheme. For assessing hydrological feasibility, BADC was supposed to hire consultant to compile Upazila Irrigation Maps. It was also instructed to ensure that (i) no DTW exists within 2,500 ft. of the site, and (ii) no STW exists within 500 ft. of the site. The study observed that most of the IDA-STWs were sunk well before the Upazila maps were prepared, and that half of these were not sited according to the original scheme. The study also observes that the service of BADC had shortcomings; and private mechanics emerged to play important roles in the market. Non-availability of spare parts was however identified as the main problem of STW operation in the north-west. Finally, for various reasons, BADC supply was cumbersome, and the users had to depend on the black market for more than 68 percent of their diesel and mobil consumption.

Prior to transfer of ownership, LLPs were mostly owned by the BADC, and these were rented out to farmer groups during the Boro season. The charges levied by BADC included Tk. 900 rent and a fixed Tk. 300 for spares and repair services, which covered only 10-15% of the cost of program (p. 3, GoB 1982).[8] A subsidy well over 90 percent was in place for DTWs, which were rented out at only Tk. 1200 per year, plus spares at cost upto a maximum of Tk. 1000, while the service was to be free. A typical DTW, with nominal capacity of 2 cusec, had a total depth of 160-180 ft. and a turbine pump set at about 60 ft., driven by a surface-mounted 20 hp diesel engine. In terms of 1981 prices, costs, excluding import duties and taxes, were Tk. 36,450 and Tk. 223,000 for respectively, LLP and DTW units (GOB 1982). In contrast, a STW with a capacity of 0.5-0.75 cusec cost Tk. 24,100 and a HTW (which could irrigate 0.3 - 0.5 acre of land) cost only Tk. 1,380 (see Table 6 below).

Table 6
Subsidy for Minor Irrigation Equipment under SFYP

Equipment	Mode	Estimated total cost to BADC (Tk)	Cost (excluding duties and taxes) Tk.	Cost recovery (Tk)	Per unit subsidy (Tk)
DTW	Rental/yr	33,500/yr	33,500/yr	1,200/yr	32,300 / yr
DTW	Sale	240,000	223,000	50,000	173,000
STW	Sale	30,000	24,100	23,800	300
HTW	Sale	1,835	1,380	1,380	0
LLP (2 cusec)	Rental /yr.	5,800/yr	5,800/yr	1,500/yr	4,300 /yr
LLP (1 cusec)	Sale	23,500	21,600	16,500	5,100

Source: p. 34, GoB (1982).

While reforms to move from rental system to full or part-cost sale of the irrigation equipments were being recommended, both the GoB and the World Bank had consensus on promoting the diesel engine manufacturing (GoB 1982). There were five companies, namely, Bangladesh Diesel Plant (BDP) – Deutz, Bangladesh Machine Tool Factory (BMTF) – Mitsubishi, Bangladesh Diesel

[8] A typical LLP then was a 16-18 hp diesel engine coupled to a centrifugal pump designed to produce 2 cusecs from a 40 foot pumping head.

Engine Co. (BDEC) – Yanmar, Bangladesh Diesel Ltd (BDL) – Lister, and Bangladesh Milnars Engineering Complex (MEC) – Kiloskar;[9] had already government approval to manufacture diesel engines. Protection was given to this industry with the hope that there would be positive linkage effects and external economies (p. 23, GoB 1982).

Given virtual monopoly of BADC over procurement of irrigation equipments, coupled with inefficient domestic manufacture of diesel engines, move from rental to sale of equipment had only marginal effect on the expansion of irrigation in the country. While transfer of ownership may have facilitated more efficient management of the pumps (and thereby, expansion of the command area per pump), the transfer also led to increase in prices. This is reflected in price summary, presented in Table 7.

Table 7
Prices of Irrigation Equipment (current prices)

Year	LLP (2 cusec)			DTW (2 cusec)			STW sale price ('000 Tk)
	Procure-ment price ('000 Tk)	Rent (Tk/yr)	Sale price ('000 Tk)	Procure-ment price ('000 Tk)	Rent (Tk/yr)	Sales – new (Tk)	
1975-76	17	600		140	1200		(10 – 12)
1976-77	19	600		160	1200		(10 – 12)
1977-78	22	600		160	1200		(10 – 12)
1978-79	26	600		180	1200		(10 – 12)
1979-80	27	600		220	1200	60	(10 – 12)
1980-81	30	900	22	260	1200	60	17
1981-82	35	1200	22	310	1800	70	20
1982-83	41	3600	25	310	3600	85	25 (32)
1983-84		3600	28.75	407	5000	112	28 (35)
1984-85		3600		421	5000	130	28 – 35
1985-86					5000		30 – 35

Note: Figures from 1983-84 are based on field work. Sale prices of STW between 198081 nad 1983-84 are for new Yanmar ts70, and those in parentheses are from field work, which may refer to different models and accessories.
Source: Compiled from Table IV.1, p. 90 in Osmai and Quasem (1990) and Table A.1, p. 32, in Palmer-Jones and Mandal (1987).

[9] BDP and BMTF were subsidiaries of public sector Bangladesh Steel and Engineering Corporation, while the others were private sector ventures.

For obvious reason, the price of irrigation paid at farm level had increased during the 1980's. While per acre irrigation costs was only Tk. 210 and Tk. 400 respectively for rented DTW and STW, the cost increased to more than Tk. 800 and Tk. 1800 for the two modes respectively by 1984 (Osmani and Quasem 1990 and Palmer-Jones and Mandal 1987). There were wide variations in pricing across managements and modes of payments. Normally, farmers had to pay higher prices under individually owned equipment, and if the payment had to be made in kind (paddy).[10] Moreover, the water prices were substantially lower under electricity-run engines compared to those under diesel-run engines. Other than the introduction of electricity-run engines, the most significant change occurred in the irrigation market when restriction on brands was withdrawn and private sector was allowed to import during 1987. This provided a wider choice of irrigation equipment at cheaper prices, and thereby, promoted investment in the minor irrigation sector. The jump in sale of STW units through private dealers, most of which were imported by the private sector, is quite evident in the summary statistics presented in Table B.1, in Appendix B. Trends in area under irrigation, by modes and regions are summarized in Tables B.15 to B.24 in the same Appendix.

Relative Prices vs Relative Availability

Traditional economic analysis is often bogged down with changes in relative prices of inputs leading to changes in choice variables. Following such a perspective, one may hypothesize that *policy reforms in the agricultural input markets led to lowering of prices of fertilizer and irrigation, which subsequently led to increase in their use, and thereby to increase in output and profitability*. It is true that the price of urea as a ratio of rice price had declined over the years due to continuation of implicit subsidy on urea produced by public sector industry. In case of the other two major varieties of chemical fertilizer, their prices had

[10] In the case of payment in kind, one would expect the price to be higher than under cash payment since there was risk sharing involved and payment is made after harvest under the former arrangement.

evidently increased relative to rice prices, though only after 1992. It is generally agreed that timely availability of fertilizer has been more important in influencing its use than variation in its prices at the margin. It is also commonly understood that of the two inputs under study, irrigation had acted as the lead input in promoting crop sector growth in Bangladesh.[11] Here also, availability of irrigation facility rather than changes in its relative prices had been instrumental in promoting growth. It is true that increase in the irrigation price paid by the farmers (who had already adopted the technology) adversely affected profitability. However, decline in price of irrigation equipment, coupled with a wider choice set through unrestricted private import, promoted investment on minor irrigation. Such investment enabled farmers in new areas to choose crops that would raise profit. Thus, one may conjecture that *early adopters of modern technology had reaped higher benefits during the initial years, which declined with policy reforms during the 1980's; and the policy reforms helped expansion of modern technology to new areas (due to reduced investment cost) where the farmers derived positive benefits*. Such a conjecture is supported by evidence provided in Mahmud *et al* (1994), where it is shown that rice production in Tangail, Noakhali and Chittagong had recorded high growth rates during 1967-68 to 1977-78 period (respectively, 10.56, 5.12 and 4.12 percents per year), while these districts performed poorly during 1979-80 to 1989-90 period (with annual growth rates of –1.12, 2.47 and 0.51 respectively).[12]

The present study does not pursue the above analysis. In stead, we look into the implications for crop choice and consequent changes in aggregate profitability of the crop sector in Bangladesh. Crop-sector profitability may increase for one or more of the following four reasons: (i) general increase in the relative price of output to those of inputs, (ii) favorable shift in relative prices of inputs, (iii) land improvements making it feasible to shift land allocation towards producing more

[11] See Ahmed (2000).
[12] See Table 2.10 in p. 23, Mahmud *et al* (1994). One may also look into the recent work by Raisuddin Ahmed. It is important to note that within a dynamic setting, additional income accrued by the early

profitable crops, and (iv) optimal use of inputs under individual crops (moving towards the boundary of production frontier from within). We have already noted that other than in the case of urea, relative price of the main crop sector produce (rice) did not increase vis-à-vis other inputs during the decade under scrutiny (1980's). It is also beyond the scope of the present study to comprehensively address the relative contribution of individual inputs to growth and then map evidence on changes in relative prices of these inputs on such contributions, in order to address point (ii) above.[13] In the rest of the chapter, therefore, we look into changes in land allocation and in intensity of input use before presenting summary statistics on changes in aggregate profitability of the crop sector.

Land Allocation by Crops

Expansion of area under modern irrigation had primarily facilitated HYV Boro rice cultivation during the dry season. Provision of supplementary irrigation, along with flood protection measures, had also facilitated cultivation of HYV Aman rice during the wet season. Over the reform period (whole of 1980's), for obvious reasons of emphasizing on cereal production, share of cereals in gross cropped area increased, while most other crop groups recorded marginal declines in their shares. However, the major shift was within rice, and the share of HYV/Pajam paddy increased from 14.3 percent of gross cropped area to about 35 percent over a decade. This is equivalent to about 47 percent of total rice area, which had later increased to more than 50 percent in 1996. The growth in total output due to switching from local to modern variety has however died down during the 1990's. It is important to note that quite a large number of non-rice minor crops (especially, spices and vegetables) exhibited large profit in static analyses (Mahmud *et al* 1994). Yet, due to market uncertainty and problems with micro-management of minor irrigation to accommodate their production within rice area,

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adopters of technology may find ways into new line of economic activities, which has rarely been probed in the context of Bangladesh.

the farmers failed to benefit from their production. Area under pulses had declined persistently, while that under oil seeds may have stabilized after initial decline. Contrary to common perception, area under vegetables has declined, which had been possible due to increased use of improved seeds in this area.

Table 8

Percentage Distribution of Gross Cropped Area Before and After the SAP

Crop	% of gross cropped area			Crop	% of gross cropped area		
	1983-84	1990-92	1996		1983-84	1990-92	1996
Local Aus	20.81	11.09	11.03	Turmeric	0.18	0.11	0.09
Modern Aus	2.83	2.78	3.47	Chili	1.15	0.49	1.52
Broadcast Aman	10.15	6.46	5.96	Ginger	0.05	0.05	0.04
Local Trans. Aman	21.73	19.80	15.14	Coriander Seed	0.09	0.04	0.05
Modern Aman	4.93	15.42	15.76	Garlic	0.21	0.09	0.37
Local Boro	3.08	2.00	3.95	Onion	0.52	0.25	0.93
Modern Boro	6.58	16.73	17.50	**Spices**	2.22		3.04
Local Paddy	**55.77**	**39.35**	**36.08**	Lentil	1.83	1.51	1.45
Pajam/HYV Paddy	**14.34**	**34.93**	**36.73**	Gram	0.90	0.67	0.15
Local Wheat	1.88	-	0.00	Khesari	2.23	1.77	1.98
Modern Wheat	2.19	4.36	5.32	Black Gram	0.68	0.49	0.25
Maize	0.04	0.02	0.03	Moong	0.44	0.40	0.71
Other minor cereals	1.72		0.17	**Pulses**	6.56	**4.84**	4.63
Jute & mesta	5.49	4.02	4.55	Brinjal	0.34	0.21	0.57
Cotton	0.12	0.14	0.08	Pumpkin	0.11	0.09	0.05
Tobacco	0.45	0.27	0.50	Radish	0.13	0.15	0.05
Sugarcane	1.22	1.36	1.15	Cucumber	0.06	0.03	0.06
Potato	1.01	0.92	2.05	Long Bean	0.04	0.02	0.02
Sweet Potato	0.45	0.35	0.09	Tomato	0.08	0.08	0.06
Rape & Mustard	2.75	2.31	3.43	Cauliflower	0.03	0.06	0.04
Sesame	0.79	0.59	0.31	Cabbage	0.02	0.06	0.02
Linseed	0.60	0.55	0.04	Ladies Finger	0.04	0.03	0.02
Ground Nut	0.25	0.27	0.34	Arum	0.17	0.09	0.06
Oil Seeds	4.42	**3.73**	4.14	**Vegetables**	1.94		1.41
Other Crops[1]	0.18	3.87	.03	Gross Crop. Area	100.00	100.00	100.00

Note: 1: In case of 1990-92, other crops include some vegetables, spices and minor cereals.
Source: In case of 1990-92, it is author's calculation from data of the Yearbook of Agricultural Statistics, BBS, various issues. Other two columns are from census data, published by the BBS.

Intensity in Input Use

[13] Ideally, one needs to decompose growth by all important factors, including, fertilizer, irrigation and labor; which has not been possible for the current exercise. Existing growth decomposition exercises are

In order to verify if the level of production efficiency has improved over time, one conventionally resorts to activity analysis. The latter however requires information on physical quantities, which are available for chemical fertilizer, but not available for irrigation. Moreover, crop yields may change per unit of land, and therefore, there are two alternative ways of expressing intensity: per unit of output and per unit of land. Summary statistics on these are presented in Table 9 for HYV boro paddy production. The findings suggest that the intensity of (total) fertilizer use per unit of land has increased, but so has the yield. Thus, the intensity of fertilizer use per unit of output has very marginally declined. More interesting finding relates to changes in the mix of fertilizer used. While relative price of urea had declined over the study period, intensity of its consumption had actually declined; and this was compensated by increases in the use of both TSP and MoP. Such reverse trends may have been due to several factors. These include, (i) time involved in learning to identify technologically required optimal mix of fertilizers, and (ii) soil environment may have changed, calling for change in the mix of fertilizer to be used.[14] Another interesting observation may be made with regards

Table 9
Intensity of Input Use in Boro Paddy Production

Inputs	Use per 100 kg paddy			Use per hectare		
	1979-82	1990-92	1997-99	1979-82	1990-92	1997-99
Urea (kg)	4.81	3.92		172	169	
TSP (kg)	2.84	2.94		101	127	
MoP (kg)	0.69	1.41		25	61	
(Total fertilizer, kg)[1]	(8.34)	(8.27)	(7.5)	(298)	(357)	(374)
Cost of Fertilizer-Tk		51	63		2223	3147
Total labor days	5.98	4.61		214	199	
(Hired labor days)	(3.17)	(2.87)	(1.50)	(113)	(124)	(75)
Irrigation cost (Tk)[2]	73.99	85.22	81.00	2641	3678	4023

not immune from methodological shortcomings.

[14] Since labor market is not at issue, we do not raise it here. One may however note that the improved efficiency apparent in labor use may have arisen due to tightening of the rural labor market as well as from partial mechanization of agriculture. The figures on labor should however be interpreted with caution since

Note 1: Cost of fertilizer was available for 1997-99. Assuming the mix to be same as 1990-92, total quantity of fertilizer use was estimated. If the shares of TSP and MoP are assumed to have increased, estimate on use of fertilizer would be lower.
Note 2: Monetary values for the first two periods are in 1990-91 prices.
Source: Appendix tables; and unpublished data from BIDS Study on PKSF-MES (Zohir *et al* 2000).

to more recent trends: both fertilizer and irrigation costs per unit of land have increased; but they have declined per unit of output.

Crop Sector Profitability – an estimate on changes

Details on Crop-specific inputs and output, along with various measures of return from cultivating a unit of land are summarized in Tables B.2 to B.14 in Appendix B. The method of arriving at aggregate crop-sector profitability is outlined in Appendix C. Table 10 below summarizes the findings on changes in aggregate profit, expressed per hectare of land. The figures capture changes in the crop mix, crop-specific yields, changes in input use, as well as changes in prices of output and inputs. While revenue had increased by 40 percent over a decade, net returns on a cash cost basis had increased only by about 17 to 20 percent. During the same period, crop-sector GDP at constant prices (1984-85) increased by about 33 percent.[15] Over the period, dependence on purchased inputs – both labor and non-labor – increased; thus, cash returns to the farming households increased at a lower pace than growths in either quantum of production or the total value of produce. We had previously noted that increased efficiency in labor use has been achieved, which is also associated with increase in the share of hired labor (which is included in the calculation of cash cost) in total labor use. Returns to aggregate crop cultivation on a full-cost basis however registered an increase of more than 75 percent. The latter is indicative of increase in the use of labor for non-crop (and possibly, non-farm) activities by the farming households.

We used the Agriculture Census data on land allocation by different groups of farmers to estimate changes in net returns from crop sector for three groups of

farmers – small (less than 2.50 acre), medium (2.50 to 7.49 acre) and large (7.50 acre or above). The findings suggest that distribution of gross cropped area by crops does not vary significantly across these groups; and therefore, net returns per unit of land are similar across these groups.

Table 10: Aggregate Financial Profitability Before and After SAP

Items	Before [a]	Before [b]	After [c]	% Change [a,c]	% Change [b,c]
Revenues					
Gross Return I, Small	5947	13698	18835	216.7	37.5
Gross Return I, Medium	5677	13077	18144	219.6	38.7
Gross Return I, Large	5663	13043	17993	217.8	38.0
Gross Return I, All farmers	5755	13257	18410	219.9	38.9
Gross Return II, Small	6318	14552	19985	216.3	37.3
Gross Return II, Medium	6053	13942	19289	218.7	38.4
Gross Return II, Large	6040	13913	19151	217.0	37.6
Gross Return II, All farmers	6130	14120	19559	219.1	38.5
Costs based on Crop-specific Input Prices					
Cash Cost, Small	3255	6098	10044	208.6	64.7
Cash Cost, Medium	3079	5813	9575	210.9	64.7
Cash Cost, Large	3085	5816	9437	205.9	62.3
Cash Cost, All farmers	3134	5900	9750	211.1	65.3
Full Cost, Small	5554	11394	14579	162.5	28.0
Full Cost, Medium	5311	10953	13993	163.5	27.8
Full Cost, Large	5278	10867	13789	161.3	26.9
Full Cost, All farmers	5376	11066	14206	164.2	28.4
Net Returns on Cash Costs Basis					
Net Return I, Small	2692	7600	8791	226.5	15.7
Net Return I, Medium	2598	7264	8569	229.8	18.0
Net Return I, Large	2578	7228	8556	231.9	18.4
Net Return I, All farmers	2622	7357	8660	230.3	17.7
Net Return II, Small	3063	8454	9941	224.6	17.6
Net Return II, Medium	2974	8129	9715	226.7	19.5
Net Return II, Large	2956	8098	9713	228.6	20.0
Net Return II, All farmers	2996	8220	9809	227.4	19.3
Net Returns on Full Costs Basis					
Net Return I, Small	393	2304	4256	982.5	84.7
Net Return I, Medium	367	2125	4151	1031.9	95.4
Net Return I, Large	385	2176	4204	992.2	93.2
Net Return I, All farmers	379	2191	4203	1009.3	91.9
Net Return II, Small	764	3158	5406	607.8	71.2
Net Return II, Medium	742	2990	5296	613.6	77.2
Net Return II, Large	763	3046	5362	603.0	76.0
Net Return II, All farmers	754	3054	5353	610.4	75.3

Note: 'a' is at 1979-81 average prices, while 'b' is based on 1990-91 prices
Crop share before SAP is based on the Census of Agriculture and Livestock, 1983-84

[15] See World Bank (1992).

Crop share after SAP is based on the Census of Agriculture, 1996
The relevant figures in 'a' were calculated from Tables B.2 & B.5 weighted by the share of the crop in the total cropped area.
The relevant figures in 'b' were calculated from Tables B.2 & B.6 weighted by the share of the crop in the total cropped area.
The relevant figures in 'c' were calculated from Tables B.3 & B.6 weighted by the share of the crop in the total cropped area.
Source: Author's Calculation

Increase in crop-sector profitability has however dampened during the 1990's. A comparison with 1997-2000, upon changing a limited set of variables (on which information was available), shows net returns on per unit of land, in nominal terms, to have increased at the most by less than 1 percent on full-cost basis (Table 11). This is primarily because the wage rates have increased by more than 25 percent over the period; fertilizer costs have increased by more than 50 percent and irrigation costs have increased by about 10 percent. In contrast, the prices of most crop-sector produce have only marginally increased. In real terms, returns on land declined by more than 25 percent, which largely reflects the persistent decline in terms of trade against crop sector in Bangladesh. Note that our estimate on changes in profitability over the recent past is only suggestive and does not capture the changes in land productivity. However, given that physical quantity of output produced per unit of land did not increase significantly over the years, the finding on decline in real profitability of the crop sector during the 1990's remains valid.

In the absence of counter-factual scenario, it is hard to suggest if the growth in aggregate crop-sector profit is high or low, nor is possible to associate the changes with reforms in the markets of agricultural inputs. The following section attempts to address this, following the recent work in Ahmed (2000).

Table 11 Changes in Crop-Sector Profitability beyond SAP

Items	1990-92	1997-2000	Percentage change	
			Nominal	Real
Revenues				
Gross Return I, Small	18835	21880	16.17	-21.43
Gross Return I, Medium	18144	21182	16.74	-21.04
Gross Return I, Large	17993	20874	16.01	-21.53
Gross Return I, All farmers	18410	21426	16.38	-21.28
Gross Return II, Small	19985	23030	15.24	-22.06
Gross Return II, Medium	19289	22327	15.75	-21.71
Gross Return II, Large	19151	22031	15.04	-22.19
Gross Return II, All farmers	19559	22575	15.42	-21.93
Costs of production				
Cash Cost, Small	10044	12018	19.66	-19.07
Cash Cost, Medium	9575	11482	19.92	-18.89
Cash Cost, Large	9437	11288	19.61	-19.10
Cash Cost, All farmers	9750	11676	19.76	-19.00
Full Cost, Small	14579	17623	20.88	-18.24
Full Cost, Medium	13993	16959	21.19	-18.03
Full Cost, Large	13789	16660	20.82	-18.28
Full Cost, All farmers	14206	17190	21.00	-18.16
Net Returns on Cash Costs Basis				
Net Return I, Small	8791	9861	12.18	-24.13
Net Return I, Medium	8569	9700	13.19	-23.44
Net Return I, Large	8556	9587	12.04	-24.21
Net Return I, All farmers	8660	9749	12.58	-23.86
Net Return II, Small	9941	11012	10.77	-25.08
Net Return II, Medium	9715	10845	11.64	-24.50
Net Return II, Large	9713	10744	10.61	-25.18
Net Return II, All farmers	9809	10899	11.11	-24.85
Net Returns on Full Costs Basis				
Net Return I, Small	4256	4257	0.02	-32.35
Net Return I, Medium	4151	4223	1.74	-31.19
Net Return I, Large	4204	4214	0.23	-32.20
Net Return I, All farmers	4203	4236	0.77	-31.83
Net Return II, Small	5406	5407	0.02	-32.35
Net Return II, Medium	5296	5369	1.36	-31.43
Net Return II, Large	5362	5371	0.18	-32.25
Net Return II, All farmers	5353	5385	0.6	-31.96

Note: Output per unit of land is retained at 1990-92 level. Output prices for main produce have been included. Irrigation cost for 1997-2000 has been arrived at by applying the ratio observed for MV Boro cultivation. Fertilizer prices and wage rates are not specific to crops in 1997-2000.

Impact of Policy Reforms: a quantitative exercise

In a recent publication (Ahmed 2000), Ahmed estimates a system with five equations by Zellner's Seemingly Unrelated Regression (SUR) method, and shows that reforms in the market for irrigation equipment had significant impact in increasing the area under irrigation, which had played central role in promoting the crop-sector production (captured in terms of rice production). The equations estimated and the description of variables, are summarized in Appendix D. Since the data was provided in Ahmed (2000), we were able to re-estimate the equations by the same SUR method with RATS (Regression Analysis of Time Series) program. Ahmed's estimates (of model 1 reported in Ahmed 2000) and our estimates of the same sets of equations are presented in the first two columns in Table 12. There are variations in the estimated coefficients, even though the estimated t-statistics are comparable. More importantly, Ahmed considers 1988-89 as the first year of the post-reform period, and accordingly chooses the dummy variable. Our discussion in the text suggests that 1987-88 should be considered in stead. We have therefore defined the dummy variable differently, and the estimates are reported in the third column in Table 11. Since private sector import of fertilizer was allowed since 1992 and a number of other important reforms in the foodgrain market came about around that time, we include an additional dummy for 1992-93 onward, and estimate the set of equations, whose results are summarized in the fourth column in Table 11. In the following, we summarize the differences in our estimates with those in Ahmed (2000).

1. The perverse negative relation between short-term credit and fertilizer consumption remains, but is statistically insignificant.
2. Irrigated area is found to have dominant influence on fertilizer consumption and the sign of relative price of fertilizer is negative, but insignificant. However, unlike Ahmed's estimate, fertilizer consumption had increased during post-1988 period.

3. Retail fertilizer price is found to be significantly related with factory-gate price, but a unit increase in the latter is found to increase the retail price by only 1.01 (and not 1.2 as found by Ahmed). This suggests of greater price transmission than that evident from Ahmed's estimates. More importantly, Ahmed found the period dummy to be insignificant, where as, we find the fertilizer price to have significantly declined during post-1987-88 period (with marginal increase after import liberalization). This is important to note since lower fertilizer prices may have facilitated adoption of HYV rice, which is difficult to be captured with the specification of equations estimated in Ahmed (2000).
4. The equation on irrigated rice area has right signs for diesel price and lagged public expenditures on water development measures. However, unlike Ahmed (2000), estimated coefficient for long-term credit in our exercise is statistically significant, which is expected.
5. It is true that irrigated area under rice increased significantly during post-1992 period, which remains to be adequately explained. However, it had also increased significantly during 1987-92 period, following the policy reforms.
6. Relationship between dry land rice area and irrigated rice area has changed substantially during the 1990's compared to the earlier period. The size of dry land rice area has clearly declined more during the post-1992 period than the decline during 1987-92.
7. Finally, when two dummies are included, irrigated area emerges as the single variable that significantly effects production of rice.

In spite of the differences, both the exercises suggest that policy reforms in the market for irrigation equipment, undertaken during 1987 and 1988, had been central in promoting crop-sector growth in Bangladesh.

Table 12: SUR Estimates of Fertilizer Consumption, Fertilizer Price, Irrigated Area and Rice Production

Explanatory Variables ↓	RA's Estimate	Our Estimate (1)	Our Estimate (2)	Our Estimate (3)
Dependent Variable: Fertilizer Consumption (FC)				
Intercept	-145.432 (0.35)	30.353 (0.10)	24.138 (0.08)	52.073 (0.14)
Retail Fertilizer Price (PFR/PR)	-162.551 (0.39)	-225.130 (0.66)	-196.194 (0.57)	-253.017 (0.72)
Irrigated Rice Area (AGR)	0.435 (9.22)	0.372 (10.00)	0.365 (9.75)	0.370 (8.77)
Other Crop Area (NAR)	-0.023 (0.82)	-0.014 (0.66)	-0.016 (0.75)	-0.017 (0.68)
Short-term Credit (CDS/P)	-26.383 (2.08)	-21.935 (2.07)	-19.196 (1.78)	-19.924 (1.80)
Dummy1 (D_1)	-129.134 (0.78)	46.192 (0.39)	75.225 (0.61)	64.668 (0.51)
Dummy2 (D_2)				-13.351 (0.14)
Adjusted R^2	0.95	0.96	0.96	0.96
Dependent Variable: Retail Fertilizer Price (PFR/PR)				
Intercept	-0.087 (2.16)	-0.061 (2.13)	-0.048 (1.83)	-0.053 (2.06)
Factory-gate Price (PFD/PR)	1.120 (15.73)	1.018 (18.09)	1.004 (20.17)	1.014 (21.38)
HYV Area	0.000 (0.81)	456×10^{-8} (1.75)	571×10^{-8} (2.45)	573×10^{-8} (2.25)
World Fertilizer Price (PFM/PR)	0.125 (2.49)	0.161 (4.40)	0.141 (4.42)	0.142 (4.56)
Dummy1 (D_1) / D	-0.001 (0.04)	-0.026 (1.37)	-0.034 (2.09)	-0.034 (2.16)
Dummy2 (D_2)				0.002 (0.20)
Adjusted R^2	0.92	0.95	0.96	0.95
Dependent Variable: Irrigated Rice Area (AGR)				
Intercept	886.791 (1.28)	593.798 (0.75)	191.157 (0.25)	623.112 (1.12)
Diesel Price (PD/PR)	-760.518 (0.69)	139.964 (0.12)	-390.388 (0.37)	-79.646 (0.11)
Lagged Public Expenditure (EG/P)	509.050 (3.26)	323.099 (1.97)	393.605 (2.79)	326.316 (3.18)
Lagged Long-term Credit (CDL/P)	79.241 (1.25)	114.382 (1.75)	151.912 (2.32)	115.001 (2.42)
Dummy1 (D_1) / D	2024.292 (4.32)	2678.068 (5.08)	2688.091 (5.59)	2087.017 (5.57)
Dummy2 (D_2)				1192.905 (4.29)
Adjusted R^2	0.87	0.81	0.83	0.90
Dependent Variable: Dry-land Rice Area (DAR)				
Intercept	22840.0 (22.22)	23172.8 (20.36)	23358.4 (20.42)	23005.8 (25.39)
Irrigated Rice Area (AGR)	-0.626 (3.46)	-0.883 (5.10)	-0.775 (4.84)	-0.426 (-2.68)
Rice Price (PR/PO)	1968.157 (1.26)	2744.617 (1.56)	1965.969 (1.24)	613.320 (0.49)
Dummy1 (D_1) / D	-1484.394 (2.37)	-393.146 (0.67)	-803.194 (1.50)	-1030.586 (2.35)
Dummy2 (D_2)				-1581.598 (4.22)
Adjusted R^2	0.89	0.86	0.86	0.91
Dependent Variable: Rice Production (QR)				
Intercept	-1903.471 (0.42)	1335.950 (0.33)	837.200 (0.21)	2461.8 (0.50)
Fertilizer Consump (FC)	1.661 (2.14)	1.808 (2.01)	1.565 (1.69)	1.528 (1.65)
Irrigated Rice Area (AGR)	0.993 (2.88)	0.964 (2.72)	1.023 (2.90)	1.087 (3.08)
Dry-land Rice Area (DAR)	0.490 (2.65)	0.342 (2.15)	0.365 (2.30)	0.283 (1.38)
Dummy1 (D_1) / D	553.040 (0.98)	-148.541 (0.30)	51.749 (0.11)	-116.365 (0.23)
Dummy2 (D_2)	-	-	-	-459.996 (0.98)
Adjusted R^2	0.95	0.94	0.94	0.94

Chapter 5

Beyond Structural Adjustment: policies to address emerging concerns

Introduction

The present study raised the problem in periodization in order to adequately assess the impacts of structural adjustment policies on the crop sector profitability in Bangladesh. We had compared 1990-92 (post-SAP) with 1979-81 (pre-SAP) and found the farmer-level net returns from crop production to have increased in real terms. The econometric exercise had shown that liberalization with regards to the irrigation market (procurement of equipments as well as siting of wells) had the most significant impact on the adoption of modern variety of rice, which raised land productivity and increased farm-level profit. Moreover, gradual privatization of fertilizer distribution had generally ensured timely supply of fertilizer to the farmers; and the fertilizer market is found to be spatially well-integrated. Thus, short-term impacts of SAP in these two areas are found to be positive. Policies, however, open up new opportunities, and the short-term gains may not be sustained in the long term. Moreover, behavior of agents under a new policy regime raise new set of issues, all of which may not be conducive to healthy growth in the agricultural sector. Even though a limited set of information have been provided on recent changes in the crop sector, they suggest of stagnation in the crop sector, with possible decline in returns from crop production in real terms. It is therefore important that the second generation problems be raised so that the economy may be revitalized out of current stagnation and future policies may designed upon lessons drawn from past experience. We discuss a number of such issues, which are directly related to policy changes that were initiated during the 1980's and early 1990's.

Observations on the Irrigation Sector

There are several lessons to be learnt from the policy experiences during the 1980's; these are summarized below.

1. The move towards import substitution with establishment of plants to manufacture pumps and diesel engines during the early 1980's proved to be a wastage of scarce capital for the country. These plants turned out to be inefficient when the standardization was withdrawn and private import of irrigation equipment was allowed during 1987.
2. In retrospect, it now appears that continuation of subsidy on fertilizer during the late 1980's was not a fair policy to maintain, especially since such subsidy was later withdrawn during 1992. Since there are complementarities in usage of the two inputs (irrigation water and chemical fertilizer), stability in relative prices and availability of these inputs is crucial in ensuring healthy investment. It is quite possible that low fertilizer prices had induced excessive investment on minor irrigation, a part of which turned out to be less economic under later policy regime (with no fertilizer subsidy). This, however, remains a conjecture, and cannot be verified due to absence of adequate data.
3. Increase in investment on irrigation with the withdrawal of standardization does suggest that size of investment is an important factor, which should be duly considered in future policy formulation.
4. While withdrawal of standardization did promote investment in irrigation, in the absence of complete knowledge on makes, farmers had often incurred losses due to inappropriate choices. Adequate information, independent of the promotional activities of the commercial firms, could have reduced such losses.

Increase investment in irrigation opened up several new concerns, which needs to be adequately addressed in the future. They include,

1. Current practice of irrigation through flooding of land promotes rice cultivation, and in the absence of appropriate design of field channels, cultivation of minor crops in association with rice within the same command area has not been in vogue. Thus, increased dependence on minor irrigation has led to increase in the extent of monoculture practice in the crop sector. We have also observed that revenue from rice production has declined in real terms; and it is necessary to promote other crops in order to reverse the trend.
2. Excessive extraction of ground water is believed to have led to drying out of aquifers during the dry season. In parts of the country, this has led to digging the well deeper, and often switching from shallow to deep tubewells. Such technological switch necessitates significant institutional rearrangements. Moreover, irrigation with deep tubewell at the latter's economic price, is yet to prove financially viable. These two aspects remain to be resolved in the future.
3. Extraction of ground water, in excess of the natural recharging capacity of the aquifers, is also believed to have led to the arsenic problem, which is considered to be a major health disaster during the recent past. It is therefore important to bring in balance between the alternative uses of water and between alternative sources of water.

Observations on the Fertilizer Sector

Policy changes had been more gradual in the field of chemical fertilizer. Gradual phasing out of the monopoly role, once played by the BADC, is considered to have benefited the farmers. There are however several aspects to take note of for future policy making. These are briefly highlighted below.

1. On withdrawal of subsidy, the experience shows that there had always been two opposite views, upheld by the World Bank and the GoB, without any party ever engaging in any major confrontation. GoB was able to continue its subsidies on imported fertilizer until 1992; and is alleged to

continue with implicit subsidy on urea through administration of mill-gate prices. Unfortunately, the debate was never based on meaningful reference prices. In the specific context of Bangladesh, where urea is locally produced and MoP and part of TSP are imported, it is necessary to define the objectives of a price policy (including tax and subsidy) more explicitly. Simplistic reference to the world price is no less dubious than an ad hoc continuation of subsidy on fertilizer on political ground. In future, it is therefore important to resolve this issue, not only within the context of the crop sector, but also upon taking cognizance of the externalities that fertilizer use cause for other sub-sectors of the economy.

2. Private sector participation in procurement and distribution of fertilizer gave rise to several vices of the market forces. Two noteworthy ones are, (i) since the content of any particular fertilizer is not visible, it has been easy for profit-seeking firm to fool the customers and sale poor quality fertilizer (say, TSP) at a price normally associated with higher quality fertilizer; and (ii) due to differences in demand for fertilizer across seasons and across space, market segmentation (across time and space) and oligopolistic pricing has often been observed.[16] Effort by the current Minister for Agriculture in regulating the market forces through persuasion and threat (to cancel dealership) is generally perceived to have been effective. In future, it is important to institutionalize regular monitoring of the market forces and regulate market forces, which deviate from fair play.
3. The policy focus on fertilizer had largely dealt with three major types of fertilizer – urea, TSP and MoP. The concern with environmental degradation due to fertilizer use and due to more intensive cultivation of land requires future policies to address use of micro-nutrients as well.

[16] An extreme consequence of which was observed during the fertilizer crisis of 1994-95.

Concluding Observation

The present study had a narrow focus on two major input markets and policy changes affecting these markets to explain how crop-sector profitability had changed due to structural adjustment policies. It abstracted from the changes in the output market, which determines one important component of profit (i.e., prices influencing revenue). Various exercises presented in this paper shows that crop sector profit had increased during the 1980's in real terms, and that such increase is largely attributable to increase in output due to switch to modern variety of rice, facilitated by change in policy towards the irrigation sector. It is however important to acknowledge the fact that output prices (especially, that of rice) had also increased; and is alleged to have been artificially maintained at a high level till the market crush in 1992. The trends during the recent past clearly show how the stagnation in output prices may reduce the real return from crop cultivation. These are outcomes of broad macroeconomic policies pursued; and have not been probed into in this study.

The review of policies suggest that both the Government of Bangladesh and the World Bank had identical objective of raising crop sector output, primarily through increasing food production. There had also been consensus on how to realize this objective. The only difference possibly lay in the pace of bringing about the required changes. Given that the oversights have been commonly erred and the short-term decisions have been commonly upheld, it may be worth looking into, in future, how the appearances are so similar. On the whole, policies of the 1980's had helped farmers in Bangladesh to reap additional benefits in real terms. This could not however be sustained during the 1990's, both due to stagnation in crop-specific yield and deteriorating terms of trade for the crop sector. The report does not discuss the technologies in the pipeline. Within the current set, it is suggested that there should be regular monitoring of the input markets and regulatory mechanisms may be institutionalized to make the market function in a healthy way.

Appendix A

Spatial Integration of Farm-level Fertilizer Prices after the SAP (1995-99)

With the onset of the Structural Adjustment Program (SAP) the fertilizer market in Bangladesh underwent significant changes. The past system of selling fertilizers through Bangladesh Agricultural Development Corporation appointed dealers was gradually phased out; instead the private sector dealers were allowed to operate in the fertilizer market. As a result of increased competition on the part of the dealers, availability of this input to farmers is expected to be better assured. However, it still remains to be examined whether the private sector involvement of the fertilizer distribution has brought any fruit to the farmers in terms of competitive price across the spatial markets. Because under competitive environment, prices of fertilizers in terminal markets equal prices in the source market plus the transportation costs inclusive of normal profit. When this condition is fulfilled, price changes in the source market, in the presence of competition, will lead to price changes in the terminal markets. Such a relation among several spatially separated markets represents an extreme case when the two markets are integrated. This relationship may be examined by applying the cointegration technique on the price series of different types of fertilizers across the markets.

Monthly price data for March '95 to August '99 were obtained from the ATDP of the IFDC, Dhaka, which collects such data for more than 400 markets and on various types of fertilizers. These dissaggregated price series were used to construct the aggregate price series for the 19 old districts. Due to some missing cases, observations on 17 markets of urea prices, 6 markets of TSP prices, and 15 markets of MoP prices were used in the exercise. Before applying the cointegration technique, the order of integration of the variables was examined by ADF and KPSS tests[17]. These unit root tests, considered as a whole, are

[17] For details see Fuller (1976), Dickey and Fuller (1979, 1981), and Kwiatkowski et al. (1992).

expected to give more accurate pictures of the order of integration of the price series. The lag length of the ADF test was chosen on the basis of its significance: initially maximum number of lags (12 lags in the present case) was included in the regression and the last lag was retained if it was found significant at 5% error probability level. In the estimation of the long-run variance of residuals, the lag truncation parameter was set at *l* = 8 on the basis of the Kwiatkowski *et al* (1992) criterion of choosing the value of *l* at which the test statistic settles down. The order of integration was assumed as I(1) when 'unequivocal decision' could not be arrived at – favoring the order of integration when one of the two tests supports it.

The unit root results reported in Tables A.1 & A.2 indicate that all of the market specific series are I(1) except the prices of urea fertilizers in Comilla, Mymensingh, Jamalpur, Rajshahi, and Pabna. As these five price series seem to be I(2), no cointegration exercise was conducted involving these series. Although two series of different orders of integration cannot be cointegrated, this apparent mixture of different order series is still possible when *three* (or more) series are involved[18].

Since the present cointegration analysis involves more than two variables the Engle-Granger (1987) two-step method is inappropriate, due to its small sample bias, which produces results that are not invariant to the direction of normalization, i.e., the choice of dependent variable. Consequently, the Johansen multivariate method (1988) was applied to test the spatial market integration. Following Johansen, the lag lengths of the VAR were selected. The deterministic components of cointegrating VARs included an unrestricted constant in view of transportation costs involved in realizing the 'commodity arbitrage' opportunity, if any. The numbers of cointegrating vector were

[18] See Granger (1986) in support of this contention. See also Johansen (1992) for a discussion of how to implement multivariate cointegration tests when the set of variables under consideration consists of both I(1) and I(2) variables.

determined on the basis of trace and $l_{\text{-}max}$ statistics. The hypothesis of at most one cointegrating vector cannot be rejected in many cases.

The exercise was carried in two steps for fertilizer prices in most of the administrative divisions: in the first step, the spatial market integration in an administrative division was examined. Once cointegration was found in all divisions, a representative market from each administrative division was selected and cointegration across these 'representative markets' was examined. As the Johansen statistics in Table A.3 shows, the highest number of cointegrating vectors was found for the urea prices of Dhaka administrative division. In all other markets, at least one cointegrating vector could be found.

The above analysis implies that spatial markets usually maintain a long run relationship with a neutral band due to transportation costs between markets. As fertilizer dealers always try to make profit out of any spatial rice differential through arbitrage, fertilizer prices, even at the retail level appear to have become highly competitive. As a result, farmers are able to purchase fertilizers at the competitive prices across the districts of the country round the year.

Table A.1: Unit Root Tests on Levels of Fertilizer Prices at Farm Level

District ↓	Dickey-Fuller		KPSS	
Statistic →	τ_μ	τ_τ	η_μ	η_τ
Prices of Urea				
Chittagong	-1.009	-5.987a	0.548b	0.096
Noakhali	-1.045	-5.620a	0.630b	0.089
Comilla	-0.803	-2.964	0.395c	0.149b
Dhaka	-1.056	-2.270	0.426c	0.136c
Kishoreganj	-4.018a	-5.177a	0.364c	0.149b
Mymensingh	-0.797	-3.249c	0.169	0.161b
Jamalpur	-1.388	-4.123b	0.202	0.156b
Tangail	-6.538a	-7.948a	0.211	0.151b
Rajshahi	-1.367	-2.303	0.156	0.159b
Dinajpur	-0.510	-2.202	0.442c	0.142c
Bogra	-1.997	-2.431	0.167	0.167b
Rangpur	-0.154	-2.730	0.263	0.161b
Pabna	-1.264	-4.936a	0.304	0.127c
Faridpur	-0.366	-4.923a	0.533b	0.122c
Khulna	-2.284	-3.864b	0.519b	0.106
Kushtia	-2.689c	-4.014b	0.455c	0.109
Jessore	-2.440	-4.807a	0.449c	0.122c
Prices of TSP				
Chittagong	-2.648c	-2.238	0.523b	0.185b
Comilla	-2.472	-2.271	0.570b	0.187b
Dhaka	-2.384	-1.604	0.515b	0.177b
Bogra	-2.502	-2.766	0.578b	0.178b
Faridpur	-2.115	-1.808	0.473b	0.170b
Jessore	-2.512	-1.774	0.460c	0.185b
Prices of MoP				
Chittagong	-1.663	-2.436	0.518b	0.142c
Noakhali	-1.034	-1.864	0.531b	0.157b
Comilla	-1.409	-2.156	0.547b	0.149b
Dhaka	-1.025	-2.966	0.616b	0.138c
Kishoreganj	1.548	-3.681b	0.681b	0.145c
Mymensingh	0.596	-2.949	0.635b	0.135c
Jamalpur	-1.738	-2.336	0.583b	0.129c
Rajshahi	-0.924	-2.282	0.526b	0.153b
Dinajpur	-1.263	-1.854	0.507b	0.138c
Bogra	-1.458	-2.108	0.513b	0.154b
Rangpur	-1.116	-1.687	0.542b	0.133c
Pabna	-1.324	-1.830	0.439c	0.143c
Faridpur	-1.728	-3.097	0.539b	0.130c
Kushtia	-1.701	-2.607	0.488b	0.135c
Jessore	-0.967	-2.957	0.570b	0.122c

Note: A rejection of the null at 1% level is marked with 'a', at 5% level with 'b', and at 10% level with 'c' respectively. Figures under t_m in column 2 and under t_t in column 3 are the augmented Dickey-Fuller (ADF) statistics found from regression with a constant, and a constant together with a trend respectively. Their significance levels are taken from blocks 2 and 3 of Table 8.5.2 in Fuller (1976). Finally, figures under h_m in column 4 and under h_t in column 5 are the KPSS statistics with drift, and with drift and trend respectively. Their significance levels are taken from Table 1 in Kwiatkowski *et al*. (1992).

Table A.2: Unit Root Tests on First Difference of Fertilizer Prices at Farm Level

District ↓	Dickey-Fuller		KPSS	
Statistic →	τ_μ	τ_τ	η_μ	η_τ
Prices of Urea				
Chittagong	-3.485b	-3.508b	0.169	0.122c
Noakhali	-4.470a	-4.460a	0.098	0.087
Comilla	-1.561	-1.509	0.325	0.131c
Dhaka	-2.823c	-2.806	0.325	0.145c
Kishoreganj	-6.005a	-5.910a	0.311	0.124c
Mymensingh	-2.316	-2.228	0.303	0.128c
Jamalpur	-1.483	-1.979	0.336	0.120c
Tangail	-6.330a	-6.443a	0.361c	0.136c
Rajshahi	-1.728	-1.862	0.362c	0.143c
Dinajpur	-3.994a	-1.534	0.318	0.142c
Bogra	-4.936a	-5.475a	0.330	0.128c
Rangpur	-4.116a	-4.647a	0.302	0.119c
Pabna	-1.744	-1.985	0.277	0.120c
Faridpur	-1.551	-4.034b	0.338	0.111
Khulna	-6.226a	-6.184a	0.197	0.108
Kushtia	-6.885a	-6.904a	0.193	0.119c
Jessore	-6.542a	-6.491a	0.328	0.132c
Prices of TSP				
Chittagong	-7.720a	-8.114a	0.401c	0.071
Comilla	-12.095a	-3.795b	0.273	0.094
Dhaka	-10.638a	-10.967a	0.400c	0.064
Bogra	-7.285a	-7.349a	0.304	0.092
Faridpur	-8.511a	-7.101a	0.259	0.066
Jessore	-7.910a	-8.316a	0.441c	0.068
Prices of MoP				
Chittagong	-9.428a	-9.319a	0.084	0.086
Noakhali	-11.262a	-5.817a	0.118	0.081
Comilla	-7.795a	-7.716a	0.095	0.098
Dhaka	-8.308a	-8.239a	0.151	0.064
Kishoreganj	-5.805a	-4.705a	0.119	0.116
Mymensingh	-3.318b	-3.496c	0.117	0.093
Jamalpur	-7.616a	-7.533a	0.084	0.082
Rajshahi	-9.885a	-9.785a	0.100	0.100
Dinajpur	-6.635a	-6.566a	0.084	0.085
Bogra	-8.718a	-8.634a	0.094	0.097
Rangpur	-3.050b	-2.958	0.077	0.080
Pabna	-6.402a	-6.337a	0.089	0.085
Faridpur	-9.127a	-9.033a	0.082	0.079
Kushtia	-6.250a	-6.190a	0.100	0.074
Jessore	-3.627a	-3.581b	0.125	0.097

Note: See Table A.1 above.

Table A.3: Spatial Integration of Fertilizer Markets After SAP

Regions → Null ↓	Chittagong Division	Dhaka Division	Rajshahi Division	Khulna Division	Across Divisions
Prices of Urea					
Trace					
r = 0	44.98a	144.66a	89.13a	45.49a	54.60b
r ≤ 1	13.19	89.28a	36.53	13.61	29.81
r ≤ 2	4.47	55.59a	21.81	2.05	11.64
r ≤ 3		28.72	9.89		4.80
r ≤ 4		14.68	3.79		
r ≤ 5		4.44			
λ_{-max}					
r = 0	31.79a	55.38a	52.61a	31.88a	24.79
r ≤ 1	8.72	33.69b	14.72	11.56	18.17
r ≤ 2	4.47	26.86	11.91	2.05	6.84
r ≤ 3		14.04	6.10		4.80
r ≤ 4		10.25	3.79		
r ≤ 5		4.44			
Prices of TSP					
Trace					
r = 0	21.16a	28.76a			59.45b
r ≤ 1	5.67	6.08			32.11c
r ≤ 2					15.63
r ≤ 3					5.65
λ_{-max}					
r = 0	15.49b	22.68a			27.34c
r ≤ 1	5.67	6.08			16.47
r ≤ 2					9.99
r ≤ 3					5.65
Prices of MoP					
Trace					
r = 0	36.93b	84.95a	77.21b	30.98a	67.42a
r ≤ 1	8.72	48.10	39.65	3.49	19.24
r ≤ 2	3.27	24.30	18.91		6.12
r ≤ 3		11.69	9.07		2.44
r ≤ 4		2.80	2.51		
λ_{-max}					
r = 0	28.21a	36.84a	37.56b	27.49a	48.18a
r ≤ 1	5.45	23.80	20.74	3.49	13.12
r ≤ 2	3.27	12.61	9.84		3.68
r ≤ 3		8.89	6.56		2.44
r ≤ 4		2.80	2.51		

Note: An unrestricted constant is included in the cointegration space in view of transportation costs between markets. The letters 'a', 'b', and 'c' denote significant at 1%, 5%, and 10%. The critical values for the trace statistics are taken from Hansen and Juselius (1995) and the λ_{-max} statistics are from Osterwald-Lenum(1992).

Appendix B
Statistical Tables

Table B.1
Sales and Rentals of Minor Irrigation Equipment, FY79-FY88

By source	FY79	FY80	FY81	FY82	FY83	FY84	FY85	FY86	FY87	FY88
SALES										
STW	5259	4485	17551	27100	39055	30626	30602	8432	16307	35179
BADC	2541	1315	11837	21815	18796	6988	7678	2045	12519	15097
BKB	2718	3170	5714	4510	6116	11762	8633	4062	1458	2082
Private dealers	-	-	-	775	14143	11876	14291	2325	2330 (2000)	18000 (10000)
DTW	-	763	575	1468	3282	2290	2170	617	638	541
LLP	-	-	2206	7388	12379	12334	8017	7513	4467	2935
New	-	-	2206	5366	5445	3705	4632	2423	3012	1943
Old	-	-	-	2022	6934	8629	3385	5090	1455	992
HTW	26450	18702	50529	84064	70970	90744	57480	30846	23700	43100
UNICEF	26450	-	-	-	-	-	-	-	-	-
BADC	-	18702	45029	72068	49821	-	-	-	-	-
BKB	-	-	5500	11996	21149	29878	19144	531	4	63
BRDB	-	-	-	-	-	60866	38336	30315	23696	43037
RENTALS										
LLP	35846	37346	31688	28232	17619	9297	8312	-	2699	7291
DTW	9329	9750	9878	10735	11302	10200	10233	7219	10240	10288

Note: BKB sales of STW in FY87 and FY88 do not include RAKUB sales. DTW and LLP sales were from BADC source only. Figures in parentheses are estimates on private imports.
Source: Attachment 38, World Bank (1990b).

Table B.2: Per Hectare Input-output Coefficients of Crops Before SAP

Crops	L.Aus	M.Aus	B.Aman	LT.Aman	M.Aman	L.Boro	M.Boro	L.Wheat	M.Wheat	Jute_Cap	Jute-Olit
Outputs											
Main Product(kg)	1240.38	2535.50	1591.89	1745.91	2655.30	2437.99	3568.89	1262.94	1619.38	1497.25	1419.67
By-product (kg)	1545.29	2035.78	2259.64	1907.51	2124.09	2083.48	2727.94	276.69	1022.37	1812.36	1822.65
Inputs											
Seed (kg)	70.33	40.35	79.93	34.36	28.36	50.00	53.95	120.00	125.18	11.49	10.04
Seedling Costs (Tk.)	0.00	886.15	0.00	727.66	623.92	1097.88	1139.11	0.00	0.00	0.00	0.00
Chemical Fertilizers (kg)	46.54	198.62	26.19	57.06	167.23	70.55	268.59	94.75	216.81	67.41	70.00
Urea (kg)	31.24	112.97	20.27	35.28	90.07	55.98	171.66	48.65	101.86	31.75	40.58
TSP (kg)	12.25	64.31	5.15	16.02	54.26	20.25	101.38	32.98	83.74	23.25	17.65
MoP (kg)	3.48	21.35	1.15	5.76	22.91	8.30	24.58	13.12	31.22	12.41	11.77
Manure (kg)	231.88	263.34	36.84	111.82	124.62	65.01	228.89	53.13	93.77	120.83	41.60
Labor (person/day)	135.22	198.03	153.15	167.55	213.24	189.29	213.56	101.58	136.74	257.73	276.26
Family (person/day)	90.07	114.57	94.79	95.12	101.94	62.50	100.60	62.89	79.43	138.51	139.96
Hired (person/day)	45.15	83.45	58.36	72.43	111.29	126.79	112.96	38.68	57.30	119.22	136.31
Animal Power (pair/day)	46.52	45.53	50.19	21.78	45.43	40.39	48.47	33.35	47.60	48.66	42.75
Family (pair/day)	40.56	39.70	38.89	18.99	39.61	38.87	43.47	32.44	42.77	42.43	38.27
Hired (pair/day)	5.96	5.83	11.30	2.79	5.82	1.52	5.00	0.91	4.83	6.22	4.48
Other Costs											
Irrigation Costs (Tk.)	51.40	1028.05			400.94	709.36	2640.60		840.87		
Pesticides Costs (Tk.)	15.42	51.40		20.56	107.95		277.34		27.47	5.14	8.76

Note: Normally data ranging from 1978/79 to 1983/84 have been selected for the purpose. However, data in all of the years were not available for some crops.
Source: Author's Calculation from AER and IFDC.

Table B.3: Per Hectare Input-output Coefficients of Crops After SAP

Crops	L.Aus	M.Aus	B.Aman	LT.Aman	M.Aman	L.Boro	M.Boro	Wheat	Jute_Cap	Jute-Olit
Outputs										
Main Product(kg)	1554.00	3090.00	1646.00	2096.00	3499.00	2189.00	4316.00	2199.00	1530.00	1765.00
By-product (kg)	1936.00	2481.00	2629.00	2290.00	2799.00	2395.00	3299.00	2060.00	1852.00	2266.00
Inputs										
Seed (kg)	98.00	61.00	58.00	66.00	66.00	63.00	67.00	124.00	10.00	7.00
Seedling Costs (Tk.)	0.00	644.00	0.00	672.00	698.00	665.00	680.00	0.00	0.00	0.00
Chemical Fertilizers (kg)	85.00	242.00	26.00	79.00	259.00	69.00	357.00	272.00	111.00	136.00
Urea (kg)	48.00	113.00	19.00	39.00	125.00	42.00	169.00	124.00	55.00	58.00
TSP (kg)	26.00	87.00	7.00	28.00	92.00	22.00	127.00	102.00	38.00	57.00
MoP (kg)	11.00	42.00	0.00	12.00	41.00	5.00	61.00	46.00	19.00	20.00
Manure (kg)	1113.00	2409.00	455.00	834.00	1870.00	285.00	1499.00	1475.00	1974.00	2195.00
Labor (person/day)	161.00	178.00	132.00	160.00	189.00	135.00	199.00	156.00	247.00	245.00
Family (person/day)	80.00	78.00	46.00	63.00	74.00	43.00	75.00	68.00	74.00	72.00
Hired (person/day)	81.00	100.00	86.00	97.00	115.00	92.00	124.00	88.00	173.00	173.00
Animal Power (pair/day)	32.00	35.00	32.00	39.00	39.00	23.00	37.00	41.00	40.00	37.00
Family (pair/day)	27.00	26.00	24.00	33.00	30.00	21.00	28.00	34.00	25.00	30.00
Hired (pair/day)	5.00	9.00	8.00	6.00	9.00	2.00	9.00	7.00	15.00	7.00
Other Costs										
Pesticides Costs (Tk.)	95.00	451.00	31.00	236.00	522.00	174.00	690.00	121.00	53.00	224.00
Irrigation Costs (Tk.)	9.00	576.00	48.00	28.00	268.00	397.00	3678.00	843.00	0.00	298.00
Tractor/Power Tiller Costs (Tk.)	10.00	170.00	124.00	26.00	143.00	0.00	188.00	8.00	108.00	32.00
Sprayer Costs (Tk.)	2.00	40.00	6.00	19.00	28.00	19.00	42.00	2.00	4.00	40.00
Transport Costs (Tk.)	9.00	17.00			40.00		10.00	26.00		36.00
Post-harvest Processing Costs (Tk.)	6.00	82.00		4.00	36.00		55.00			

Source: Author's calculation from Zohir (1993).

Table B.4: Percentage Changes in the Input Use on Crops After SAP

Inputs/Crops	**L.Aus**	**M.Aus**	**B.Aman**	**LT.Aman**	**M.Aman**	**L.Boro**	**M.Boro**	**Wheat**	**Jute_Cap**	**Jute-Olit**
Seed (kg)	39.35	51.17	-27.44	92.11	132.72	26.00	24.18	3.33	-92.01	-39.07
Seedling Costs (Tk.)	0.00	-27.33	0.00	-7.65	11.87	-39.43	-40.30	0.00	0.00	0.00
Fertilizers (kg)	82.65	21.84	-0.73	38.45	54.87	-2.19	32.92	187.06	-48.80	101.74
Urea (kg)	53.66	0.03	-6.27	10.56	38.79	-24.97	-1.55	154.87	-46.00	82.66
TSP (kg)	112.25	35.29	35.80	74.77	69.55	8.65	25.27	209.28	-54.62	145.18
MoP (kg)	215.66	96.75	-100.00	108.23	78.98	-39.75	148.15	250.53	-39.14	61.13
Manure (kg)	379.99	814.78	1134.96	645.87	1400.52	338.39	554.90	2676.33	2005.17	1716.53
Labor (person/day)	19.06	-10.11	-13.81	-4.51	-11.37	-28.68	-6.82	53.58	80.64	-4.94
Family (person/day)	-11.18	-31.92	-51.47	-33.77	-27.41	-31.20	-25.44	8.12	-6.84	-48.02
Hired (person/day)	79.40	19.83	47.36	33.93	3.33	-27.44	9.77	127.50	201.90	45.11
Animal Power (pair/day)	-31.21	-23.13	-36.25	79.09	-14.15	-43.06	-23.66	22.93	-15.96	-23.95
Family (pair/day)	-33.43	-34.51	-38.29	73.81	-24.25	-45.98	-35.59	4.81	-41.55	-29.30
Hired (pair/day)	-16.11	54.27	-29.21	115.05	54.63	31.75	80.13	669.13	210.70	12.52
Pesticides Costs (Tk.)	84.82	-56.13			30.19	-75.47	-73.87		-93.70	
Irrigation Costs (Tk.)	-41.64	1020.57		36.18	148.27		1226.16		-100.00	5697.37

Source: Author's calculation from Tables B.2 & B.3.

Table B.5: Farm Level Financial Prices of Crops and Inputs Before SAP

Crops	**L.Aus**	**M.Aus**	**B.Aman**	**LT.Aman**	**M.Aman**	**L.Boro**	**M.Boro**	**L.Wheat**	**M.Wheat**	**Jute_Cap**	**Jute-Olit**
Outputs											
Main Product(kg) [a]	2.63	2.63	3.24	3.24	3.24	3.17	3.17	3.18	3.18	3.70	3.70
By-product (kg) [b]	0.20	0.24	0.15	0.24	0.25	0.11	0.24	0.16	0.16	0.62	0.51
Inputs											
Seed (kg) [b]	4.91	5.13	5.65	4.99	5.10	5.48	5.40	5.50	5.50	18.18	25.32
Urea (kg) [a]	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52
TSP (kg) [a]	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14
MoP (kg) [a]	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69
Manure (kg) [b]	0.05	0.10	0.07	0.07	0.10	0.05	0.10	0.07	0.07	0.08	0.07
Wage Rate(person/day) [a]	13.97	13.97	13.97	13.97	13.97	13.97	13.97	13.97	13.97	13.97	13.97
Animal Power (pair/day) [b]	19.99	20.48	23.32	17.48	20.46	18.63	20.02	17.93	17.93	21.32	19.35

Sources: a. BBS, Yearbook of Statistics, various issues and b. adapted from Zohir (1993).

Table B.6: Farm Level Financial Prices of Crops and Inputs at 1990-91

Crops	**L.Aus**	**M.Aus**	**B.Aman**	**LT.Aman**	**M.Aman**	**L.Boro**	**M.Boro**	**Wheat**	**Jute_Cap**	**Jute-Olit**
Outputs										
Main Product(kg)	5.85	6.06	6.00	6.01	5.97	5.80	5.90	5.67	5.80	7.23
By-product (kg)	0.41	0.50	0.32	0.50	0.53	0.22	0.50	0.33	1.28	1.06
Inputs										
Seed (kg)	10.22	10.68	11.76	10.39	10.60	11.04	10.24	11.44	37.81	52.68
Urea (kg)	5.39	5.26	5.58	5.31	5.28	5.50	5.36	5.44	5.43	5.38
TSP (kg)	5.83	5.68	6.04	5.75	5.71	5.95	5.72	5.98	5.59	5.77
MoP (kg)	4.85	4.88	4.81	4.89	4.81	5.25	4.77	4.93	4.77	4.83
Manure (kg)	0.11	0.20	0.15	0.14	0.20	0.11	0.20	0.14	0.16	0.14
Wage Rate(person/day)	36.08	46.45	35.18	42.02	45.62	49.73	44.27	37.83	37.56	33.39
Animal Power (pair/day)	41.59	42.60	48.51	36.37	42.56	38.75	41.64	37.30	44.34	40.26

Source: Excerpted from Zohir (1993).

Table B.7: Costs of Crop Cultivation Before SAP at 1990 Prices

Crops	**L.Aus**	**M.Aus**	**B.Aman**	**LT.Aman**	**M.Aman**	**L.Boro**	**M.Boro**	**L.Wheat**	**M.Wheat**	**Jute_Cap**	**Jute-Olit**
Seed	718.73	430.94	940.01	356.96	300.62	552.00	552.49	1372.80	1432.01	434.41	528.89
Seedling Costs		886.15		727.66	623.92	1097.88	1139.11				
Fertilizers	282.20	1116.33	155.30	323.27	920.48	479.07	1663.02	534.02	1221.89	380.92	382.82
Urea	168.38	594.23	113.11	187.31	475.54	307.87	920.09	264.66	554.11	172.42	218.33
TSP	71.42	365.26	31.13	92.12	309.83	120.48	579.90	197.22	500.74	129.96	101.83
MoP	16.90	104.17	5.53	28.18	110.18	43.57	117.26	64.70	153.91	59.21	56.85
Manure	25.51	52.67	5.53	15.65	24.92	7.15	45.78	7.44	13.13	19.33	5.82
Labor	4878.82	9198.39	5387.81	7040.44	9727.80	9413.34	9454.32	3842.65	5172.81	9680.37	9224.45
Family	3249.79	5321.93	3334.74	3997.06	4650.71	3108.22	4453.41	2379.32	3005.00	5202.35	4673.22
Hired	1629.02	3876.46	2053.06	3043.38	5077.09	6305.12	5000.91	1463.33	2167.81	4478.03	4551.23
Animal Power	1934.80	1939.75	2434.88	792.00	1933.34	1565.16	2018.19	1243.99	1775.38	2157.37	1721.08
Family	1686.90	1691.22	1886.63	690.52	1685.63	1506.33	1810.15	1210.04	1595.31	1881.52	1540.73
Hired	247.90	248.53	548.25	101.48	247.71	58.82	208.04	33.95	180.08	275.85	180.35
Irrigation Costs	51.40	1028.05			400.94	709.36	2640.60		840.87		
Pesticides Costs	15.42	51.40		20.56	107.95		277.34		27.47	5.14	8.76
Total Cash Costs	2919.16	7585.21	3691.10	4557.64	7653.79	9195.09	11435.75	3396.66	5857.00	5555.01	5646.24
Total Full Costs	7881.36	14651.02	8917.99	9260.89	14015.05	13816.79	17745.09	6993.46	10470.44	12658.21	11866.01

Source: Author's calculation from Tables B.2 & B.6.

Table B.8: Costs of Crop Cultivation After SAP at 1990 Prices

Crops	**L.Aus**	**M.Aus**	**B.Aman**	**LT.Aman**	**M.Aman**	**L.Boro**	**M.Boro**	**Wheat**	**Jute_Cap**	**Jute-Olit**
Seed	1001.56	651.48	682.08	685.74	699.60	695.52	686.08	1418.56	378.10	368.76
Seedling Costs		644.00		672.00	698.00	665.00	680.00			
Fertilizers	586.08	1775.30	216.55	543.53	1756.53	419.50	2223.05	1717.80	917.54	1044.83
Urea	258.72	594.38	106.02	207.09	660.00	231.00	905.84	674.56	298.65	312.04
TSP	151.58	494.16	42.28	161.00	525.32	130.90	726.44	609.96	212.42	328.89
MoP	53.35	204.96		58.68	197.21	26.25	290.97	226.78	90.63	96.60
Manure	122.43	481.80	68.25	116.76	374.00	31.35	299.80	206.50	315.84	307.30
Labor	5808.88	8268.10	4643.76	6723.20	8622.18	6713.55	8809.73	5901.48	9277.32	8180.55
Family	2886.40	3623.10	1618.28	2647.26	3375.88	2138.39	3320.25	2572.44	2779.44	2404.08
Hired	2922.48	4645.00	3025.48	4075.94	5246.30	4575.16	5489.48	3329.04	6497.88	5776.47
Animal Power	1330.88	1491.00	1552.32	1418.43	1659.84	891.25	1540.68	1529.30	1773.60	1489.62
Family	1122.93	1107.60	1164.24	1200.21	1276.80	813.75	1165.92	1268.20	1108.50	1207.80
Hired	207.95	383.40	388.08	218.22	383.04	77.50	374.76	261.10	665.10	281.82
Pesticide Costs	95.00	451.00	31.00	236.00	522.00	174.00	690.00	121.00	53.00	224.00
Irrigation Costs	9.00	576.00	48.00	28.00	268.00	397.00	3678.00	843.00		298.00
Tractor/Power Tiller Costs	10.00	170.00	124.00	26.00	143.00		188.00	8.00	108.00	32.00
Sprayer Costs	2.00	40.00	6.00	19.00	28.00	19.00	42.00	2.00	4.00	40.00
Transport Costs	9.00	17.00			40.00		10.00	26.00		36.00
Post-harvest Processing Cost	6.00	82.00		4.00	36.00		55.00			
Total Cash Costs	4726.64	8953.38	4452.94	6391.67	9446.47	6991.33	13816.57	7520.00	8307.78	7794.58
Total Full Costs	8858.40	14165.88	7303.71	10355.90	14473.15	9974.82	18602.54	11567.14	12511.56	11713.76

Source: Author's calculation from Tables B.3 & B.6.

Table B.9: Distribution of Costs of Crop Cultivation Before SAP at 1990 Prices

Crops	**L.Aus**	**M.Aus**	**B.Aman**	**LT.Aman**	**M.Aman**	**L.Boro**	**M.Boro**	**L.Wheat**	**M.Wheat**	**Jute_Cap**	**Jute-Olit**
Seed	9.12	2.94	10.54	3.85	2.15	4.00	3.11	19.63	13.68	3.43	4.46
Seedling Costs		6.05		7.86	4.45	7.95	6.42				
Fertilizers	3.58	7.62	1.74	3.49	6.57	3.47	9.37	7.64	11.67	3.01	3.23
Urea	2.14	4.06	1.27	2.02	3.39	2.23	5.19	3.78	5.29	1.36	1.84
TSP	0.91	2.49	0.35	0.99	2.21	0.87	3.27	2.82	4.78	1.03	0.86
MoP	0.21	0.71	0.06	0.30	0.79	0.32	0.66	0.93	1.47	0.47	0.48
Manure	0.32	0.36	0.06	0.17	0.18	0.05	0.26	0.11	0.13	0.15	0.05
Labor	61.90	62.78	60.42	76.02	69.41	68.13	53.28	54.95	49.40	76.48	77.74
Family	41.23	36.32	37.39	43.16	33.18	22.50	25.10	34.02	28.70	41.10	39.38
Hired	20.67	26.46	23.02	32.86	36.23	45.63	28.18	20.92	20.70	35.38	38.36
Animal Power	24.55	13.24	27.30	8.55	13.79	11.33	11.37	17.79	16.96	17.04	14.50
Family	21.40	11.54	21.16	7.46	12.03	10.90	10.20	17.30	15.24	14.86	12.98
Hired	3.15	1.70	6.15	1.10	1.77	0.43	1.17	0.49	1.72	2.18	1.52
Irrigation Costs	0.65	7.02			2.86	5.13	14.88		8.03		
Pesticide Costs	0.20	0.35		0.22	0.77		1.56		0.26	0.04	0.07
Total Cash Costs	37.04	51.77	41.39	49.21	54.61	66.55	64.44	48.57	55.94	43.88	47.58
Total Full Costs	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Author's calculation from Table B.7.

Table B.10: Distribution of Costs of Crop Cultivation After SAP at 1990 Prices

Crops	**L.Aus**	**M.Aus**	**B.Aman**	**LT.Aman**	**M.Aman**	**L.Boro**	**M.Boro**	**Wheat**	**Jute_Cap**	**Jute-Olit**
Seed	11.31	4.60	9.34	6.62	4.83	6.97	3.69	12.26	3.02	3.15
Seedling Costs		4.55		6.49	4.82	6.67	3.66			
Fertilizers	6.62	12.53	2.96	5.25	12.14	4.21	11.95	14.85	7.33	8.92
Urea	2.92	4.20	1.45	2.00	4.56	2.32	4.87	5.83	2.39	2.66
TSP	1.71	3.49	0.58	1.55	3.63	1.31	3.91	5.27	1.70	2.81
MoP	0.60	1.45		0.57	1.36	0.26	1.56	1.96	0.72	0.82
Manure	1.38	3.40	0.93	1.13	2.58	0.31	1.61	1.79	2.52	2.62
Labor	65.57	58.37	63.58	64.92	59.57	67.30	47.36	51.02	74.15	69.84
Family	32.58	25.58	22.16	25.56	23.33	21.44	17.85	22.24	22.21	20.52
Hired	32.99	32.79	41.42	39.36	36.25	45.87	29.51	28.78	51.94	49.31
Animal Power	15.02	10.53	21.25	13.70	11.47	8.93	8.28	13.22	14.18	12.72
Family	12.68	7.82	15.94	11.59	8.82	8.16	6.27	10.96	8.86	10.31
Hired	2.35	2.71	5.31	2.11	2.65	0.78	2.01	2.26	5.32	2.41
Pesticide Costs	1.07	3.18	0.42	2.28	3.61	1.74	3.71	1.05	0.42	1.91
Irrigation Costs	0.10	4.07	0.66	0.27	1.85	3.98	19.77	7.29		2.54
Tractor/Power Tiller Costs	0.11	1.20	1.70	0.25	0.99		1.01	0.07	0.86	0.27
Sprayer Costs	0.02	0.28	0.08	0.18	0.19	0.19	0.23	0.02	0.03	0.34
Transport Costs	0.10	0.12			0.28		0.05	0.22		0.31
Post-harvest Processing Costs	0.07	0.58		0.04	0.25		0.30			
Total Cash Costs	53.36	63.20	60.97	61.72	65.27	70.09	74.27	65.01	66.40	66.54
Total Full Costs	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Author's calculation from Table B.8.

Table B.11: Financial Profitability of Some Crops Before SAP at the Average Prices During 1978/79-1983/84.

Crops	L.Aus	M.Aus	B.Aman	LT.Aman	M.Aman	L.Boro	M.Boro	L.Wheat	M.Wheat	J_Capsularis	J-Olitorius
Revenues											
Gross Return I	3256.49	6656.69	5158.04	5657.11	8603.71	7738.17	11327.66	4019.42	5153.82	5546.12	5258.75
Gross Return II	3561.06	7146.02	5505.65	6115.61	9144.90	7958.52	11983.35	4063.32	5316.01	6661.32	6187.51
Costs based on Crop-specific Input Prices											
Cash Costs	1238.19	2895.21	1594.60	1724.52	2744.12	3140.27	4610.20	1431.73	2481.02	2159.83	2408.85
Full Costs	3307.25	5308.58	3825.59	3385.15	4978.41	4737.43	6885.52	2891.94	4357.47	4999.00	5104.46
Net Returns on Cash Costs Basis											
Net Returns I	2018.30	3761.48	3563.45	3932.59	5859.59	4597.90	6717.45	2587.70	2672.80	3386.29	2849.90
Net Returns II	2322.88	4250.81	3911.05	4391.09	6400.77	4818.25	7373.15	2631.59	2834.99	4501.49	3778.66
Net Returns on Full Costs Basis											
Net Returns I	-50.76	1348.11	1332.46	2271.96	3625.30	3000.74	4442.14	1127.48	796.36	547.12	154.29
Net Returns II	253.82	1837.44	1680.06	2730.46	4166.49	3221.09	5097.83	1171.37	958.55	1662.32	1083.05

Source: Author's calculation from Tables B.2 & B.5.

Table B12: Financial Profitability of Some Crops Before SAP at 1990-91 Prices

Crops	L.Aus	M.Aus	B.Aman	LT.Aman	M.Aman	L.Boro	M.Boro	L.Wheat	M.Wheat	Jute_Cap	Jute-Olit
Revenues											
Gross Return I	7256.22	15365.11	9551.34	10492.95	15852.16	14140.32	21056.45	7160.85	9181.86	8684.06	10264.22
Gross Return II	7889.78	16383.00	10274.43	11446.70	16977.93	14598.68	22420.42	7252.16	9519.24	11003.88	12196.23
Costs based on Crop-specific Input Prices											
Cash Costs	2919.16	7585.21	3691.10	4557.64	7653.79	9195.09	11435.75	3396.66	5857.00	5555.01	5646.24
Full Costs	7881.36	14651.02	8917.99	9260.89	14015.05	13816.79	17745.09	6993.46	10470.44	12658.21	11866.01
Net Returns on Cash Costs Basis											
Net Returns I	4337.05	7779.90	5860.25	5935.30	8198.37	4945.23	9620.70	3764.19	3324.86	3129.05	4617.99
Net Returns II	4970.62	8797.79	6583.33	6889.06	9324.14	5403.59	10984.67	3855.50	3662.24	5448.87	6549.99
Net Returns on Full Costs Basis											
Net Returns I	-625.15	714.08	633.35	1232.06	1837.11	323.52	3311.37	167.39	-1288.58	-3974.15	-1601.79
Net Returns II	8.42	1731.97	1356.43	2185.82	2962.87	781.89	4675.34	258.70	-951.20	-1654.33	330.22

Table B13: Financial Profitability of Some Crops After SAP at 1990-91 Prices

Crops	L.Aus	M.Aus	B.Aman	LT.Aman	M.Aman	L.Boro	M.Boro	Wheat	Jute_Cap	Jute-Olit
Revenues										
Gross Return I	9090.90	18725.40	9876.00	12596.96	20889.03	12696.20	25464.40	12468.33	8874.00	12760.95
Gross Return II	9884.66	19965.90	10717.28	13741.96	22372.50	13223.10	27113.90	13148.13	11244.56	15162.91
Costs based on Crop-specific Input Prices										
Cash Costs	4726.64	8953.38	4452.94	6391.67	9446.47	6991.33	13816.57	7520.00	8307.78	7794.58
Full Costs	8858.40	14165.88	7303.71	10355.90	14473.15	9974.82	18602.54	11567.14	12511.56	11713.76
Net Returns on Cash Costs Basis										
Net Returns I	4364.26	9772.02	5423.06	6205.29	11442.56	5704.87	11647.83	4948.33	566.22	4966.37
Net Returns II	5158.02	11012.52	6264.34	7350.29	12926.03	6231.77	13297.33	5628.13	2936.78	7368.33
Net Returns on Full Costs Basis										
Net Returns I	232.50	4559.52	2572.29	2241.06	6415.88	2721.38	6861.86	901.19	-3637.56	1047.19
Net Returns II	1026.26	5800.02	3413.57	3386.06	7899.35	3248.28	8511.36	1580.99	-1267.00	3449.15

Source: Author's calculation from Tables B.3 & B.6.

Table B.14: Percentage Changes in the Financial Profitability of Some Crops After SAP at 1990-91 Prices

Crops	L.Aus	M.Aus	B.Aman	LT.Aman	M.Aman	L.Boro	M.Boro	Wheat	Jute_Cap	Jute-Olit
Revenues										
Gross Return I	25.28	21.87	3.40	20.05	31.77	-10.21	20.93	13.15	2.19	24.32
Gross Return II	25.28	21.87	4.31	20.05	31.77	-9.42	20.93	14.20	2.19	24.32
Costs based on Crop-specific Input Prices										
Cash Costs	61.92	18.04	20.64	40.24	23.42	-23.97	20.82	15.63	49.55	38.05
Full Costs	12.40	-3.31	-18.10	11.82	3.27	-27.81	4.83	8.12	-1.16	-1.28
Net Returns on Cash Costs Basis										
Net Returns I	0.63	25.61	-7.46	4.55	39.57	15.36	21.07	9.90	-81.90	7.54
Net Returns II	3.77	25.17	-4.85	6.70	38.63	15.33	21.05	12.43	-46.10	12.49
Net Returns on Full Costs Basis										
Net Returns I	-137.19	538.51	306.14	81.90	249.24	741.17	107.22	-65.19	-8.47	-165.38
Net Returns II	12087.94	234.88	151.66	54.91	166.61	315.44	82.05	-139.15	-23.41	944.50

Source: Author's calculation from Tables 11 & 12.

Table B.15: Input-output Relationships and Input-Output Price Relatives of Modern Variety Rices and Wheat

Input Uses and Output Production								
Inputs/Output	M. Aus		M. Aman		M. Boro		Wheat	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Output (Kg.)	2535.50	3090.00	2655.30	3499.00	3568.89	4316.00	1441.16	2199.00
Urea (Kg.)	112.97	113.00	90.07	125.00	171.66	169.00	75.26	124.00
TSP (kg.)	64.31	87.00	54.26	92.00	101.38	127.00	58.36	102.00
MoP (Kg.)	21.35	42.00	22.91	41.00	24.58	61.00	22.17	46.00
Hired Labor (Person/Day)	83.45	100.00	111.29	115.00	112.96	124.00	47.99	88.00
Total Labor (Person/Day)	198.03	178.00	213.24	189.00	213.56	199.00	119.16	156.00
Input-Output Prices (in Tk./Unit)								
Inputs/Output	M. Aus		M. Aman		M. Boro		Wheat	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Output (Kg.)	2.63	5.92	3.24	6.06	3.17	5.59	3.18	5.94
Urea (Kg.)	3.51	5.21	3.52	4.98	3.59	5.02	3.57	4.94
TSP (kg.)	3.16	6.58	3.16	5.92	3.22	6.61	3.15	6.68
MoP (Kg.)	2.48	5.62	2.46	4.93	2.47	5.56	2.42	5.51
Labor (Person/Day)	15.50	33.03	15.50	33.03	15.50	33.03	15.50	33.03
Input Prices Relative to Output Price								
Inputs	M. Aus		M. Aman		M. Boro		Wheat	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Urea	1.34	0.88	1.09	0.82	1.13	0.90	1.12	0.83
TSP	1.20	1.11	0.98	0.98	1.02	1.18	0.99	1.12
MoP	0.94	0.95	0.76	0.81	0.78	0.99	0.76	0.93
Labor	5.89	5.58	4.78	5.45	4.89	5.91	4.87	5.56

Sources: Author's calculations from BBS, IFDC, and Zohir (1993).

Table B.16: Area Irrigated by Modern Methods as Share of Total Area Irrigated

Districts	**1979-80**	**1980-81**	**1981-82**	**1982-83**	**1983-84**	**1984-85**	**1985-86**	**1986-87**	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	**1992-93**	**1993-94**	**1994-95**	**1995-96**
Chittagong	66.84	62.38	64.12	62.48	74.69	85.74	69.97	74.67	66.73	64.19	60.88	62.49	65.11	65.25	68.90	68.59	67.41
Chitt. H.T	25.11	27.65	37.91	41.53	52.92	51.37	46.65	45.16	34.35	35.95	33.25	40.09	37.19	40.30	38.88	39.52	40.68
Comilla	67.85	75.36	78.57	80.23	83.42	82.41	81.48	84.27	84.59	74.97	73.55	74.55	80.32	78.39	83.86	84.73	84.18
Noakhali	39.23	53.26	39.21	50.19	53.00	65.73	84.34	85.29	91.93	83.03	84.34	87.79	89.31	90.06	92.13	92.58	92.34
Sylhet	31.88	34.69	38.83	37.13	42.99	49.60	49.82	51.13	41.94	38.34	38.49	42.60	44.90	46.67	44.93	44.47	45.31
Dhaka	75.18	75.40	76.48	82.71	86.55	88.56	89.34	89.85	96.98	86.18	87.59	88.56	88.89	90.32	90.87	92.21	92.60
Faridpur	73.34	76.17	83.03	87.21	81.88	87.80	88.59	93.65	97.79	95.29	94.75	96.92	97.01	96.19	95.76	94.62	95.74
Jamalpur	61.53	79.63	84.21	85.54	93.71	94.58	95.02	96.82	88.97	94.35	89.67	92.01	92.09	93.02	93.03	93.76	94.18
Kishorganj	55.51	57.23	60.42	70.81	69.06	74.53	73.77	73.68	93.19	79.91	75.03	76.86	75.35	77.55	80.93	81.06	81.95
Mymsingh	68.57	62.71	69.68	83.79	86.94	89.29	90.05	92.48	93.98	88.01	89.41	87.43	88.60	87.45	87.35	88.35	89.35
Tangail	86.02	93.58	96.15	95.52	96.04	95.38	95.47	97.18	98.45	96.80	96.95	97.07	96.94	97.00	97.09	96.81	96.94
Barisal	75.69	65.48	67.92	66.45	52.87	51.08	52.32	42.98	44.05	44.78	44.53	46.89	50.92	50.92	71.47	66.01	66.77
Jessore	68.68	70.92	73.45	75.56	78.03	81.02	67.49	76.81	92.99	85.66	86.22	88.20	91.23	91.69	92.30	94.14	93.79
Khulna	42.87	47.22	53.11	64.08	67.62	55.27	64.59	57.93	64.10	78.71	80.89	81.48	83.91	82.87	83.30	82.99	82.62
Kushtia	41.66	50.98	53.26	51.08	55.66	57.29	43.38	57.84	62.66	60.33	60.40	64.74	65.61	70.65	71.99	71.73	72.05
Patuakhali	98.69	96.57	96.96	97.66	98.15	96.59	99.16	67.97	51.68	77.26	65.99	95.39	41.22	38.92	30.73	26.69	41.45
Bogra	62.96	70.05	79.46	82.42	82.60	88.13	87.45	74.27	95.16	93.59	94.88	96.14	97.19	96.33	96.58	97.09	97.05
Dinajpur	63.88	68.79	74.23	75.66	84.71	91.13	87.61	87.16	91.83	87.23	87.51	91.64	92.78	93.41	93.96	95.51	96.13
Pabna	80.56	86.05	89.34	94.05	94.35	93.96	94.14	90.51	96.90	96.83	96.76	95.13	96.40	96.17	96.29	95.87	96.40
Rajshahi	51.92	58.20	65.57	86.52	83.54	82.00	92.82	81.06	83.11	31.75	81.29	85.33	85.19	84.97	86.60	84.34	87.69
Rangpur	64.16	63.37	64.55	68.27	63.55	62.98	58.61	75.57	89.96	77.15	76.52	83.48	85.59	84.89	85.42	85.38	86.27
Bang'des	**59.19**	**62.97**	**67.00**	**72.52**	**74.91**	**77.60**	**78.11**	**77.39**	**83.80**	**67.72**	**77.93**	**80.96**	**82.40**	**82.59**	**84.15**	**84.38**	**85.16**

Source: Author's calculation from BBS, Yearbook of Agricultural Statistics, and Statistical Yearbook of Bangladesh, various issues.

Table B.17: Area Irrigated by STW as Share of the Area Irrigated by Modern Methods

(in percent)

Districts	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96
Chittagong	1.15	1.88	3.25	3.37	3.28	6.44	4.47	14.31	7.91	8.86	7.94	8.34	8.17	7.38	9.70	10.05
Chitt. HT	0.00	0.00	0.29	0.21	0.22	19.63	0.19	6.29	2.93	0.57	0.00	0.00	0.00	0.00	0.00	0.00
Comilla	5.68	9.10	12.08	13.23	13.78	12.52	13.96	32.68	24.39	23.07	22.02	20.96	27.50	23.69	23.71	24.48
Noakhali	0.65	2.04	3.59	6.16	7.28	9.11	6.33	5.47	6.95	7.05	6.68	6.50	6.35	6.39	6.24	6.09
Sylhet	0.31	0.80	1.16	1.43	1.40	1.52	1.58	4.00	5.31	4.93	6.57	7.97	5.54	6.21	6.55	6.14
Dhaka	2.56	6.93	13.32	16.25	14.87	14.74	20.69	32.84	24.00	33.06	34.22	34.99	38.45	40.43	42.57	47.14
Faridpur	13.28	16.69	24.69	26.89	40.13	35.08	40.66	54.74	43.00	47.71	44.86	45.42	49.72	50.77	49.76	52.37
Jamalpur	19.96	38.97	43.84	43.55	43.49	43.74	39.59	51.03	52.06	62.82	59.60	61.45	66.99	68.43	72.21	73.77
Kishorganj	3.47	9.61	14.18	17.25	17.85	16.91	15.81	40.81	23.53	31.62	30.39	30.30	30.15	34.61	35.27	36.08
Mymensing	4.63	8.34	15.90	22.09	17.03	15.72	23.51	22.53	26.67	33.08	30.43	29.90	31.27	32.49	33.56	35.01
Tangail	16.48	33.34	48.22	36.12	43.27	42.74	59.42	63.67	65.50	72.19	66.85	68.90	69.12	70.48	69.86	71.48
Barisal	0.01	0.02	0.02	0.05	0.17	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jessore	11.23	9.59	17.13	18.27	19.89	27.13	48.14	66.58	65.03	68.93	60.99	68.31	68.48	71.32	71.53	73.18
Khulna	16.95	13.99	28.48	36.76	33.69	34.40	24.76	60.01	56.76	65.98	63.27	52.89	61.21	59.33	61.67	59.42
Kushtia	9.32	8.83	9.54	13.54	17.39	0.02	38.99	48.25	56.59	62.78	55.96	57.56	59.50	64.37	64.64	67.36
Patuakhali	0.00	0.04	0.05	0.04	0.10	61.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bogra	27.51	36.22	28.71	41.42	37.31	35.95	57.51	68.12	66.60	76.01	65.43	73.71	74.33	74.27	74.25	74.32
Dinajpur	10.49	8.78	17.42	20.22	20.59	52.62	38.93	50.77	45.68	47.85	44.33	53.55	55.35	58.41	65.14	64.96
Pabna	39.66	40.92	33.16	26.13	26.29	29.79	43.28	51.61	60.74	72.31	75.68	75.95	77.11	79.48	81.26	81.26
Rajshahi	20.21	40.45	37.47	35.63	30.04	81.57	43.05	61.71	45.81	52.08	48.96	49.36	52.88	57.61	56.16	54.16
Rangpur	6.35	9.85	16.45	15.45	22.22	5.85	64.57	62.58	69.85	72.47	70.29	72.25	72.80	75.13	77.63	78.59
Bangladesh	**9.63**	**16.44**	**20.09**	**21.22**	**21.12**	**35.07**	**33.23**	**47.51**	**43.67**	**49.04**	**46.71**	**49.10**	**50.86**	**52.21**	**53.81**	**54.69**

Source: Author's calculation from BBS, Yearbook of Agricultural Statistics, and Statistical Yearbook of Bangladesh, various issues.

Table B.18: Area Irrigated by DTW as Share of the Area Irrigated by Modern Methods

Districts	**1979-80**	**1980-81**	**1981-82**	**1982-83**	**1983-84**	**1984-85**	**1985-86**	**1986-87**	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	**1992-93**	**1993-94**	**1994-95**	**1995-96**
Chittagong	2.09	1.72	3.17	2.82	3.11	2.72	3.76	0.78	1.45	1.12	3.73	4.38	4.58	4.64	5.43	5.34	5.26
Chitt. H.T	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.33	42.68	28.99	0.33	0.00	0.00	0.00	0.00	0.00	0.00
Comilla	24.22	19.52	19.92	24.23	26.02	25.67	23.96	21.27	23.69	25.64	26.99	30.17	32.19	15.12	32.52	33.00	33.00
Noakhali	6.80	3.27	6.01	4.97	6.86	8.01	6.49	6.38	5.10	6.76	4.89	4.71	4.97	6.37	6.89	6.36	7.02
Sylhet	1.09	1.48	1.53	2.54	2.43	3.15	3.59	3.38	5.90	6.48	6.23	8.39	8.00	9.50	9.43	9.33	10.37
Dhaka	31.18	33.65	33.74	34.94	32.86	35.52	36.10	30.94	31.09	37.77	28.62	31.54	31.09	30.48	28.76	26.98	25.60
Faridpur	23.97	19.10	24.20	20.52	18.83	19.86	19.84	17.94	16.07	11.28	7.34	14.50	15.32	10.79	10.09	8.62	8.50
Jamalpur	0.00	40.01	43.39	38.66	34.80	34.35	35.75	38.70	35.20	30.93	24.40	30.97	29.82	25.83	25.12	21.80	19.73
Kishorganj	17.30	15.49	16.05	14.49	13.30	14.97	13.31	15.92	9.99	17.20	8.46	16.43	16.60	17.03	17.27	17.67	18.03
Mym.singh	63.78	46.00	53.91	59.50	59.39	61.90	63.47	57.84	67.45	57.35	53.16	57.13	57.93	57.09	56.87	56.83	53.89
Tangail	51.15	61.16	42.49	26.84	49.54	47.78	48.58	35.65	30.97	31.37	26.12	30.72	29.51	29.08	27.70	28.13	26.76
Barisal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jessore	47.52	50.81	54.25	46.59	52.59	50.57	29.87	22.68	18.83	15.27	13.77	24.57	22.93	22.08	20.18	19.79	18.94
Khulna	12.20	13.52	16.56	17.95	18.45	16.75	25.91	29.31	25.03	23.46	17.97	22.76	32.72	26.97	27.75	27.77	28.87
Kushtia	34.09	40.91	47.36	50.08	49.46	50.97	54.67	31.71	32.13	23.76	23.87	33.76	34.06	33.46	29.75	29.35	26.56
Patuakhali	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bogra	52.35	33.48	26.99	40.40	46.00	50.53	50.06	31.79	19.98	28.45	16.76	29.08	23.89	23.52	23.92	24.15	23.67
Dinajpur	53.76	46.68	54.60	48.52	52.76	53.74	28.61	37.10	33.80	35.15	32.53	42.74	36.10	35.29	33.86	29.97	29.22
Pabna	31.73	15.18	19.74	33.60	40.11	35.70	45.71	34.61	34.10	26.88	20.99	18.33	18.91	18.10	16.12	14.61	13.97
Rajshahi	27.20	17.36	13.47	15.58	13.35	18.79	4.49	20.88	25.64	30.77	25.87	29.69	29.52	28.94	28.15	31.66	30.91
Rangpur	39.68	36.49	36.59	37.96	48.49	48.27	58.49	21.28	25.16	20.46	17.83	21.89	21.03	21.20	19.48	17.90	16.25
Bang'des	**27.49**	**25.34**	**26.30**	**27.43**	**30.24**	**31.03**	**24.05**	**24.71**	**23.65**	**24.38**	**20.11**	**25.42**	**24.90**	**23.02**	**23.41**	**23.29**	**22.50**

Source: Author's calculation from BBS, Yearbook of Agricultural Statistics, and Statistical Yearbook of Bangladesh, various issues.

Table B.19: Area Irrigated by Power Pumps as Share of the Area Irrigated by Modern Methods

Districts	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96
Chittaong	97.91	97.13	94.95	93.93	93.52	93.99	89.80	94.74	84.24	90.96	87.41	87.68	87.08	87.18	87.19	84.96	84.69
Chitt H.T	100.00	100.00	100.00	99.71	99.79	99.78	80.37	61.48	51.03	68.09	99.09	100.00	100.00	100.00	100.00	100.00	100.00
Comilla	75.78	74.80	70.98	63.69	60.75	60.55	63.52	64.78	43.63	49.98	49.93	47.81	46.85	57.38	43.80	43.29	42.53
Noakhali	93.20	96.07	91.95	91.44	86.98	84.71	84.40	87.29	89.43	86.29	88.06	88.60	88.53	87.28	86.73	87.40	86.88
Sylhet	98.91	98.22	97.66	96.29	96.14	95.45	94.89	95.05	90.09	88.20	88.84	85.04	84.03	84.96	84.36	84.12	83.48
Dhaka	68.82	63.79	59.33	51.74	50.89	49.61	49.17	48.37	36.07	38.23	38.32	34.24	33.92	31.07	30.80	30.45	27.27
Faridpur	76.03	67.63	59.12	54.79	54.28	40.01	45.07	41.40	29.19	45.73	44.96	40.64	39.26	39.50	39.15	41.61	39.13
Jamalpur	100.00	40.03	17.64	17.49	21.65	22.17	20.52	21.71	13.77	17.00	12.78	9.43	8.73	7.17	6.46	5.99	6.50
Kish'ganj	82.70	81.03	74.34	71.34	69.45	67.17	69.78	68.27	49.20	59.27	59.92	53.17	53.10	52.81	48.12	47.06	45.89
Mym'sing	36.22	49.36	37.75	24.60	18.52	21.06	20.81	18.65	10.02	15.98	13.76	12.43	12.17	11.64	10.64	9.62	11.10
Tangail	48.85	22.35	24.17	24.94	14.34	8.95	8.68	4.93	5.36	3.13	1.69	2.43	1.59	1.80	1.82	2.01	1.76
Barisal	100.00	99.99	99.98	99.98	99.95	99.83	99.89	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Jessore	52.48	37.96	36.15	36.28	29.15	29.54	43.00	29.18	14.60	19.71	17.30	14.44	8.76	9.44	8.50	8.68	7.88
Khulna	87.80	69.53	69.44	53.57	44.80	49.56	39.68	45.92	14.96	19.78	16.05	13.97	14.39	11.82	12.92	10.56	11.71
Kushtia	65.91	49.77	43.81	40.38	37.00	31.65	45.32	29.30	19.62	19.65	13.35	10.27	8.37	7.04	5.88	6.01	6.08
Patukhali	100.00	100.00	99.96	99.95	99.96	99.90	38.93	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Bogra	47.65	39.01	36.79	30.89	12.58	12.16	13.98	10.70	11.90	4.95	7.23	5.49	2.40	2.15	1.81	1.60	2.02
Dinajpur	46.24	42.83	36.62	34.06	27.03	25.67	18.77	23.97	15.43	19.17	19.62	12.93	10.35	9.36	7.72	4.89	5.81
Pabna	68.27	45.16	39.34	33.24	33.76	38.01	24.50	22.11	14.30	12.38	6.70	5.99	5.14	4.79	4.40	4.13	4.78
Rajshahi	72.80	62.43	46.08	46.95	51.03	51.17	13.94	36.07	12.64	23.42	22.05	21.35	21.12	18.18	14.24	12.18	14.93
Rangpur	60.32	57.16	53.57	45.59	36.05	29.52	35.66	14.15	12.26	9.69	9.69	7.82	6.72	6.00	5.38	4.47	5.15
Bangdes	**72.51**	**65.03**	**57.26**	**52.48**	**48.53**	**47.85**	**40.87**	**42.06**	**28.84**	**31.95**	**30.85**	**27.87**	**25.99**	**26.12**	**24.37**	**22.90**	**22.82**

Source: Author's calculation from BBS, Yearbook of Agricultural Statistics, and Statistical Yearbook of Bangladesh, various issues.

Table B.20: Irrigated Area as Percentage of Gross Cropped Area: Aus

Districts	**1979-80**	**1980-81**	**1981-82**	**1982-83**	**1983-84**	**1984-85**	**1985-86**	**1986-87**	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	**1992-93**	**1993-94**	**1994-95**	**1995-96**
Chittagong	0.00	8.09	5.98	5.10	0.33	0.41	0.56	3.05	0.65	9.48	3.39	2.66	0.52	0.45	0.30	0.36	0.41
Chitt. H.T	0.00	0.00	0.16	0.08	3.13	3.29	2.50	5.85	10.61	5.20	5.37	4.57	3.29	4.82	4.58	3.08	3.71
Comilla	0.21	2.14	0.18	0.32	0.56	1.07	3.06	4.42	9.68	5.87	5.64	2.74	6.16	4.19	3.96	4.06	3.25
Noakhali	0.00	5.72	0.03	1.21	0.16	0.20	0.18	0.10	0.00	0.00	0.03	0.02	0.03	0.04	0.07	0.06	0.02
Sylhet	0.00	0.00	0.00	0.00	3.67	4.57	5.32	2.96	0.69	1.72	1.35	1.46	1.92	1.65	3.61	1.39	1.83
Dhaka	4.78	4.35	4.36	3.14	2.40	3.22	3.33	1.57	1.90	1.70	2.24	3.06	4.02	3.51	3.34	3.45	3.57
Faridpur	0.00	0.00	1.31	1.36	0.37	0.88	0.43	0.41	0.77	0.70	0.74	0.35	0.38	0.35	0.19	0.11	0.11
Jamalpur	0.00	0.00	0.09	0.11	8.31	7.17	7.63	6.87	7.18	7.67	6.79	4.89	5.23	5.25	5.95	4.96	5.25
Kishoreganj	9.29	7.29	6.62	6.31	0.77	0.49	0.49	0.33	0.01	0.68	0.63	0.72	0.73	0.37	0.39	0.39	0.48
Mymensingh	0.00	0.00	0.00	2.16	1.56	3.26	4.75	3.43	0.91	2.02	1.79	1.73	0.78	1.64	1.60	1.45	2.00
Tangail	0.00	0.00	0.20	1.08	1.48	1.76	1.75	1.47	4.42	1.04	0.86	1.03	0.90	0.80	0.79	1.93	1.81
Barisal	15.27	17.12	16.10	15.18	17.41	16.30	15.69	13.67	6.89	8.48	10.93	12.30	14.52	17.48	3.49	6.74	4.44
Jessore	2.91	4.40	3.69	3.45	8.59	5.68	8.94	6.15	3.99	8.82	11.56	14.10	14.42	20.19	17.97	20.13	22.03
Khulna	10.07	5.96	12.96	15.22	2.88	2.88	2.31	2.50	1.21	1.32	0.70	0.97	0.88	0.69	0.81	0.89	1.30
Kushtia	11.25	9.74	14.03	14.26	15.85	18.91	20.87	19.63	8.56	14.83	19.00	20.25	21.41	22.65	18.22	15.23	20.38
Patuakhali	24.45	7.38	6.77	9.82	10.21	4.14	5.76	7.78	0.39	1.64	9.07	9.52	9.69	9.96	11.25	12.49	8.94
Bogra	0.43	1.35	1.82	1.90	3.21	2.44	3.29	5.63	16.89	6.24	6.94	8.97	30.48	15.91	28.55	43.50	35.90
Dinajpur	2.29	2.55	2.98	3.28	6.08	8.11	8.53	9.73	6.57	10.87	17.95	19.34	17.69	23.25	23.97	24.18	27.94
Pabna	0.32	1.17	3.57	0.72	0.62	0.67	0.82	1.21	1.49	1.12	1.41	1.30	1.37	1.91	2.31	2.40	2.99
Rajshahi	3.31	5.00	2.43	5.14	3.82	3.64	5.33	5.24	5.55	5.67	7.27	6.33	7.60	8.79	15.14	20.92	22.58
Rangpur	0.48	1.48	2.43	3.80	4.38	4.57	6.28	8.63	8.55	13.11	14.34	12.44	20.85	26.15	27.84	30.49	31.74
Bangladesh	**3.01**	**3.85**	**3.59**	**3.97**	**4.62**	**4.79**	**5.71**	**5.65**	**4.27**	**5.38**	**6.25**	**6.52**	**7.94**	**8.14**	**7.70**	**7.41**	**7.32**

Source: Author's calculation from BBS, Yearbook of Agricultural Statistics, and Statistical Yearbook of Bangladesh, various issues.

Table B.21: Irrigated Area as Percentage of Gross Cropped Area: Aman

Districts	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96
Chitagon	0.00	4.25	6.43	8.24	3.14	8.48	18.80	14.43	0.02	5.03	0.64	0.74	0.22	0.02	0.03	0.03	0.04
Chitt H.T	0.00	0.00	3.77	1.98	6.51	39.77	47.32	62.23	3.30	5.76	5.27	4.11	4.07	5.77	7.35	3.93	5.06
Comilla	1.52	1.21	2.76	1.95	0.46	1.08	1.07	2.30	1.61	2.22	1.46	1.45	1.18	1.04	0.81	0.74	0.77
Noakhali	0.00	1.18	0.08	1.28	0.22	0.38	0.34	0.37	1.11	0.00	0.22	0.08	0.07	0.07	0.06	0.07	0.06
Sylhet	0.00	0.00	0.00	0.00	1.57	2.11	2.42	2.04	0.59	1.57	1.27	0.98	1.42	1.33	3.75	2.36	2.04
Dhaka	1.90	1.30	2.15	2.16	2.03	5.05	5.80	4.36	4.42	5.97	5.71	5.64	5.43	4.22	4.78	3.94	4.36
Faridpur	0.08	0.41	1.55	0.63	0.07	0.64	0.60	0.61	0.73	1.44	5.14	4.61	4.52	3.08	5.22	4.24	4.91
Jamalpur	1.24	1.27	1.73	1.94	2.44	3.65	4.07	3.05	2.60	3.73	3.36	2.41	3.12	3.42	2.71	4.03	1.80
Kishganj	4.30	8.15	9.69	9.71	0.96	1.23	1.20	0.25	0.49	0.33	0.14	0.35	0.37	0.37	0.42	0.41	0.36
Mymsing	1.25	1.28	1.39	3.31	3.27	4.84	6.34	6.13	0.41	1.45	1.11	1.86	1.48	1.36	1.23	1.54	1.23
Tangail	1.26	0.34	3.87	1.98	1.36	2.21	3.74	3.71	4.15	13.25	2.76	2.34	3.41	2.04	2.18	3.01	4.42
Barisal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.86	1.47
Jessore	4.95	3.43	7.21	6.93	8.57	14.26	19.49	17.90	10.11	21.37	20.61	19.46	18.59	17.32	18.86	20.02	19.32
Khulna	0.10	0.44	0.90	1.44	0.44	0.20	0.17	0.26	0.00	0.13	0.11	0.07	0.05	0.06	0.06	0.04	0.04
Kushtia	54.23	15.79	33.98	35.77	42.91	81.03	59.37	71.08	25.67	37.55	36.13	37.63	41.42	45.41	48.67	48.11	48.67
Patuakali	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.07	0.06	0.08	0.06	0.07
Bogra	2.37	2.95	3.93	3.63	2.27	1.30	1.70	2.15	0.73	1.41	1.02	0.87	5.75	6.40	6.94	10.01	7.12
Dinajpur	2.38	2.87	3.11	3.21	2.32	0.75	1.01	1.41	1.22	1.34	1.34	2.01	2.53	2.68	3.10	13.48	6.54
Pabna	1.53	1.77	5.76	4.16	3.51	2.46	2.59	4.34	7.50	6.75	7.51	6.17	10.76	8.94	12.52	13.66	13.63
Rajshahi	4.16	3.08	4.44	6.86	7.25	6.76	6.85	9.75	12.60	17.21	12.54	11.23	11.61	18.91	10.58	17.39	14.75
Rangpur	3.55	2.20	2.90	2.53	2.58	4.63	3.22	2.22	3.15	1.55	1.17	1.79	1.64	2.01	2.17	2.94	2.61
Bangdes	**2.12**	**1.85**	**3.07**	**3.24**	**2.64**	**3.37**	**3.91**	**3.96**	**2.86**	**4.14**	**3.76**	**3.69**	**4.15**	**4.61**	**4.57**	**5.82**	**5.23**

Source: Author's calculation from BBS, Yearbook of Agricultural Statistics, and Statistical Yearbook of Bangladesh, various issues.

Table B.22: Irrigated Area as Percentage of Gross Cropped Area: Boro

Districts	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96
Chittagong	100.00	97.18	94.78	88.56	93.66	82.91	80.38	94.69	73.42	89.37	99.65	89.07	87.73	89.53	97.58	94.44	94.61
Chitt. H.T	99.12	100.00	98.59	90.09	63.93	67.28	73.44	70.01	79.62	98.94	98.47	99.10	92.84	99.15	86.76	89.07	93.80
Comilla	90.29	84.48	84.55	87.55	80.23	100.00	98.87	99.78	72.01	67.32	73.55	79.32	85.20	90.67	94.79	93.31	92.53
Noakhali	100.00	99.69	96.67	74.02	70.65	48.66	45.48	42.04	53.91	40.42	42.58	42.23	42.92	58.58	59.51	64.39	63.30
Sylhet	81.40	80.24	83.18	77.78	70.97	63.05	64.56	68.76	71.72	64.31	69.74	66.73	69.68	75.85	66.34	70.77	75.66
Dhaka	78.19	80.01	73.21	70.59	95.64	100.00	99.55	97.36	96.13	69.42	70.61	71.10	74.46	77.18	79.20	88.91	93.64
Faridpur	87.97	75.87	39.21	35.72	66.81	53.04	63.19	55.82	48.68	54.00	82.56	78.30	82.95	99.97	98.46	98.00	98.40
Jamalpur	87.76	82.04	75.86	72.93	88.31	92.49	98.98	93.70	78.65	80.53	91.62	95.31	98.70	97.15	99.96	96.68	96.30
Kishorganj	75.80	80.25	80.09	79.14	99.96	81.70	90.82	94.16	89.68	78.41	77.81	77.53	75.35	77.75	75.45	76.58	76.25
Mymensing	100.00	97.15	78.34	82.25	92.82	92.55	98.73	85.56	74.36	90.43	91.96	84.86	98.13	95.57	96.81	95.89	92.48
Tangail	95.73	84.17	65.49	94.05	98.74	96.70	99.11	93.85	92.89	93.92	94.16	98.80	98.87	99.74	96.87	99.85	99.62
Barisal	99.07	98.48	98.44	72.78	74.47	55.31	43.11	47.60	58.24	41.89	60.24	59.04	66.71	83.33	96.57	81.64	91.12
Jessore	100.00	59.65	51.91	64.36	69.98	51.86	95.67	84.90	85.34	66.02	79.59	92.47	97.47	86.05	92.67	92.15	89.78
Khulna	100.00	98.48	99.86	100.00	97.92	99.66	63.74	80.71	99.29	82.14	82.93	89.06	84.11	75.70	83.63	90.53	93.22
Kushtia	100.00	99.81	54.37	81.56	68.85	68.98	86.34	93.44	78.37	55.88	56.86	61.61	73.88	77.90	91.46	91.45	86.43
Patuakhali	78.08	59.15	59.77	75.96	61.64	38.11	9.89	29.73	7.61	21.07	45.78	39.80	34.74	28.74	16.00	11.56	7.36
Bogra	91.82	99.25	86.31	71.53	99.45	100.00	94.04	89.05	81.11	87.27	92.41	94.91	94.36	97.59	97.07	97.89	97.06
Dinajpur	87.83	90.88	79.04	69.17	84.28	100.00	71.87	68.28	72.36	59.23	70.73	84.45	74.44	93.75	78.21	83.62	92.20
Pabna	100.00	97.56	45.30	92.03	70.52	91.64	91.12	82.88	58.99	91.82	94.78	99.54	96.63	97.84	93.81	94.02	94.22
Rajshahi	100.00	97.81	76.63	84.04	92.16	99.96	82.78	89.82	96.03	99.92	86.45	97.36	99.13	93.00	91.57	91.26	91.70
Rangpur	87.78	93.88	92.78	79.67	86.59	100.00	79.36	74.90	72.53	81.34	86.41	88.32	98.56	93.72	94.97	89.41	94.53
Banglades	**87.61**	**86.06**	**79.82**	**78.95**	**85.47**	**81.61**	**82.09**	**82.51**	**77.79**	**74.63**	**79.55**	**81.03**	**83.50**	**86.68**	**86.35**	**87.50**	**88.94**

Source: Author's calculation from BBS, Yearbook of Agricultural Statistics, and Statistical Yearbook of Bangladesh, various issues.

Table B.23: Irrigated Area as Percentage of Gross Cropped Area: Wheat

Districts	**1979-80**	**1980-81**	**1981-82**	**1982-83**	**1983-84**	**1984-85**	**1985-86**	**1986-87**	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	**1992-93**	**1993-94**	**1994-95**	**1995-96**
Chittagong	0.00	99.15	24.07	31.31	30.00	23.08	71.74	18.95	82.96		87.50		65.22	87.69	91.67	73.21	93.06
Chitt. H.T	60.00	45.24	100.00		27.50	54.55	46.43	7.14	17.65			0.00	36.36	8.00	3.33	1.33	0.00
Comilla	29.60	21.39	21.22	24.73	25.02	31.09	35.40	28.53	17.90	31.00	27.14	29.41	28.48	17.41	19.34	19.35	17.20
Noakhali	49.15	40.52	60.29	64.04	99.77	38.32	57.05	49.61	32.68	88.52	20.78	65.43	48.15	23.75	16.31	13.26	52.20
Sylhet	0.00	0.00	0.00	0.00	18.45	25.36	7.86	20.43	18.50	33.25	25.61	92.31	11.85	11.72	11.03	8.69	17.83
Dhaka	38.72	18.81	16.56	15.61	12.94	12.43	14.48	18.26	4.82	7.39	14.33	15.70	16.06	11.33	11.43	10.02	9.38
Faridpur	21.26	18.81	14.69	13.47	9.96	15.34	22.56	29.20	33.09	27.13	24.09	29.81	31.44	26.72	28.83	30.36	25.89
Jamalpur	40.84	32.36	28.58	21.91	47.24	34.28	42.25	24.36	29.53	24.25	26.93	27.76	28.58	25.86	29.05	38.96	55.80
Kishorganj	6.44	22.84	19.03	20.48	34.92	36.06	28.88	25.16	33.24	29.84	27.06	26.52	26.65	21.55	21.01	22.79	19.83
Mymensing	53.64	46.83	42.01	36.46	35.96	35.11	27.66	32.61	33.14	36.03	40.06	30.13	24.71	12.07	16.50	20.88	19.75
Tangail	5.72	3.24	12.98	1.46	25.27	29.14	33.51	21.77	17.14	17.58	11.07	20.01	17.77	17.03	16.39	17.89	16.91
Barisal	100.00	79.71	87.74	89.25	100.00	70.72	66.63	69.04	14.06	20.09	17.88	31.47	46.28	35.81	8.18	7.94	5.77
Jessore	34.80	27.37	21.75	42.62	73.88	59.06	77.00	56.56	48.23	68.15	53.45	44.17	37.86	36.99	37.48	34.07	32.36
Khulna	59.45	47.93	24.66	100.00	77.71	60.67	38.31	34.13	46.21	65.75	82.60	47.68	31.87	41.04	29.83	33.30	35.79
Kushtia	100.00	75.35	70.85	93.64	79.72	82.99	92.37	93.04	36.10	94.86	87.86	86.53	77.08	77.31	88.90	86.83	78.61
Patuakhali	100.00	51.43	80.00	33.33	100.00	100.00	75.71	95.00	0.00	0.00	13.79	0.00	2.63	0.26	0.08	0.00	0.00
Bogra	100.00	71.48	91.37	95.61	85.35	57.59	88.90	80.78	80.83	75.14	78.97	70.94	78.81	95.04	89.42	8.97	83.64
Dinajpur	49.28	22.43	25.26	33.66	29.20	49.76	64.84	51.73	34.40	60.22	48.72	46.19	50.11	48.40	53.56	59.04	62.29
Pabna	12.68	9.53	16.97	15.77	34.81	24.62	29.99	23.35	15.97	14.64	12.76	6.82	13.13	13.91	14.06	12.97	10.53
Rajshahi	32.78	52.04	73.55	59.24	38.34	41.90	52.19	65.04	48.03	78.95	74.30	66.48	60.47	75.11	73.48	71.40	63.85
Rangpur	29.28	29.90	37.35	31.99	42.90	50.80	68.72	57.04	28.09	49.53	91.07	99.97	89.49	78.06	79.74	77.33	74.71
Banglades	**39.82**	**32.95**	**35.50**	**39.17**	**40.76**	**41.89**	**49.41**	**45.39**	**30.96**	**46.43**	**46.85**	**47.16**	**44.56**	**42.74**	**44.17**	**36.04**	**42.85**

Source: Author's calculation from BBS, Yearbook of Agricultural Statistics, and Statistical Yearbook of Bangladesh, various issues.

Table B.24: Irrigated Area as Percentage of Gross Cropped Area: Potato

Districts	**1979-80**	**1980-81**	**1981-82**	**1982-83**	**1983-84**	**1984-85**	**1985-86**	**1986-87**	**1987-88**	**1988-89**	**1989-90**	**1990-91**	**1991-92**	**1992-93**	**1993-94**	**1994-95**	**1995-96**
Chittagong	98.58	99.15	93.27	93.27	96.32	99.80	95.77	95.33	95.45	96.00	92.66	93.23	89.90	87.05	87.23	92.13	95.85
Chitt. H.T	31.88	50.60	56.11	72.00	54.75	39.54	45.29	56.93	45.82	97.10	59.13	62.01	71.14	74.85	79.04	81.78	84.77
Comilla	97.91	80.55	78.23	86.58	52.21	54.75	75.81	75.17	28.85	65.27	64.84	61.87	59.51	64.14	72.39	79.32	77.16
Noakhali	100.00	98.99	85.10	85.12	99.39	96.45	90.84	68.48	10.55	64.60	48.27	72.99	71.21	69.14	67.51	56.22	74.46
Sylhet	73.34	60.17	61.35	76.08	69.84	49.14	46.93	60.62	29.81	55.66	58.47	60.76	57.53	57.71	61.13	65.78	70.12
Dhaka	65.33	66.88	66.57	68.44	60.63	38.68	32.98	48.51	1.71	63.23	63.47	56.62	41.83	33.55	36.57	34.99	37.68
Faridpur	0.00	0.00	44.51	0.00	18.82	16.99	24.04	21.27	80.81	24.46	14.77	13.10	21.57	33.71	58.29	92.22	91.79
Jamalpur	73.26	71.23	66.95	66.80	44.62	45.17	60.15	64.56	44.38	81.00	78.39	75.64	39.71	55.39	66.94	71.21	59.36
Kishorganj	4.33	45.57	42.09	40.69	2.76	5.24	3.93	14.29	12.08	24.76	11.69	13.52	8.45	13.68	36.48	38.99	39.24
Mymensing	45.05	51.55	56.05	12.99	21.50	27.73	31.30	37.91	6.43	37.42	33.81	25.40	13.92	10.56	11.21	11.72	12.88
Tangail	0.00	8.11	7.98	13.15	21.20	21.32	26.86	15.71	6.51	8.72	4.96	5.63	5.58	5.25	6.76	7.52	6.36
Barisal	87.38	99.81	88.41	85.07	85.30	89.14	87.86	98.33	94.20	99.13	94.69	92.57	89.82	93.19	39.29	65.17	44.63
Jessore	56.28	81.89	71.04	79.88	100.00	81.76	83.89	75.74	87.42	91.27	92.39	97.15	98.35	99.90	99.49	98.82	96.76
Khulna	9.34	63.56	83.28	77.72	70.36	71.64	68.65	78.74	87.40	89.94	97.54	95.50	90.90	86.88	92.49	82.46	85.16
Kushtia	48.63	78.44	70.85	61.10	77.21	89.45	78.78	91.27	96.62	99.97	96.28	95.94	97.11	95.59	97.29	98.49	99.76
Patuakhali	100.00	100.00	78.67	29.35	23.96	40.74	30.59	68.67	12.79	5.19	20.45	56.91	32.68	38.99	58.85	72.95	77.12
Bogra	98.78	92.63	95.16	92.97	96.18	97.04	97.36	99.37	89.13	89.71	86.41	83.73	89.45	90.33	95.27	92.90	87.68
Dinajpur	69.12	73.92	76.47	83.90	60.24	69.63	58.46	56.39	44.58	72.23	61.61	55.84	51.64	51.26	46.92	51.01	54.53
Pabna	23.81	26.64	20.00	15.46	15.09	39.39	44.69	33.40	8.05	3.46	12.84	12.74	96.45	16.05	21.41	24.01	23.43
Rajshahi	84.32	96.93	74.04	57.22	92.70	95.39	97.46	87.02	55.57	72.85	77.60	80.28	79.81	92.25	94.90	93.36	99.33
Rangpur	38.31	51.17	83.87	82.29	83.73	91.64	66.14	54.54	40.62	83.12	74.09	92.08	95.60	91.86	97.19	96.59	97.48
Banglades	**64.93**	**69.89**	**71.41**	**70.47**	**63.95**	**61.99**	**62.13**	**63.94**	**37.42**	**66.04**	**64.46**	**63.62**	**63.15**	**60.51**	**63.81**	**66.45**	**67.65**

Source: Author's calculation from BBS, Yearbook of Agricultural Statistics, and Statistical Yearbook of Bangladesh, various issues.

Appendix C

A Note on the Aggregate Profitability of the Crop Sector

An understanding of the incentive structure for sustained growth of agriculture is required for policy formulation. The profitability of individual crop reveals comparative dynamics within the crop sector only; it does not provide comparative advantage of the agriculture sector over the other sectors of the economy. The aggregate financial profitability of the crop sector as a whole is required to assess the latter comparative dynamics.

It would have been ideal if all the crops produced in the country could be considered in the profitability analysis. This was not possible due to lack of relevant information. We considered around three dozens of crops for estimating aggregate financial profitability of the crop sector during pre- and post-SAP periods. These crops, however, account for more than 96 per cent of the gross cropped area in Bangladesh.

Information on all crops was not available for both the periods. While Zohir (1993) provided information on the physical input-output structures of most crops for 1990-91, they were not readily available for the pre-SAP period. Various studies by the Agro-Economic Research Unit of the Ministry of Agriculture and the International Fertilizer Development Center, Dhaka, provided information on some of the major crops for the latter period (see Table A1).

It was relatively easy to estimate aggregate profitability of the crop sector for the post-SAP period. Since we wanted to include all the crops in order to ensure some degree of robustness of the aggregate profitability estimate, it was assumed that the input-output structures for the minor crops remained unchanged – that is, the pre-SAP input-output structure was same as that observed during the post-SAP period. It may be noted that changes in technology and market environment during the 1980s affected primarily the major crops. This was particularly so due to the fact that most of these (minor) crops

were subsistence crops. The cash costs (such as, irrigation) incurred in producing these crops, as observed during the post-SAP period were adjusted using appropriate deflators to make them relevant for use for the pre-SAP analysis.

Two different sets of prices for inputs and outputs were used in the calculation of financial profitability before the SAP. In most cases, the pre-SAP prices published by the BBS, were used. For some inputs and by-products, BBS did not quote prices. In such cases the prices of Zohir (1993) were deflated appropriately.

The aggregate financial profitability of the crop sector is expressed per unit of land (hectare) and is the weighted average of crop-specific profit (per unit of land), where the weights are the shares (proportions) of the respective crops in the gross cropped area. The pre-SAP aggregate profitability was analyzed using both before and after SAP prices. The initial exercise used average shares of crops during 1980-81 to 1982-83 as proxy for pre-SAP scenario, and averages during 1990-91 to 1992-93 for the post-SAP period. With the publication of the 1996 Agriculture Census, we have used information from 1983-84 and 1996 census to arrive at crop-specific land allocation. The percentage shares are shown in Table A2.

Table A1: Availability of Input-output Coefficients of the Crops

Before SAP	After SAP			
L. Aus	L.Aus	Maize		Moong
M Aus	M.Aus	Cotton	Raw Turmeric	Brinjal
B Aman	B.Aman	Tobacco	Green & Dry Chili	Pumpkin
L T Aman	LT.Aman	Sugarcane/Gur	Ginger	Radish
M Aman	M.Aman	Local Potato	Corriander Seed	Cucumber
L Boro	L.Boro	Modern Potato	Garlic	Barbati
M Boro	M.Boro	Sweet Potato	Onion	Tomato
Local Wheat	L.Wheat	Rape & Mustard	Masur	C.flower
Modern Wheat	M.Wheat	Til	Gram	Cabbage
Jute (Capsularis)	Jute (Capsularis)	Linseed	Khesari	L. Finger
Jute (Olitorious)	Jute (Olitorius)	Ground Nut	Mashkalai	Arum

TableA.2: Land Allocation by Crop, Before and After SAP

Crop / Crop Group	Agriculture Census 1983-84				Agriculture Census 1996			
	Small	Medium	Large	Total	Small	Medium	Large	Total
MAJOR CEREALS								
AUS								
Broadcast Aus	74.63	77.96	79.59	77.23	48.26	53.16	53.06	51.01
Local Transplanted Aus	11.28	10.63	10.47	10.81	24.97	25.00	25.67	25.08
HYV Aus	12.45	10.04	8.65	10.53	24.61	19.69	18.50	21.67
Pajam Aus	1.64	1.36	1.29	1.44	2.16	2.15	2.77	2.24
TOTAL AUS	33.05	31.74	27.45	31.13	19.37	18.79	15.57	18.51
AMAN								
Broadcast Aman	28.73	27.58	26.33	27.59	16.27	16.66	14.71	16.17
Loacal Transplanted Aman	54.03	59.48	63.74	59.03	37.57	41.80	47.11	41.07
HYV Broasdcast Aman	0.62	0.49	0.44	0.51	2.36	1.99	1.95	2.13
HYV Transplanted Aman	7.75	6.49	5.73	6.65	37.89	33.99	31.18	35.03
Pajam Aman	8.87	5.96	3.76	6.22	5.92	5.56	5.06	5.61
TOTAL AMAN	44.84	48.90	52.32	48.48	44.43	48.31	50.54	47.06
BORO								
Local Boro	23.68	31.62	42.72	31.87	15.79	18.93	23.75	18.41
HYV Boro	69.78	61.29	49.85	61.14	81.03	77.70	72.83	78.29
Pajam Boro	6.54	7.08	7.43	7.00	3.18	3.37	3.42	3.30
TOTAL BORO	13.43	11.80	13.60	12.71	28.09	26.24	28.53	27.38
WHEAT								
Local Wheat	49.24	45.45	42.24	46.19	34.85	32.40	30.72	33.38
HYV Wheat	50.76	54.55	57.76	53.81	65.15	67.60	69.28	66.62
TOTAL WHEAT	6.37	5.19	4.40	5.36	7.91	6.35	5.09	6.79
MINOR CEREALS								
Italian Millet	65.68	60.93	58.81	61.88	47.61	43.11	46.68	45.19
Common Millet	15.12	15.63	16.02	15.57	12.70	9.62	12.51	11.12
Pearl Millet	0.49	0.57	0.70	0.57	2.77	1.97	3.29	2.46
Great Millet	0.83	0.81	0.83	0.82	5.60	3.61	4.08	4.34
Oat	13.79	16.46	17.63	15.92	7.03	10.34	6.49	8.60
Maize	1.55	2.67	2.45	2.29	9.95	21.17	14.07	16.28
Barley	0.32	0.41	0.48	0.40	2.72	2.02	2.26	2.29
Other Minor Cereals	2.22	2.52	3.09	2.56	11.62	8.15	10.61	9.71
TOTAL MINOR CEREALS	2.31	2.37	2.23	2.32	0.20	0.31	0.26	0.26
TOTAL CEREALS	75.36	75.92	76.66	75.92	77.66	78.14	80.54	78.32
PULSES								
Chickling Vetch	35.90	33.86	32.31	34.01	42.30	43.28	42.52	42.80
Lentil	29.00	28.32	26.26	27.98	34.59	30.23	27.21	31.22
Gram	12.32	14.13	14.32	13.69	2.72	3.42	3.34	3.16
Black Gram	8.50	10.27	12.34	10.32	5.03	5.46	5.71	5.36
Green Gram	6.41	6.37	7.60	6.70	13.36	15.40	18.48	15.23
Pea	3.11	2.80	2.58	2.83	0.73	0.84	0.93	0.82
Pigeon Pea	0.63	0.87	1.04	0.85	0.11	0.12	0.08	0.11
Gari kalai	0.99	1.18	1.33	1.17	0.22	0.19	0.21	0.21
Other Pulses	3.15	2.21	2.21	2.46	0.94	1.06	1.52	1.10
TOTAL PULSES	5.78	6.75	7.19	6.56	3.88	5.15	5.23	4.63

Crop / Crop Group	Agriculture Census 1983-84				Agriculture Census 1996			
	Small	Medium	Large	Total	Small	Medium	Large	Total
OIL SEEDS								
Rape & Mustard	66.59	61.27	58.67	62.17	88.25	79.76	74.96	82.74
Sesame	16.18	18.41	19.15	17.95	4.64	9.49	10.54	7.54
Linseed	11.10	14.27	14.80	13.49	0.59	1.12	1.53	0.95
Ground Nut	5.48	5.46	6.67	5.76	5.95	9.06	12.30	8.19
Soyabean	0.29	0.29	0.33	0.30	0.30	0.28	0.46	0.31
Sunflower	0.15	0.11	0.13	0.13	0.15	0.16	0.15	0.16
Castor	0.08	0.08	0.07	0.07	0.05	0.05	0.01	0.04
Other Oil Seeds	0.14	0.12	0.17	0.14	0.06	0.07	0.05	0.06
TOTAL OIL SEEDS	4.16	4.50	4.60	4.42	4.28	4.12	3.82	4.14
CASH CROPS								
Jute	76.69	73.35	67.75	73.09	75.21	70.99	64.78	71.98
Sugarcane	12.70	16.49	21.77	16.55	14.49	19.23	27.23	18.25
Tobacco	7.40	5.83	5.24	6.16	9.15	7.24	6.07	7.91
Mesta	1.21	1.53	1.77	1.49	0.24	0.28	0.18	0.25
Cotton	1.02	1.86	2.08	1.66	0.61	1.96	1.31	1.28
Sunhemp	0.42	0.52	0.70	0.53	0.09	0.12	0.21	0.12
Other Cash Crops	0.57	0.42	0.69	0.53	0.22	0.19	0.23	0.21
TOTAL CASH CROPS	7.22	7.57	7.15	7.36	6.56	6.35	5.46	6.30
VEGETABLES								
Potato	27.19	31.95	31.13	29.78	59.71	55.41	57.61	57.81
Sweet Potato	12.54	13.48	13.75	13.12	2.33	2.78	3.36	2.62
Brinjal	9.47	10.34	10.55	10.00	16.19	16.04	15.68	16.08
Water Gourd	6.31	3.39	2.41	4.49	1.78	1.24	0.99	1.48
Beans	5.32	2.53	1.67	3.59	2.53	1.51	1.24	1.99
Amaranta (Danta Shak)	4.74	2.40	1.97	3.34	0.33	0.21	0.24	0.27
Arum	4.32	5.04	5.81	4.85	1.43	2.06	2.46	1.79
Radish	3.64	3.77	3.91	3.74	1.54	1.41	1.72	1.51
Pumpkin	3.04	3.31	4.02	3.31	1.07	1.83	1.87	1.45
Tomato	2.54	2.19	2.03	2.31	1.69	1.77	1.40	1.69
Bitter Gourd	2.50	2.55	2.39	2.50	1.28	1.48	1.22	1.35
White Gourd	2.44	2.04	1.90	2.19	0.38	0.89	0.51	0.59
Lal Shak/Palong Shak	1.94	1.13	1.16	1.48	0.96	0.70	0.73	0.83
Ribbed Gourd	1.86	1.34	1.16	1.53	0.27	0.53	0.29	0.37
Patal	1.84	3.01	3.70	2.62	1.63	2.05	2.40	1.88
Cucumber	1.65	1.84	1.94	1.77	0.90	2.53	1.96	1.65
Water Melon	1.37	1.86	2.02	1.68	1.32	1.81	1.76	1.56
Lady's Finger	1.20	1.20	1.39	1.23	0.36	0.75	0.38	0.51
Cauliflower	0.99	0.88	0.86	0.92	1.20	0.96	0.96	1.08
Indian Spinach (Puin Shak)	0.93	0.60	0.62	0.74	0.35	0.72	0.36	0.49
Long Beans	0.87	1.24	1.14	1.06	0.36	0.72	0.42	0.51
Melon	0.70	0.92	1.03	0.85	0.22	0.48	0.41	0.34
Cabbage	0.55	0.71	0.93	0.68	0.49	0.47	0.55	0.49
Kakrol	0.37	0.49	0.33	0.41	0.75	0.66	0.54	0.69
Knolkkhol (Wolkopy)	0.25	0.29	0.38	0.29	0.30	0.28	0.37	0.30
Turnip	0.09	0.08	0.07	0.08	0.05	0.05	0.09	0.06
Carrot	0.04	0.04	0.04	0.04	0.12	0.09	0.05	0.10
Others Vegetables	1.31	1.39	1.68	1.40	0.47	0.58	0.44	0.51
TOTAL VEGETABLES	4.81	3.01	2.35	3.40	4.23	3.27	2.50	3.55

Crop / Crop Group	Agriculture Census 1983-84				Agriculture Census 1996			
	Small	Medium	Large	Total	Small	Medium	Large	Total
SPICES								
Chillies	58.82	49.36	44.73	51.81	53.37	47.63	45.60	50.03
Onion	19.80	25.26	25.56	23.38	29.75	31.70	30.54	30.65
Turmaric	7.58	7.87	9.15	8.02	2.28	3.27	4.16	2.93
Garlic	7.48	9.74	11.27	9.24	11.39	12.54	14.19	12.22
Coriander Seed	3.15	3.89	4.92	3.83	1.55	1.89	2.33	1.78
Ginger	1.91	2.36	2.61	2.25	0.69	1.77	1.80	1.27
Back Cumin seed (kala zira)	0.50	0.63	0.78	0.61	0.10	0.17	0.33	0.16
Ani Seed (mauri)	0.34	0.44	0.48	0.41	0.15	0.19	0.36	0.19
Other Spices	0.41	0.44	0.50	0.44	0.73	0.84	0.69	0.77
TOTAL SPICES	2.60	2.14	1.89	2.22	3.36	2.94	2.43	3.04
Fodder	0.05	0.09	0.13	0.09	0.01	0.01	0.01	0.01
Dhaincha	0.02	0.02	0.04	0.03	0.01	0.01	0.01	0.01
Gross Cropped Area	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Cropping Intensity	187.00	171.00	153.00	171.00	187.00	171.00	154.00	174.00

Appendix D

Equations and Variables for SUR Estimation in Ahmed (2000)

The following equations were included,

$FC_t = (PFR_t/PR_t, AGR_t, NAR_t, CDS_t/P_t, D)$

$(PFR_t/PR_t) = f(PFD_t/PR_t, HYV, PFM_t/PR_t, D)$

$AGR_t = f(PD_t/PR_t, Eg_{t-1}/P_{t-1}, CDL_{t-1}/P_{t-1})$

$DAR_t = f(AGR_t, PR_t/PO_t, D)$

$QR_t = f(FC_t, AGR_t, DAR_t, D)$

The algebraic symbols are defined as,
FC_t = consumption of fertilizers (urea, triple superphosphate and murate of potash) in year *t* (measured in thousands of tons),
PFR_t, PFD_t, PFM_t = respectively, retail, domestic factory-gate, and border prices of fertilizer in year *t*, measured in taka per ton (with prices being weighted averages of three types of fertilizers),
PR_t = wholesale price of rice in year *t* (taka per ton),
AGR_t = total irrigated area of rice in year *t* (thousands of acres),
NAR_t = other crop area in year *t* (thousands of acres),
CDS_t = short-term crop loan advanced to farmers from banking institutions and public agencies in year *t* (10 million taka),
P_t = general price index,
PD_t = price of diesel fuel in year *t* (taka per ton),
Eg_{t-1} = public expenditure on water control and irrigation development in year *t-1* (10 million taka),
CDL_{t-1} = long-term loan to farmers from banks and public agencies in year *t-1* (10 million taka),
DAR_t = dry land rice area in year *t* (thousands of acres),
HYV = area planted in high-yielding varieties of rice (thousands of acres),
PO_t = price of mustard oil seeds (taka per ton) as proxy for crop prices other than rice,
QR_t = production of rice,
D/D_1 = dummy variable that takes a value 0 for 1975-76 to 1988-89 (1987-88 in our case), and 1 for 1989-90 (1988-89 in our case) to 1996-97,
D_2 = dummy variable that takes a value 0 for 1975-76 to 1991-92, and 1 for 1992-93 to 1996-97.

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