IRRIGATION SYSTEMS AND THEIR IMPACT ON AGRICULTURAL SECTOR IN WEST BENGAL: A DISTRICT LEVEL ANALYSIS

Dissertation Submitted to Jawaharlal Nehru University
in Partial Fulfillment of the Requirement for
the Award of the Degree of

MASTER OF PHILOSOPHY

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2005

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CERTIFICATE

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This Dissertation is Dedicated to

My Reverent Parents and Dear Runa.

Acknowledgement

I am deeply indebted to my supervisor ***Dr. Sucharita Sen,*** *whose valuable guidance, support, suggestions and constant encouragement at all stages of my work were indispensable for the completion of my dissertation.*

I am extremely grateful to Associate Prof. Vikas Rawal for giving me valuable suggestions at the crucial stage of my work. I would also like to mention my teacher at Jamia Millia Islamia, Dr. Atiqur Rahman, who motivated me to come to this stage of academic life.

A number of institutions have provided useful assistance in the collection of secondary data. I am specially thankful to the officials of State Water Investigation Directorate (SWID), Government of West Bengal, Kolkata; Evaluation Wing, Directorate of Agriculture, Government of West Bengal, Kolkata; Irrigation and Waterways Department, Government of West Bengal, Kolkata; West Bengal Secretariat Library, Writers Building, Kolkata; Economics and Statistics, Krishi Bhavan, New Delhi; Central Statistical Organization, New Delhi; Ministry of Water Resources, Minor Irrigation Division, Government of India, Shastri Bhavan, New Delhi for providing me available data related to my research topic. Special mention must be made of Dr. Saswati Banerjee and Tapon Roy, who helped me to get all the minor irrigation data from SWID, Kolkata.

I am also grateful to some of my friends, namely ***Anjan, Animesh,*** *Sridhar, Saikat, Biplab and Ashis, who were instrumental to complete my dissertation.*

Without the presence of ***My Parents****, who are the source of my life, dreams and constant inspiration, the dissertation would not have been probably completed.*

28.07.2005 Animesh Roy

Animesh Roy.

Contents

		Page No.
I	List of Tables	i-iii
II	List of Figures	iv
III	List of Maps	iv
	Chapter-I Introduction	1-15
1.1	Statement of the Problems	1-3
1.2	Review of Literature	3-10
1.3	Objectives	10
1.4	Hypotheses	11
1.5	Database	11-12
1.6	Methodology	12-13
1.7	Framework of Analysis	13-14
1.8	Chapter Scheme	14-15
	Chapter-II Growth and Development of Irrigation in West Bengal	16-42
2.1	Introduction	16-17
2.2	Data and Concepts: Inconsistencies in Existing Sources	17-22
	2.2.1 Report on Minor Irrigation Census	18-19
	2.2.2 Statistical Abstract of West Bengal	19
	2.2.3 District Statistical Hand-book	19-20
	2.2.4 Mismatches between District Statistical Hand-book and Report on Minor Irrigation Census	20-22
2.3	Structure of Irrigation Systems	22-23
2.4	Growth and Development of Irrigation	23-38
	2.4.1 Canal Irrigation	25-28
	2.4.2 Dug well Irrigation	28-29
	2.4.3 Tubewell Irrigation	29-32
	2.4.4 Surface Minor Irrigation	32-34

2.4.5 Growth Trend of Gross Irrigated Area by All Sources Across Districts 34-38
2.5 Disparity in Irrigation Development across Districts 38-40
2.6 Conclusion 40-42

Chapter-III Irrigation Systems and Changes in Trends of Area, Yield and Production of Major Crops **Page No.** 43-69

3.1 Introduction 43-44
3.2 Inter District Variations in Area under Major Crops or Crop Groups 45-55
3.3 Level of crop Diversification across Districts in west Bengal 56-58
3.4 Growth in Yield of Major Crops across Districts in West Bengal 58-59
3.5 Growth rates of Area, Yield and Production 59-66
3.6 Conclusion 67-69

Chapter-IV Crop returns and Cost Of Production: An Analysis across Irrigation Systems 70-97

4.1 Introduction 70-72
4.2 Farm size and Input Use 72-79
4.2.1 Aman Local Rice 73
4.2.2 Aman HYV rice 73-77
4.2.3 Boro Rice 77-79
4.3 Structure of Input Use across Districts in West Bengal 79-87
4.3.1 Aman Local Rice 80
4.3.2 Aman HYV rice 80-84
4.3.3 Boro Rice 84-87
4.4 Income-Cost Ratio of Major Crops across Districts in West Bengal 87-91
4.4.1 Aman Local Rice 87-89
4.4.2 Aman HYV rice 89-90
4.4.3 Boro Rice 90-91
4.5 Net Income across Major Crops in West Bengal 91-94
4.6 Inequalities in Net Income among Farmer Groups Across Major Crops in West Bengal 94-95
4.7 Conclusion 96-97

Chapter-V Conclusions and Policy Implications 98-103

5.1 Summary and Conclusions 98-101

5.2 Policy Implications 101-103

Bibliography 104-110

Appendix i-ix

List of Tables

Table No.	Table Title	Page No.
2.1	Classification Scheme / Format of Report on Census of Minor Irrigation and District Statistical Handbook.	21
2.2	Deviation of Gross Irrigated Area by All Minor Irrigation Systems between Report on Census of Minor Irrigation and District Statistical Handbook	21
2.3	Percentage Share of Government Owned Tubewells	22
2.4	Growth (%) of Minor Irrigation Structures between 1986-87 and 2000-01	23
2.5	Growth of Irrigation Potential Created and Actual Area Irrigated by Minor Irrigation Sources in West Bengal during 1993-94 to 2000-01	25
2.6	Gross Area Irrigated by Canals and Its growth.	27
2.7	Growth of Gross Area Irrigated by Canals between 1986-87 and 1993-94	27
2.8	Growth of Gross Area Irrigated by Canals between 1993-94 and 2000-01	27
2.9	Growth of Gross Area Irrigated by Dug Wells	28
2.10	Growth of Gross Area Irrigated by Tubewells	30
2.11	Growth of Irrigated Area in India	30
2.12	Growth of Gross Area Irrigated by Tube wells between 1986-87 and 1993-94	31
2.13	Growth of Gross Area Irrigated by Tubewells between 1993-94 and 2000-01	32
2.14	Growth of Gross Area Irrigated by Tubewells between 1986-87 and 2000-01	32
2.15	Growth of Gross Area Irrigated by Surface Minor Schemes	33
2.16	Growth of Gross Area Irrigated by Surface Minor Schemes between 1986-87 and 2000-01	34
2.17	Growth of the Number of Surface Minor Schemes between 1986-87 and 2000-01	34
2.18	Annual Compound Growth Rate (%) of Total Gross Area Irrigated (in ha) by All Sources	35

		Page No.
2.19	Percentage Share of Area Irrigated by Major Sources to Total Gross Irrigated Area in 1986-87.	36
2.20	Percentage Share of Area Irrigated by Major Sources to Total Gross Irrigated Area in 1993-94	37
2.21	Percentage Share of Area Irrigated by Major Sources to Total Gross Irrigated Area in 2000-01	37
2.22	Irrigation Status and Dominated Irrigation Systems across Districts in West Bengal	39
2.23	Percentage Share of Gross Irrigated Area to Total Gross Cropped Area	40
2.24	Coefficient of Variation of Percentage Share of Gross Irrigated Area to Total Gross Cropped Area	40
3.1	Percentage Share of Rice to Gross Cropped Area	45
3.2	Specialization in Rice across Districts in West Bengal	46
3.3	Percentage Share of Major Individual Crop to Gross Cropped Area across Districts in West Bengal during 1986-97 to 2000-01	47-48
3.4	Growth Trend of Percentage Share of Area under Aus, Aman and Boro Rice between 1986-87 to 2000-01	50
3.5	Growth Trend of Percentage Share of Area under Jute to Gross Cropped Area across Districts during 1986-87 to 2000-01	52
3.6	Percentage Share of Major Crop Groups to Gross Cropped Area during 1986-87 to 2000-01	53
3.7	Changes in Cropping Pattern in West Bengal during 1986-87 to 2000-01	55
3.8	Changes in Cropping Pattern across Districts during 1986-87 to 2000-01	55
3.9	Transformed Herfindal Index	56
3.10	Crop Diversification Status across Districts in West Bengal	58
3.11	Annual Compound Growth (%) of Production, Area and Yield of Major Crops Across Districts in West Bengal during 1986-87 to 2000-01	60-61
3.12	Compound Growth Rate (%) of Area under Major Crop Groups and their Production in West Bengal during 1986-87 to2000-01	64
4.1	Per Acre Cost of Different Inputs and Total Production Cost of Aman Local Rice across Districts in West Bengal	74

		Page No.
4.2	Per Acre Cost of Different Inputs and Total Production Cost of Aman HYV Rice across Districts in West Bengal.	75
4.3	Per Acre Average Cost of Production of Aman HYV Rice across Districts in West Bengal	76
4.4	Per Acre Cost of Different Inputs and Total Production Cost of Boro Rice across Districts in West Bengal	78
4.5	Average Cost of Irrigation per Acre of Boro Rice across Districts in West Bengal	79
4.6	Per Acre Average Total Cost of Production of Boro Rice across Districts in West Bengal	79
4.7	Percentage Share of the Cost of Different Inputs per Acre of Aman Local Rice to Total Cost of Production during 1991-92 to 2000-01	81
4.8	Percentage Share of the Cost of Different Inputs per Acre of Aman HYV Rice to Total Production Cost during 1991-92 to 2000-01	82-83
4.9	Percentage Share of the Cost of Different Inputs per Acre of Boro Rice to Total Cost of Production during 1991-92 to 2000-01	85-86
4.10	Income-Cost Ratio per Acre of Aman Local Rice across Districts in West Bengal	88
4.11	Rank of Income-Cost Ratio of Aman Local Rice and Irrigation Systems across Districts in West Bengal	88
4.12	Income-Cost Ratio per Acre of Aman HYV Rice across Districts in West Bengal	89
4.13	Rank of Income-Cost Ratio of Aman HYV Rice and Dominating Irrigation Systems across Districts in West Bengal	90
4.14	Income-Cost Ratio per Acre of Boro Rice across Districts in West Bengal	91
4.15	Net Income (Rs) per Acre of Major Crops over Paid Out Cost in West Bengal	92
4.16	Rank of Different Crops (based on Average Net Income per Acre) in West Bengal during 1991-92 to 2000-01	93
4.17	Inequalities in Net Income across Major Crops in West Bengal during 1991-92 to 2000-01	95

List of Figures

Figure No.	Title	Page No.
2.I	Area Irrigated By Canals	26
3.I	Percentage Share of Area under Aus, Aman and Boro Rice in West Bengal	46
3.II	Percentage Share of Area under Major Crops in West Bengal	54
3.III	Percentage Share of Area under Crop Groups In West Bengal	54
3.IV	Growth of Production of Major Crops in West Bengal during 1986-87 to 2000-01	65
3.V	Growth Trend of Area Under Major Crops in West Bengal during 1986-87 to 2000-01	66
3.VI	Growth Trend of Yield Of Major Crops in West Bengal during 1986-87 to 2000-01	66

List of Maps

Map No.	
1.1	Administrative Map of West Bengal
2.1	Growth of Tubewell Irrigation
2.3	Growth Trend of Gross Irrigated Area during 1986-87 to 2000-01 in West Bengal

CHAPTER-I

INTRODUCTION:

Invention of irrigation as a dependable and efficient means for increasing food production from limited resources was achieved by our forefathers around 6500 B.C. (Bagchi, 1995). This process was remodeled, modified, upgraded and indigenised in course of time. After independence, thrust has been given especially on building the large projects- the large are the better. Thousand of crores invaluable national income was spent on the construction of new irrigation projects and maintenance of the old ones during the consecutive five-year plans. There is no doubt that the large dams and multipurpose river valley projects have provided food security to India at a crucial period. The irrigation potential, which was only 19.5 million ha in the year immediately following independence increased to 95 million ha by 1999-2000 (Ministry of Water Resources, 2002). Likewise, the nation's food production increased four folds during the past four decades- from 51 million tones in 1950-51 to 208 million tones in 1999-2000 (WCD, 2000).

1.1 STATEMENT OF THE PROBLEMS:

The impact of irrigation on yield, cropping pattern and crop diversification in arid and semi-arid areas has been dealt by many authors. But the studies regarding the impact of irrigation on these aspects in humid and sub-humid areas are scarce. Thus this study takes West Bengal as a case to examine the role of different irrigation systems on agricultural sector.

From independence through the 1980s, the record of agricultural production in West Bengal was mired in stagnation. Various scholars official committees examined the problems of agricultural stagnation in West Bengal and identified underdevelopment of irrigation as one of the key constraints in the growth of agricultural production (Rawal, 2001). West Bengal came out of 'agrarian impasse' in the 1980s when the food grain production grew at a rate of about 6 percent per annum. Out of all

irrigation sources, the highest growth in irrigation was from tube-wells during this period. In West Bengal as whole, the number of shallow tubewells increased by 130 percent between 1981 and 1988 (Dhawan, 1990). The tube-well irrigation is most developed in the eastern districts of the state namely, North and South 24 Parganas, Nadia and Murshidabad. The growth of tubewell irrigation in West Bengal has been supported by public investment in rural electrification. Private investment in irrigation and in particular tubewell has been the major source of irrigation expansion in the 1980s (Rawal and Swaminathan, 1998). In many states of India, over exploitation of ground water through the wide spread of tubewell irrigation has led to the lowering of water table. The initial investment cost of ground water irrigation (tubewells) is beyond the reach of the majority of the marginal and small farmers. Government has provided many submersible mini tubewells in many parts of the state to make irrigation facility available for the poor small and marginal farmers, particularly in the south West Bengal, where canal irrigation is developed. There are two groups, who have put forwarded their opinions about the agricultural development in West Bengal. One group argues that the development of agriculture came basically due to the participation and active involvement of Panchyat Raj in 1980s. The other group contends that the development came for the introduction of new technologies in the form of ample use of fertilizers, HYV seeds and machinery[1]. Agricultural growth in West Bengal in the 1980s was mainly because of the growth in production of boro paddy and it was based on an expansion of irrigation by private shallow tubewells. Further, public investment in the form of electrification has been a crucial input in the development of ground water irrigation (Harris, 1993). According to the Central Water Commission (2000), the percentage share of total irrigation potential created to total cultivable area in West Bengal was 77.4 percent in 1995-96 and out of the total irrigation potential created, 85 percent had been utilized in 1995-96, which was only about 40 percent in 1980-81 (Swaminathan and Rawal, 1998). The compound growth rate of food grain production from 1950 to 1980 was 2.56 percent, which became 4.56 percent between 1980 and 1995 (Swaminathan, 1998).

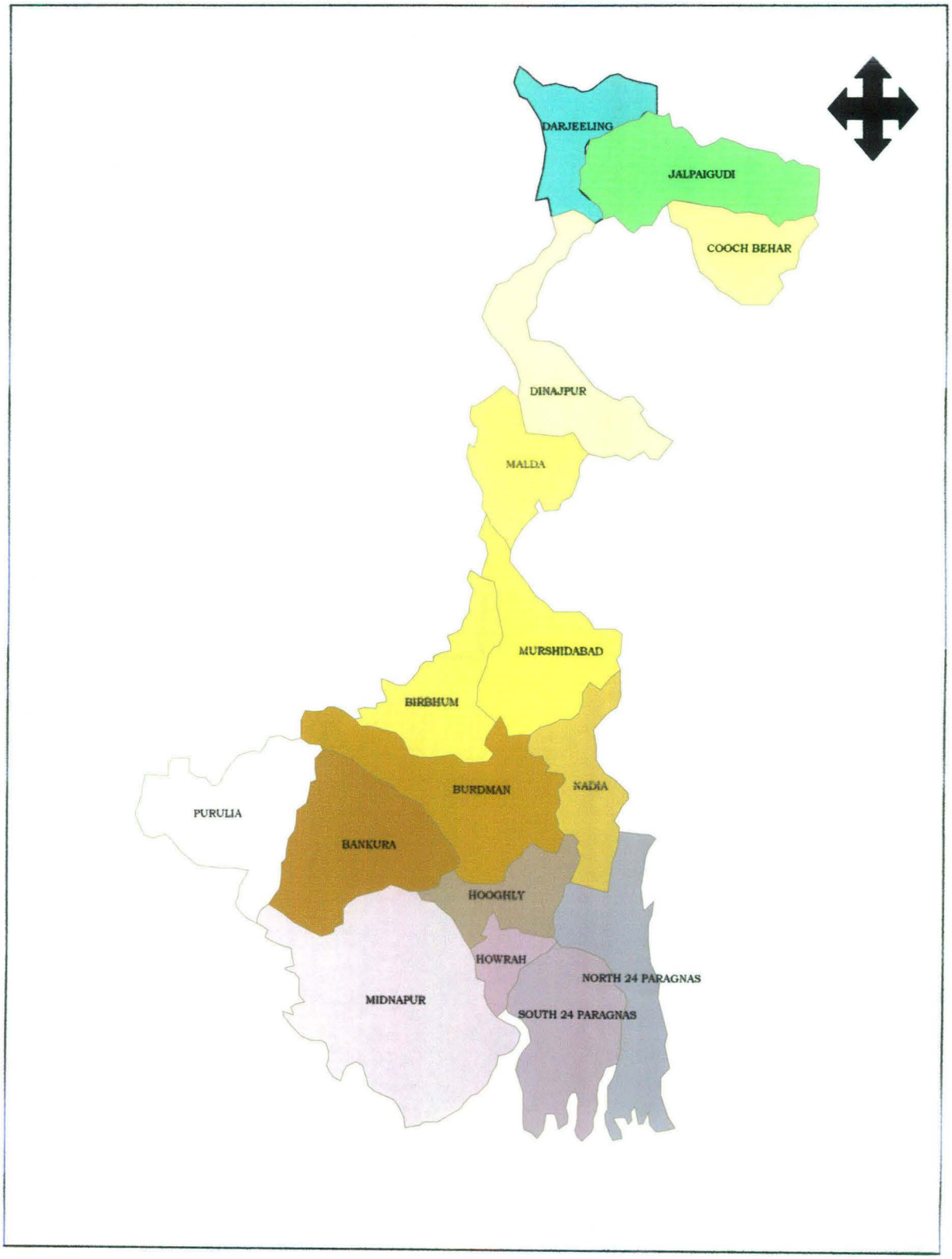
There would be no disagreement about the direct impact of irrigation in terms of increasing and stabilizing yields, increasing cropping intensity, changing toward

[1] See Banerjee et al (2002), 'Strategy for Economic Reform in West Bengal', EPW, Oct, 2002.

Map-1.1

WEST BENGAL

ADMINISTRATIVE DIVISIONS



a more productive and remunerative cropping pattern and in general in generating a higher level of output and net income to the farmers. In most arid regions of the world, agriculture is hardly possible without irrigation. But in heavy rainfall region, such as West Bengal, the role of productive irrigation becomes less clear. In most of the humid areas of our country, more than 80 percent of the rainfall is concentrated within the four months of the year, which subsumes only one agricultural season. The other two seasons- Rabi and Zaid are dry for all practical purposes (Sen, 1994). Earlier the main purpose of the investment in irrigation was to combat the vagaries of monsoon and hence, bring about a decline in the instability of the yield levels. However, after the introduction of new technologies in agriculture, the productive form of irrigation, which ensures timely and assured supply of water, has become the utmost importance to realize the full potential of the HYV seeds.

1.2 REVIEW OF LITERATURE:

Irrigation affecting agriculture in particular and rural development in general has been the object of the study by a large number of scholars. The present review of literature will be restricted to issues pertaining to this study under the following sub-headings:

(a) The Impact of Irrigation on Agricultural Growth:

More extensive and better irrigation facilities, varietal improvement and increasing use of fertilizers have been the main sources of sustained growth of agricultural production in recent decades in India (Rajgopal, 1992; Ghosh, 1998; Vaidyanathan, 1999). According to Vaidyanathan, faster growth goes with higher irrigation ratio and the synergy between irrigation and fertilizer is underlined by the fact that a higher level of irrigation is associated with high efficiency of fertilizer use. He again based on the time series data, found out that productivity of unirrigated land is more or less stagnant and the productivity differential between irrigated and rain-fed areas has progressively widened both in absolute and relative terms. Moreover, he proved that irrigated yields are generally more stable than rain-fed yields and the degree of crop

diversification is strongly influenced by the source of irrigation and there is a noticeable tendency for irrigated crop patterns to become more diversified. In a district level study over 17 major states in India, Bhalla and Singh (2001) found out that the growth rate of crop output accelerated from 2.38 percent during1970-73 to 1980-83 to 3.40 percent during 1980-83 to 1992-95. And the most significant development was a notable acceleration of growth rate in the high populated but hitherto agriculturally stagnant states of eastern India. The growth rate in agricultural output has increased to an unprecedented level of 5.39 percent per annum in West Bengal during 1980 to 1995.

(b) Sustainable Use of Irrigation Water:

Sustainability basically arises from higher than expected rate of siltation of reservoirs, widespread lowering of the ground water tables and the spread of water logging and salinity in irrigated tracts (Vaidyanathan, 1999).

1. Water Logging and Salinity:

The problem of water logging in kharif season, particularly in low-lying areas is still very acute. The problem is not so much due to irrigation but heavy rainfall coupled with lack of drainage, inadequate water reservoirs and unfavourable topographic situations (Chand and Haque, 1998). In a seminar on irrigation water management, Joshi (1992) pointed out that land use intensity has been declined due to the water logging and soil salinity and crop choice becomes restricted due to soil degradation. Crop yields and income also decline in degraded soils. The presence of salt invariably causes reduction in yields of all crops in different water tables and salinity affected zones and the process of land degradation is causing decline in land productivity and ultimately creating labour displacement from the agricultural sector. In the absence of requisite investments forthcoming for drainage purpose including cross drainage, water logging becomes inevitable (Dhawan, 1989). He found out two tendencies: (1) the emergence of sharp deviation in irrigated crop pattern in the project commands and a hallmark of this deviation is the farmer's marked preference for heavily irrigated crops like paddy and sugarcane over lightly irrigated crops of pulses, oilseeds, coarse cereals

etc. (2) the other tendency on the part of the farmers is to consciously over water the crop during the course of an irrigation operation. These two lead the field percolation losses shooting up well above the envisaged level.

2. Lowering of Ground Water Table:

Over-exploitation of ground water in some of the regions endowed with good quality water is equally serious problem. The ground water levels are drastically falling in most of the intensive cropped areas of the country, because, withdrawal exceeds recharge (Joshi, 1992). The major regions as he mentioned: (1) inadequate availability on absence of canal water, (2) no private cost of extracting additional quantity of water, (3) flat rate of electricity to extract ground water by using pumps, tube-wells and deep and dug tube-wells and (4) low rainfall in the region. The long term consequences of a progressive fall in ground water table are likely to be different in areas depending solely on well and tube-well irrigation and those areas where they are used along with surface water (Vaidyanathan, 1999; Chand and Haque, 1998). Kumar et el (2003) in a study showed that during the past decades intensive ground water development in some parts of the country has resulted over exploitation and depletion of ground water resources and the number of shallow tube-wells doubled every 3.7 years between 1951 and 1991 causing severe water level decline.

(c) Irrigation and Instability:

Irrigation has impact on agricultural instability. Without dependable irrigation, irrigation based agricultural growth would prove unstable, resulting in price instability in farm product markets and income instability in the farm sectors. The yield differential due to irrigation is a joint effect of changes in both pure crop yield and pure crop pattern brought about by irrigation (Dhawan, 1988). In a research note based on an empirical comparative study between West Bengal and Punjab-Haryana over a period of time (1950-51 to 1984-85), it has been observed that in West Bengal as a whole, fluctuations during the post-green revolution period in the production of rice had significantly increased compared to pre-green revolution period. There are definite signs

of diminishing year-to-year fluctuations in the production of wheat in Punjab-Haryana. In contrast, in West Bengal there was a fall in the rate of growth of production in a number of districts. The remaining districts of the state, however, registered only marginal increase in the rate of growth of production during the post-green revolution period compared to pre-green revolution period and the year to year fluctuations in the production of rice became widening in the districts of West Bengal during the post-green revolution period.

(d) Growth of Agriculture and New Technology:

The changes in the pattern of development and use of irrigation have occurred in India due to wide spread adoption of yield increasing seed fertilizer technology. He found out that while the area expansion effect of irrigation declined significantly in the post 1971, the impact of irrigation on cropping pattern and yield did not record any significant improvement (Ray,1992). Bezbaruah and Ray (2002), found out that both farm size and tenancy have significant bearing on the use of practices that raise farm productivity per unit of net area sown. Farm size is a significant determinant of proportion of rice acreage planted with HYV and intensity of cropping. They also found out that the smaller farmers have tendency to put large proportion of rice acreage under HYV and to cultivate the net sown area more intensively. Inequality in terms of productivity as well as income has increased due to the adoption of new technology among the different groups of farmers (Berhard, 1987; Sivaprasad, 1987; Sharma, 1990; Mukhopadhyay, 1997; Nandy and Siddhanta, 2000).

(e) Equity and the Distribution of costs and Benefits:

Though large dams have provided substantial socio-economic benefits through the delivery of water, electricity and food control as well as various ancillary services, large dams tend to produce benefits that accrue to groups other than those who bear the social and environmental costs. Those who bear the costs, are quite often poor, vulnerable, such as indigenous people. So, it is clear that dams have lead to inequitable outcomes (WCD, 2000). Equity is central to democratic norms. But large dams ignore the

typical mismatch between the distribution of the gains and losses of a project across different social groups. Equity comes into play when some communities suffer from disproportionate losses compared with those who enjoy benefits. The issues involved are complex, because, the communities affected by dams are heterogeneous and the spread of benefits and costs also uneven. There are glaring imbalances between the winners and losers (Srinivasan, 2001).

(f) Inappropriate Pricing of Irrigation Water:

The financial management of public irrigation works is very dismal. These works do not generate sufficient revenue to cover even their working costs, not to speak of recouping the high investment costs (Dhawan, 1989; Vaidyanathan, 1999). According to the Water Management Forum (1992), there is no parity between water charges from canal and cost of pumping ground water in a situation of adequate canal supply. Public system in India run at considerable and increasing losses. Vaidyanathan (1999) traced out that users of canal irrigation are charged on the basis of area irrigated; water intensive crops like paddy and sugarcane are being charged more than others. He also identified that the inter crop differences are not, however, taking into consideration with the differences in their irrigation requirements. Even in some regions, irrigated lands served by old system (including tanks) does not pay separate water rate and the collections on account of water charges have been inadequate to cover the costs of operation and maintenance. The cost recovery rate has fallen to an estimated rate of 4 percent. The emergence of water markets, both ground and surface water, has helped increase agricultural output but it has also widened the inequalities in rural areas and has failed to protect the interest small and marginal farmers and other weaker sections of the society (Ganeshprasad, 2002).

(g) Impact of Irrigation on Cropping Patten, Cropping Intensity and Crop Diversification:

Irrigation has a crucial role in altering cropping pattern. The crop pattern would become more market oriented in the wake of irrigation because not all the additional output due to irrigation is likely to be absorbed for self-consumption, except by

the very small farmers. Irrigation would shift cropping pattern in favour of non-food or non-grain crops and the final outcome depends on many other factors, such as advances in crop technologies, government price policy for crops and the design of an irrigation system (Dhawan, 1988; Nandy and Siddhanta, 2000). Variations in cropping intensity are significantly affected by both the irrigation and rainfall. The positive impact of rainfall and irrigation on crop intensity and crop diversification has been confirmed through cross-section analysis for different point of time (Karunakaran and Palanisami, 1988; Dhawan, 1990; Vaidyanathan, 1999). The unirrigated crop pattern is more diversified in comparison to the irrigated crop patterns in the early 1970s, but latter on the irrigated crop pattern has become more diversified (Vaidyanathan, 1999). Vakulabharanam (2004), in a field study found out that irrigation leads the households to produce rice and cotton from the production of coarse food grains. She also finds out the positive correlation between the growth rate of irrigation and agricultural growth rate. Mahendradev (1989) in an empirical study over Indian state showed that greater part of inter-state or inter regional disparity in the level of cropping intensity could be due to the disparity in the pattern of development of irrigation facilities, both in qualitative and in quantitative terms and the cropping intensity is higher in the region with higher percentage of net sown area irrigated and with higher intensity of land use with irrigation.

(h) Features of Different Sources of Irrigation:

The growth of area irrigated by canals declined because easily utilizable surface water resources had already been utilized and the cost of creating additional irrigation potential went up dramatically and canal provides supplementary irrigation for the kharif crops, the field is now primarily irrigated by tube-well. (Svendsen, 1991; Rawal, 2001). Agricultural growth in West Bengal in the 1980s was only mainly because of the growth in the production of boro paddy and it was based on an expansion of irrigation by private shallow tube-wells. He also argued that public investment in the form of electrification has been a crucial input in the development of ground water irrigation (Harris, 1993; Nandy and Siddhanta, 2000).

(i) Wastage of Irrigation Water:

Over irrigation is a common problem in tube-well and canal irrigation systems. In case of electricity operated private tube-wells and pumpsets, over irrigation occurs due to the changeover from variable to fixed, i.e., flat power tariff in which electricity billing is linked to the horse power of the motor only (Singh, 1984; Dhawan, 1989). In contrast, Sharma (1984) traced out significant under irrigation in the case of 230 private electric tube-wells in U.P. The result is in agreement with the National Council of Applied Economic Research. Sen (1994), attempted to assess the effect of different irrigation systems on aspect of agricultural development. The author found out canal as the most important source of irrigation (57 percent) and this system is characterized by lack of control over the supply of water. The mode of the supply of the canal water is 'field to field' irrigation, which results in wastage and uneven distribution of water within the command area.

(j) Farm-size and Productivity:

The farm-size and productivity relation controversy in Indian agriculture is of some vintage and can be represented by three general sets of findings. (i) First set established an inverse relation between farm-size and productivity. That means small farms are more productive and efficient than large farms (Sen, 1962; Bhattacharyya and Saini, 1972). (ii) Second group of studies can be characterized as a reaction to the generalization of an inverse relation for Indian agriculture as a whole (Rao, 1967; Rudra, 1968; Chattopadhya and Rudra, 1976). (iii) The third set of studies refers to the post green revolution period and reports and emerging positive relation between farm-size and productivity. According to these studies, large farms enjoy higher productivity than small farms in the post green revolution period mainly because of their greater adoption of modern inputs and techniques (Deolalikar, 1981). Undoubtedly, the use of modern inputs largely depends on cash and credit flows to which large farmers have comparatively greater access than small farmers (Verma and Bromley, 1987).

(k) Irrigation and Agricultural Situation in West Bengal:

The economic cost of irrigation through state tube-wells is higher than those private tube-wells, which are grossly inefficient and the cost differential is even higher if the gestation lag is taken into consideration and the availability of institutional credit is also positively correlated with the size of land holdings and the sale price of irrigation water is high, therefore, not very attractive to the average farmers (Prasad and Sharma, 1991). In West Bengal (1950-96) for crops other than paddy, the main change in cropping pattern in the 1980s was an increase in areas sown with wheat, minor cereals like barley, gram, other pulses and jute. Private investment in irrigation and in particular tube-well has been the major source of irrigation expansion in the 1980s (Rawal and Swaminathan, 1998). Sanyal, Biswas and Bardhan (1998) in a study in West Bengal over a period 18 years, from 1977 to 1995 showed that before 1980, smaller farmers display a higher ratio of wheat to boro acreage, because wheat requires only one-third of water as boro. But in 1980s, there was a complete reversal of the trend in cropping pattern maintained by the small farmers earlier and wheat was largely substituted by boro and other rabi crops.

1.3 OBJECTIVES:

This study primarily deals with the impact of irrigation on certain important aspects of agricultural development in West Bengal. The main objectives of this study are:

1. to trace out the change in irrigation both by extent and sources across the districts in West Bengal,
2. to assess the changes in cropping pattern and yield of major crops with the development of irrigation,
3. to compare the cost of irrigation water and cost of cultivation on the one hand and net return on the other hand across districts categorized under different systems of irrigation.

1.4 HYPOTHESES:

1. The districts, which are more developed in terms of tube-well irrigation, have performed better (all the indicators) in comparison to the other groups of districts.
2. The cost of irrigation and net return would tend to be higher in districts having a greater share of tube-well irrigation to the gross irrigated area.

1.5 DATABASE:

Source	Variable	Level	Year for which the data available and to be used
Statistical Abstract of West Bengal, 1978 to 1989, 1994-95, 1997-98, 2001-02	1. Gross Cropped Area	District	1986-87, 1993-94 and 2000-01
	2. Area under Crops, Production and Yield Rates of Major Crops	-do-	-do-
	3. Area Irrigated by Major and Medium Canals	-do-	-do-
Draft 10th Plan (2002-07) and Annual Plan (2004-05)	4. Data on Ultimate Irrigation Potential and Benefits	State	1996-97
Repot on Minor Irrigation Census, 1986-87, 1993-94 and 2000-01	5. Number of Minor Irrigation Structures (Dug-wells, Shallow tubewells, Deep tubewells, Surface Flow and Surface Lift)	State	1986-87, 1993-94 and 2000-01
	6. Irrigation Potential Created and Actual Area Irrigated (ha) by Minor Irrigation Sources	State	1993-94 and 2000-01

	7. Area Irrigated (ha) by Dug-wells, Shallow Tubewells, Deep Tubewells, Surface Flow and Surface Minor.	District	1986-87, 1993-94 and 2000-01
Statistical Abstract of India, 1990, 1997 and 2003	8. Net Area Irrigated by Tubewells 9. Gross Area Irrigated by All Sources	India -do-	1986-87, 1993-94 and 2000-01
District Statistical Hand Book	10. Gross Area Irrigated by Minor Irrigation Sources	District	1986-87, 1993-94 and 2000-01
Study on Farm Management & Cost of Production of Crops in West Bengal	11. Average Cost of Production and Expenditure (in Rs) of Major Crops	District	1991-92 and 2000-01

1.6 METHODOLOGY:

The whole study period from 1986-87 to 2000-01 has been divided into two sub-periods: (i) 1st sub-period from 1986-87 to 1993-94 and (ii) 2nd sub-period from 1993-94 to 2000-01. To show the growth and development of irrigation by different sources across the districts, simple growth has been calculated. In case of tubewell irrigation, based on the percentage growth of gross irrigated area, all the districts have been grouped into five categories: (1) very high growth- more than 75 percent, (2) high growth- 50 to 75 percent, (3) medium growth- 25 to 50 percent, (3) low growth 0-25 percent and (5) negative growth.

To show the growth rate of gross irrigated area by all sources together across districts, compound growth has been computed. Coefficient of Variance has been used to assess the variations or inequalities within the districts in terms of percentage share of gross irrigated area to total gross cropped area.

Twelve important crops have been identified. For each of these crops, crop area shift has been examined as percentage share to total gross cropped area for three points of time 1986-87, 1993-94 and 2000-01. The output growth rate, as we know, can be decomposed into growth rate in area and yield. In order to present an over all picture of the relative growth of production, area and yield of major crops and their impact on cropping pattern changes, compound growth rates of production, area and yield have been computed.

To measure the crop diversification, crop acreage has been considered to be potentially interesting variable over which to define crop diversification. The crop diversification in terms of crop acreage over the study period has been measured by using Herfindal Index, which indicate the extent of dispersion in a given time and space. It is the sum of acreage proportion of each crop in the total cropped area. Mathematically the index is calculated as:

$$HI = \sum_{i=1}^{N} Pi^2$$

Where 'N' is the total number of crops and 'Pi' represents area proportion of the ith crop in the total cropped area. With increase in diversification, the HI decreases. The index takes value '1' when there is complete concentration and approaches '0' when diversification is perfect. Since the HI is a measure of concentration, it has been transformed by subtracting it from 1, i.e., 1-HI, which will avoid confusion.

Net income per acre of land has been calculated by subtracting paid out cost from gross output value.

1.7 FRAMEWORK OF ANALYSIS:

The study has been carried out over a period of one and half decades from 1986-87 to 2000-01 at the district level in West Bengal. The changes in irrigation both by extent and sources as well as the changes in cropping pattern for all major crops have been shown during this period.

Primarily the irrigation status of the districts (unirrigated or low irrigated, moderately irrigated and highly irrigated) has been determined based on the percentage share of gross irrigated area to total gross cropped area[2]. And secondly, all the districts have been categorized under different systems of irrigation based on the dominant source / sources. To classify the districts under different status or systems of irrigation, the given below structure has been followed.

a. If a district belongs to the same category for the two points of time during the study period or more, the district will be categorized under that category,
b. If a single source contribute the maximum percentage share of irrigated area to total gross irrigated area (more than 60 percent) of that district for at least two points of time, it will be classified according to that particular source,
c. If the highest percentage share of gross irrigated area by a irrigation source to total gross irrigated area by all sources in a district is below 60 percent and the 2nd or 3rd or 4th source of irrigation systems contribute 20 percent or more for at least any two points of time, the district will be categorized under mixed category.

The cost of irrigation, net income and income cost ratio of aman local, aman HYV and boro rice have been determined for marginal, small, medium and big farms taken as per farm management survey classification over two points of time (1991-92 and 2000-01).

1.8. CHAPTER SCHEME:

The whole dissertation has been organized into five chapters. Chapter 2 discusses the structure and growth of irrigation by different sources across districts in

[2] Unirrigated or low irrigated - less than 25 percent of gross irrigated area to gross cropped area, moderately irrigated - 25 percent to 50 percent of gross irrigated area to gross cropped area and highly irrigated – more than 50 percent of gross irrigated area to gross cropped area.

West Bengal during 1986-87 to 2000-01. Chapter 3 assesses the impact of irrigation on changes in cropping pattern, levels of diversification and yield of major crops at district level. Chapter 4 analyzes the cost of irrigation, cost of production and net returns across different farm sizes and districts with different systems of irrigation for three major crops aman local, aman HYV and boro rice in West Bengal during 1991-92 to 2000-01. In chapter 5 some policy implications have been suggested.

CHAPTER-2

GROWTH AND DEVELOPMENT OF IRRIGATION IN WEST BENGAL

2.1 INTRODUCTION:

Though rainfall in West Bengal is quite sufficient, its distribution is uneven with respect to space and time and hence it can not replace systematic water supply through irrigation. Irrigation is crucial for agricultural production in the state, particularly in the dry season and it supplements rainfall in the monsoon season in years of low rainfall. Thus in a humid region as West Bengal, irrigation has a substitutional impact on yield, cropping intensity and to some extent on cropping pattern. From the independence through 1970s, the agricultural production in West Bengal was, however, in stagnation. Agricultural growth registered in 1980s for food grains was the highest among all sates in the country. The development of agricultural output in West Bengal is not only confined to the food grain sectors, but the state's nonfood grains sector has also expanded substantially (Nandi and Siddhanta, 2000)

Irrigation in West Bengal before the colonization by the British was based on mainly ponds, bunds, small storage works and in some areas also on wells. After independence, thrust has been given especially on building large dams and irrigation projects. Irrigation from these sources other than being extremely expensive, however, was mainly supplemental to rainfall in the monsoon. Special emphasis has, therefore, been laid on minor irrigation as it provides less implemental hazards. It also needs less investment and gives better dependability (10^{th} Five Year Plan, Government of West Bengal, 2002-07). Irrigation by tubewells has been the most important technological innovation in the field of irrigation in the post independence period. In West Bengal, however, the growth of tubewell became significant from the later half of 1970s. Only 16 percent of the ultimate ground water potential of the state was said to be utilized by 1982 (Boyce, 1987).

The main objectives of this chapter are:

(i) to see the growth and development of different systems of irrigation across districts in West Bengal during 1986-87 to 2000-01 and

(ii) to examine the disparity or inequality within the districts in terms irrigation extent.

The whole discussion has been organized into six sections. Section 2 compares the nature and quality of the data on irrigation given in three Government sources: 1) District Statistical Hand Book, 2) Report on Minor Irrigation Census and 3) Statistical Abstract of West Bengal one the one hand, and the differences in terms of total gross area irrigated by minor irrigation sources between District Statistical Hand Book and Report on Minor Irrigation Census on the other hand. Section 3 discusses the changes in irrigation structure in West Bengal at the state level. In section 4, growth and development of irrigation between 1986-87 and 2000-01 have been analyzed at the district level. Section 5 discusses the disparities across the districts in terms of extent of irrigation.

2.2 DATA AND CONCEPTS: INCONSISTENCIES IN EXISTING SOURCES

The secondary data available on irrigation in West Bengal published by the different departments of the state Government are not entirely comparable with respect to time and space and thus are often inconsistent. Also, data are often released after much delay and are not available for all the years by different sources, except data on gross area irrigated by Government canals. Time series data on irrigation by Government canals in West Bengal are available only for gross irrigated area not for the net irrigated area (Rawal, 2001).

A profile of irrigation from all the sources has been obtained upto 2000-01 by putting together data on gross area irrigated by canals from the Statistical Abstract of West Bengal and data on gross area irrigated by minor irrigation sources, namely dug wells, shallow tubewells, deep tubewells, surface flow and surface lift schemes from the Report on Minor Irrigation Census. Proper analysis of the irrigation development in West Bengal over a period of time is very problematic due to the above mentioned problems. Most of the scholars working on agricultural growth in West Bengal in 1970s and 1980s have faced similar problems (Rawal, 2001).

2.2.1 REPORT ON MINOR IRRIGATION CENSUS:

The Minor Irrigation Wing of the Ministry of Water Resources conducted Census of Minor Irrigation first in 1986-87. Government of India launched a scheme on "Rationalization of Minor Irrigation Statistics" in 1986-87 with the objective of conducting detailed study regarding minor irrigation structures constructed, potential created and utilized through these schemes in all the States and Union Territories to have sound data on minor irrigation sector. It may be noted that only the surface water and ground water schemes (both flow and lift) having agricultural command area upto 2000 hectares individually are considered under minor irrigation schemes. These schemes are implemented by different Government Departments and also by individual farmers, group farmers, cooperative societies and local bodies. In West Bengal, the Census was conducted by Water Investigation and Development Department, Government of West Bengal for the reference year 1986-87, 1993-94 and 2000-01 at the block level. For the years 1986-87 and 1993-94, the block level data are also available in unpublished official reports.

The Minor Irrigation Census Programme was launched by codifying the districts, blocks and all the mouzas of the state. More than 40,000 Government employees were appointed as enumerators, one for each mouza. The census involved a survey of owners of all the sources of minor irrigation in a village (Report on Third Minor Irrigation Census in West Bengal, 2000-01). The sources of minor irrigation have been classified into five schedules, namely dug wells, shallow tubewells (low and medium capacity tubewells), deep tubewells (only high capacity tubewells), surface flow (ponds, bunds and minor canal irrigation projects) and surface lift scheme (ponds and river lift irrigation).

The Report on Minor Irrigation Census provides season wise data, i.e., gross irrigated area by dug wells, shallow tubewells, deep tubewells, surface flow and surface lift schemes, but does not take into consideration the net irrigated area at district level. The first and second Census of Minor Irrigation did not enumerate the irrigated area under boro crop by different sources of minor irrigation systems, which means that the irrigated area under boro crop was included either as rabi crop or under other crops. But in 3rd Census of Minor Irrigation, area irrigated under boro crop by different sources has been estimated separately. Therefore, it is not possible to show the growth trend of irrigated area under boro crop by different sources. Second Minor Irrigation Census provides the

detailed information about ownership of tubewells and it has classified the tubewell owners into six categories, namely (a) Government owned, (b) cooperative societies, (c) panchayat owned, (d) group of farmers, (e) individual farmers and (f) others. But 3rd Minor Irrigation Census has classified the ownership into only two categories: (a) Government owned and (b) others.

2.2.2 STATISTICAL ABSTRACT OF WEST BENGAL:

Statistical Abstract of West Bengal is published by the Bureau of Applied Economics and Statistics of the Government of West Bengal. Annual district level data on gross area irrigated by government canal are available here. The only category about which information is provided is Government canals. Thus this source is incomplete with regards to the irrigation data.

2.2.3 DISTRICT STATISTICAL HAND BOOK:

District Statistical Hand-book is another source, which provides information on irrigation at district level in West Bengal. Here, irrigation data are available upto 2001-02. In District Statistical Hand-book, data on irrigation have been collated from various sources and is thus a compilation. The major problems regarding the irrigation data provided in District Statistical Hand-book are:

(i) The sources from which data are collated vary across districts as well as across years. Therefore, the data provided in this source are neither comparable across districts within a year or across years for the state as a whole.

(ii) Classification of the sources, i.e., the heads under which irrigation sources have been classified is not comparable across the districts or years[1]. Upto 1993-94, the classification scheme at was comparable for all the districts. However, after

[1] There are two different types of classification of sources, i.e., the heads under which irrigation sources have been classified- (a) Government canals, tanks, wells and others; (b) Government canals, tanks, HDTW, MDTW, LDTW, STW, RLI and other sources (HDTW- High capacity deep tube well, MDTW- Middle capacity deep tubewell, LDTW- Low capacity deep tube well, STW- Shallow tube well and RLI- River lift irrigation).

this year till 2000-01 only seven districts maintain the same format or classification[2]. The remaining ten districts have changed their formats[3].

The Report on Minor Irrigation Census in West Bengal has yielded data on various aspects of irrigation in addition to basic data on irrigated area[4]. The organization appoints enumerators upto the Mouza level. But in case of District Statistical Hand-book, even in majority of the districts the source of the data on area irrigated by minor irrigation systems and the source of the data on number of minor irrigation schemes are different. In some Districts, despite of being large number of shallow and deep tubewells, area irrigated by wells given in District Statistical Hand-book is nil for 1993-94[5].

From the above discussion regarding the structure and quality of the data given in the two irrigation statistics a) Report on Minor Irrigation Census (RMIC) and b) District Statistical Hand Book (DSHB), it appears that the data on different minor irrigation structures provided in Report on Minor Irrigation Census are more reliable and organized. Therefore, for the study of irrigation development in West Bengal, the data regarding minor irrigation have been taken from Report on Minor Irrigation Census for the three points of time, 1986-87, 1993-94 and 2000-01.

2.2.4 MISMATCHES BETWEEN DISTRICT STATISTICAL HAND-BOOK AND REPORT ON MINOR IRRIGATION CENSUS:

As mentioned in the last section, there are a large number of discrepancies in the data available for use in West Bengal from Report on Minor Irrigation Census and District Statistical Hand-book. This section attempts to compare the information provided by the two sources.

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[2] Bankura, Burdwan, Darjeeling, Jalpaiguri, Koch Bihar, Murshidabad and Purulia.

[3] Birbhum, Dakshin Dinajpur, Uttar Dinajpur, Hooghly, Howrah, Malda, Midnapur, Nadia, North 24 Parganas and South 24 Parganas.

[4] See Rawal (2001), 'Irrigation Statistics in West Bengal' and Report on Third Minor Irrigation Census in West Bengal (2000-01).

[5] See District Statistical Hand Book of North 24 Parganas, 1995; Burdwan, 1994; Uttar and Dakshin Dinajpur, 1994. In these three districts irrigation sources have been classified under Government canals, tanks, wells and others. So, it is possible that area irrigated by shallow and deep tubewells have been included in other sources. However, it can be certainly said that area irrigated by shallow and deep tubewells has been underestimated for these districts in District Statistical Hand-book.

Table- 2.1

Classification Scheme / Format of Report on Minor Irrigation Census and District Statistical Handbook.

Sources	Format / Classification	Year for which available
District Statistical Hand-book	a) Government canals, tanks, wells and others; b) Government canals, tanks, HDTW, MDTW, LDTW, STW, RLI and other Sources.	Upto 1993-94, in all districts. But in 2000-01, only seven districts followed this format. In 2000-01 ten districts have followed this format.
Report on the Census of Minor Irrigation	a) Dug wells, shallow tube wells, deep tube wells, surface flow and surface lift	1986-87, 1993-94 and 2000-01 for all the districts.

Table-2.2

Deviation of Gross Irrigated Area by All Minor Irrigation Systems between Report on Minor Irrigation Census and District Statistical Handbook

(Area in '000 Ha)

Districts	1986-87		1993-94		2000-01		{(RCMI-DSHB) / RCMI} * 100		
	DSHB	RCMI	DSHB	RCMI	DSHB	RCMI	1986-87	1993-94	2000-01
Bankura	84	178.58	145	157.48	181.77	127.04	52.96	7.92	-43.08
Birbhum*	-	-	131.42	104.01	88.12	80.89	-	-26.35	-8.94
Burdwan	-	226.46	19	212.04	27.64	212.12	100.00	91.04	86.97
D.Dinajpur*	-	-	42.68	50.93	48.24	59.46	-	16.20	18.87
Darjeeling	-	18.44	13.36	8.86	0.53	12.58	100.00	-50.79	95.79
Hooghly	157.4	141.14	163.34	127.13	120.13	140.65	-11.52	-28.48	14.59
Howrah	34.3	62.15	47.8	50.43	15.16	83.69	44.81	5.22	81.89
Jalpaiguri	3.3	29.3	3.84	40.56	26.51	51.48	88.74	90.53	48.50
Koch Bihar*	-	-	21.61	40.96	63.13	57.07	-	47.24	-10.62
Malda*	-	-	61.83	110.21	112.7	114.87	-	43.90	1.89
Midnapur	-	258.55	297.38	254.33	314.35	258.85	100.00	-16.93	-21.44
Murshidabad	48.84	191.04	152.94	225.79	177.65	210.43	74.43	32.26	15.58
Nadia**	177.7	166	-	-	211.67	167.01	-7.05	-	-26.74
N. 24 Parganas*	-	-	140.7	121.21	161.71	120.89	-	-16.08	-33.77
Purulia #	56	93.91	80	73.39	-	-	40.37	-9.01	-
S. 24 Parganas*	-	-	28.47	53.45	54.98	77.87	-	46.74	29.40
U.Dinajpur*	-	-	56.47	119.79	56.03	121.01	-	52.86	53.70
West Bengal	561.54	1365.57	1405.84	1750.57	1660.32	1895.91	58.88	19.69	12.43

Source: (i) Various Issues of District Statistical Hand-book and
(ii) Repot on Minor Irrigation Census, 1986-87, 1993-94 and 2000-01.

Note: (i) In the table gross area irrigated in West Bengal as a whole by minor irrigation sources has been calculated by adding up the available data for different districts
(ii) * Data could not be collected for 1986-87 given in District Statistical Hand-book.
(iii) ** Data could not be collected for 1993-94 given in District Statistical Hand-book.
(iv) # Data could not be collected for 2000-01 given in District Statistical Hand-book.

Overall in majority of the districts and in West Bengal as a whole, gross area irrigated by all minor irrigation sources given in Report on Minor Irrigation Census is higher than the gross area irrigated by minor irrigation sources provided in District Statistical Hand-book (Table-2.2). The districts where area irrigated by minor irrigation sources is more as per the second source over the first source, remain consistently more over the time period under consideration. But the variation in gross irrigated area between the two sources in West Bengal as a whole has declined over the study period.

2.3 STRUCTURE OF IRRIGATION SYSTEMS:

A profile or scenario of irrigation from all the sources has been obtained over a period of 14 years from 1986-87 to 2000-01 by putting together data on Government canals from Statistical Abstract of West Bengal and the data on minor irrigation sources from the Report on Minor Irrigation Census at three points of time, i.e., 1986-87, 1993-94 and 2000-01[6]. The deep tubewells are mainly Government owned and having discharge capacity of 100 to 200 cubic metres per hour. According to the 3rd Minor Irrigation Census, 2000-01, about 96 percent deep tubewells are owned by the Government, while the case is reverse with the shallow tubewells (Table-2.3). Privately owned tube wells have discharge capacity of less than 25 cubic metres per hour (Rawal, 2001).

Table-2.3

Percentage Share of Government Owned Tubewells.

	Deep Tubewells		Shallow Tubewells	
Years	Government owned	Others	Government owned	Others
1993-94	98.28	1.72	1.61	98.39
2000-01	95.63	4.31	3.64	96.36

Source: Report on Minor Irrigation Census, 1993-94 and 2000-01.

Surface minor irrigation is of mainly two types, as classified by the Census of Minor Irrigation: (i) Surface flow irrigation and (ii) Surface lift irrigation. Surface flow

[6]. Ministry of Water Resources, Government of India launched a scheme "Rationalization of Minor Irrigation Statistics" in 1986-87 with one of the objectives to conduct detailed census of minor irrigation structures on quinquennial basis for collecting data relating to minor irrigation in all the states and union territories to have a sound data base on minor irrigation sector. Ministry of Water Resources classified the minor irrigation schemes into five schedules, namely dug wells, shallow tubewells, deep tubewells, surface flow and surface lift. This classification was adopted by the Water Investigation and Development Department, Govt. of West Bengal.

irrigation includes bunds and minor irrigation projects and surface lift irrigation includes ponds, river lift irrigation and tanks. Surface lift irrigation is performed with the help of electric and diesel pump devices as well as windmills and solar pumps. In 3rd Minor Irrigation Census, there is no information on the number of schemes with lift devices. In West Bengal, over the study period from 1986-87 to 2000-01, the number of surface minor irrigation schemes has decreased, but the number of shallow tube wells and deep tube wells has increased. Dug wells, surface flow and surface lift have experienced gradual decrease in number over the study period. The highest decline in growth has been observed in case of surface lift followed by dug wells and surface flow schemes over the study period (Table-2.4).

Table-2.4

Growth (%) of Minor Irrigation Structures between 1986-87 and 2000-01

No. of Minor Irrigation Structures	1986-87	2000-01	Growth (%) between 1986-87 and 2000-01
Dug wells	63387	39377	-37.88
Shallow Tubewells	368316	603667	63.90
Deep Tubewells	3122	5139	64.61
Surface Flow	70820	53781	-24.06
Surface Lift	205471	107595	-47.63

Source: Report on Minor Irrigation Census, 1986-87 and 2000-01.

In West Bengal there were only three major projects namely Murakshi canals, Kangshabati Projects canals and Damodar Valley and B.I. Projects and ten medium irrigation projects under utilization for agricultural purposes in 1981, and the gross area irrigated was 1017 thousand hectares. But by the end of 1996-97, the number of medium irrigation projects rose to 29 and the area irrigated by the canals becomes1137.85 thousand hectares, out of which 33.64 thousand hectares (about 3 percent) was irrigated by medium schemes.[7]

2.4 GROWTH AND DEVELOPMENT OF IRRIGATION:

Irrigation in West Bengal before the colonization was mainly based on ponds, bunds and other small storage works and in some areas also on wells. Simultaneous utilization of both the ground and surface water for irrigation was first started only about

[7]. See Draft 10th Plan (2002-2007) and Annual Plan 2004-05, Major and Medium Irrigation Projects.

2000 years ago. During the beginning of the 18th century, we found another upheaval in the irrigation history. Imperial colonists from the British Empire started grabbling total administrative control of the Indian subcontinent. So, socio-cultural and administrative interactions resulted in both positive and negative outcomes[8]. Large-scale canal irrigation came up in Bengal during the colonial period. Irrigation from these sources, however, was mainly supplemental to rainfall in the monsoon season. During the 1st five year plan, many tubewells were constructed both with Governmental and foreign assistance and in order to mobilize people's involvement to a greater scale, allocation for minor irrigation works was subdivided under two heads: (i) partly under Community Development Programme and (ii) partly under State Agricultural Programme (Bagchi, 1995).

During the 3rd plan, greater stress was laid on the various aspects of minor irrigation works in general and management aspects in particular, e.g., renovation, maintenance, mobilization of the local people etc. along with the construction of the new irrigation works. Extending irrigation facilities to the doorstep of a large number of small and medium farmers was possible owing to the massive rural electrification programmes in 1970s in India. As mentioned earlier, in West Bengal the growth of tubewell irrigation was slow until the 1970s; only 16 percent of ultimate ground water potential of the state was utilized in 1982 (Boyce, 1987). According to the report of 10th Plan (2002-07) and Annual Plan 2004-05, at the end of 1996-97 the irrigation potential created and utilized by the major and medium projects together were 1233 thousand hectares and 1138 thousand hectares respectively in West Bengal as a whole and during 1997-2002 Annual plan, 10.92 thousand hectares extra irrigation potential was created and 12.61 thousand hectares more land was irrigated by the major and medium irrigation projects.

The data on potential created by the minor irrigation sources are not available in the 1st Census of Minor Irrigation. As result, irrigation potential created by the different minor irrigation systems could not be shown for 1986-87. Over a period of seven years between 1993-94 and 2000-01, despite of the increase in potential created by the surface minor irrigation systems, actual area irrigated by surface minor has decreased in West Bengal (Table-2.5). Though the potential created by dug wells has increased over time, the actual area irrigated by dug wells remained constant. On the other hand, potential created as well as actual area irrigated by shallow and deep tube wells enjoyed increase in

[8]. See Bagchi (1995), 'Irrigation in India-History and Potentials of Social Management'.

growth. But for both shallow and deep tube wells, the growth of potential created is higher than the growth of actual area irrigated. West Bengal as a whole witnessed very low growth in actual area irrigated by all minor irrigation sources between 1993-94 and 2000-01.

Table-2.5

Growth of Irrigation Potential Created and Actual Area Irrigated by Minor Irrigation Sources in West Bengal during 1993-94 to 2000-01.

(Area in '000 Ha)

Year	Dug wells		Shallow tubewells		Deep tubewells		Surface minor		Total	
	PC	AI	PC	AI	PC	AI	PC	AI	PC	AI
1993-94	39.88	22.46	1543.6	1179.67	258.19	130.42	955.72	603.54	2797.38	1936.09
2000-01	45.41	22.10	2002.2	1245.26	308.73	142.38	1070.84	553.1	3427.19	1962.84
% Growth	13.87	0.00	29.71	5.56	19.57	9.17	12.05	-8.36	22.51	1.38

Source: Report on Minor Irrigation Census, 1993-94 and 2000-01.

Note: PC - Potential created, AI - Actual area irrigated

2.4.1 CANAL IRRIGATION:

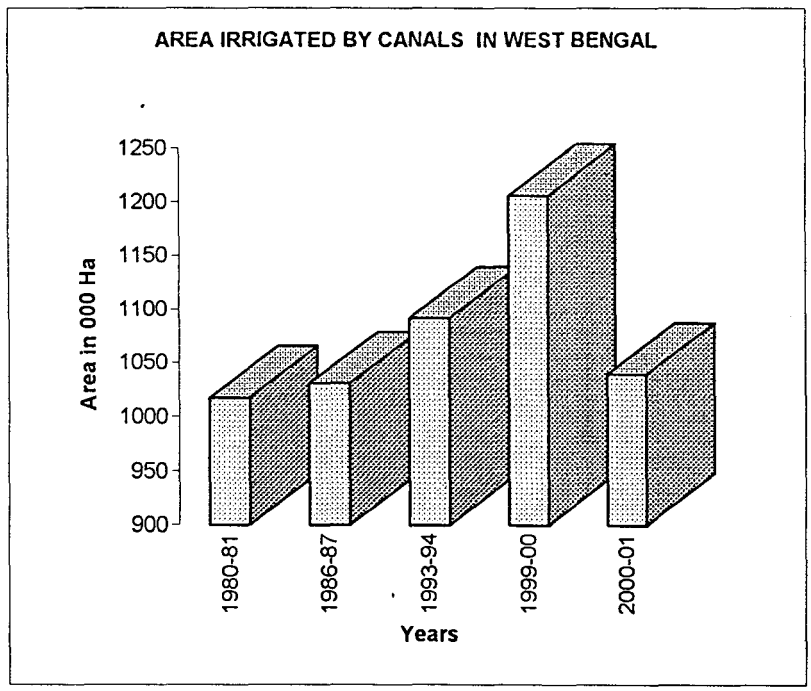
The growth of canal irrigation gradually slowed down after 1977-78 in West Bengal. The highest growth came between the year 1960-61 and 1977-78. It was 4.37 percent (Rawal, 2001). Between 1986-87 and 2000-01, the growth of gross area irrigated by canal is very slow in West Bengal (Table-2.6) because easily utilizable surface water had already been utilized and the cost of creating additional irrigational potential went up dramatically (Sevendsen, 1991). Over the study period, though there were fluctuations in gross area irrigated by canals in West Bengal (Fig-1), a marked decline in area irrigated by canals has been observed between 1999-00 and 2000-01 (-13.82 percent); this reduction took place due to less storage of Kangshabati Reservoir, which irrigates parts of Hooghly, Bankura and Midnapur (Directorate of Irrigation and Waterways, Government of West Bengal, 2001-02).

It has been already mentioned that a profile or scenario of irrigation by all the sources has been obtained over 14 years period from 1986-87 to 2000-01 by putting together data on Government canals from Statistical Abstract of West Bengal and the data on minor irrigation sources from the Report on Minor Irrigation Census. The data on minor irrigation structures in second source is available only for 1986-87, 1993-94 and

2000-01[9]. Therefore, to show the trends in the growth of area irrigated by different sources, the whole study period has been divided into two sub-periods: (i) first sub-period from 1986-87 to 1993-94 and (ii) second sub-period from 1993-94 to 2000-01.

A wide variation in growth of gross area irrigated by canals across districts in West Bengal has been noticed over the study period. Even two sub-periods show variations in trends of growth at both the state and the district level. West Bengal as a whole in the 2nd sub period experienced negative growth in area irrigated by canals (-4.78 percent) as against a positive growth (5.91 percent) in the 1st sub-period (Table-2.6). Though a number of districts have witnessed decline in area irrigated by canals in the 1st sub-period, positive growth has been observed in districts where area irrigated by canals is substantial (Table-2.7). As a result, the state as a whole in this sub-period experienced increase in growth. But in the second sub-period, the situation is reverse and the increase in growth of irrigated area has been noticed in the districts where canal irrigation is not a major source of irrigation. However, in 2nd sub-period, negative growth has been observed in those districts, which have canal irrigation as the primary source of irrigation. (Table-2.8). And most of these districts had experienced positive growth in the former sub-period.

Fig-I



[9] The first, second and third Minor Irrigation Census were conducted respectively in 1986-87, 1993-94 and 2000-01 by the Ministry of Water Resources, Government of India.

Table-2.6

Gross Area Irrigated by Canals and Its growth.

	GIA by Canals in Ha.			Percentage Growth Rate		
Districts	1986-87	1993-94	2000-01	1986-87 to 93-94	1993-94 to 00-01	1986-87 to 2000-01
Bankura	178500	204200	151000	14.40	-26.05	-15.41
Birbhum	180100	190300	185700	5.66	-2.42	3.11
Burdwan	295740	319000	292700	7.87	-8.24	-1.03
Darjeeling	2800	600	9000	-78.57	1400.00	221.43
Hooghly	92100	93900	79000	1.95	-15.87	-14.22
Howrah	5900	4800	10100	-18.64	110.42	71.19
Jalpaiguri	6700	6500	57700	-2.99	787.69	761.19
Koch Bihar	500	500	1600	0.00	220.00	220.00
Malda	-	-	-	-	-	-
Midnapur	190200	176400	152900	-7.26	-13.32	-19.61
Murshidabad	55000	49600	50200	-9.82	1.21	-8.73
N.24 Pgs	-	-	-	-	-	-
Nadia	-	-	-	-	-	-
Purulia	23100	20900	27300	-9.52	30.62	18.18
S.24 Pgs	-	24800	16100	BY-0	-35.08	BY-0
W.Dinajpur	-	-	6000	-	BY-0	BY-0
W.Bengal	1030640	1091500	1039300	5.91	-4.78	0.84

Source: Statistical Abstract of West Bengal, 1978 to 89, 1994-95, 2001-02.
Note: BY - base year

Table-2.7

Growth of Gross Area Irrigated by Canals between 1986-87 and 1993-94.

Increase in Growth	Decline in Growth
Bankura, Burdwan, Birbhum and Hooghly Total: 4 Districts	Darjeeling, Howrah, Murshidabad, Purulia, Midnapur and Jalpaiguri Total: 6 Districts

Table-2.8

Growth of Gross Area Irrigated by Canals between 1993-94 and 2000-01.

Increase in Growth	Decline in Growth
Darjeeling, Jalpaiguri, Koch Bihar, Howrah, Murshidabad, Purulia and Dinajpur. Total: 7 Districts	Bankura, Burdwan, Birbhum, Midnapur, Hooghly and South 24 Parganas. Total: 6 Districts

Over the whole study period between 1986-87 and 2000-01, though majority of the districts have experienced increase in growth of gross area irrigated by canals, the set of districts (Bankura, Burdwan, Midnapur, Murshidabad), which are having large area under canal irrigation, have witnessed an overall decline in growth.

2.4.2 DUG WELL IRRIGATION:

Dug well in West Bengal has never traditionally been an important source of irrigation. The area irrigated by dug wells has been decreasing over time, though few districts have experienced increase in growth of area irrigated by this source. The total area irrigated by dug wells in West Bengal in 1986-87 was 32.10 thousand hectares, which decreased to 22.09 thousand hectares in 2000-01. In both first and second sub-period, West Bengal as a whole has witnessed decline in growth of gross area irrigated by dug wells. But the noticeable fact is that decline in growth is much more higher in the first sub-period than the second sub-period (Table-2.9).

Table-2.9

Growth of Gross Area Irrigated by Dug Wells

	GIA by Dug Wells in Ha.			Percentage Growth Rate		
Districts	1986-87	1993-94	2000-01	1986-87 to 93-94	1993-94 to 00-01	1986-87 to 2000-01
Bankura	5806	3901	2704	-32.81	-30.68	-53.43
Birbhum	783	457	370	-41.63	-18.95	-52.70
Burdwan	443	144	47	-67.49	-67.22	-89.35
Darjeeling	101	41	483	-59.41	1079.39	378.76
Hooghly	29	164	47	465.52	-71.13	63.28
Howrah	-	3	-	BY-0	-100.00	-
Jalpaiguri	2283	1914	6348	-16.16	231.68	178.07
Koch Bihar	1706	1899	1657	11.31	-12.75	-2.88
Malda	4	20	-	400.00	-100.00	-100.00
Midnapore	15668	8054	6360	-48.60	-21.03	-59.41
Murshidabad	-	39	4	BY-0	-88.51	BY-0
N.24 Pgs	-	23	-	BY-0	-100.00	-
Nadia	-	234	3	BY-0	-98.79	BY-0
Purulia	5013	5302	4026	5.77	-24.07	-19.69
S.24 Pgs	-	77	-	BY-0	-100.00	-
W.Dinajpur	263	188	40	-28.52	-78.48	-84.62
W.Bengal	32099	22460	22091	-30.03	-1.64	-31.18

Source: Report on Minor Irrigation Census, 1986-87, 1993-94 and 2000-01.
Note: BY - base year

In most of the districts negligible area is irrigated by dug wells[10]. Bankura, Midnapur and Jalpaiguri are the three districts, where relatively large area is irrigated by dug wells as compared to the remaining districts. But the two former districts have witnessed continuous decline in area irrigated by dug wells. Over the whole study period, majority of the districts have witnessed decline in growth of dug well irrigation, because many dug wells have become derelict and nonexistent due to the lack of maintenance and renovation (State Water Investigation and Directorate, 2003).

2.4.3 TUBEWELL IRRIGATION:

Tubewell irrigation has been the most important means to boost up the agricultural production in West Bengal after the first half of 1970s. There is gradual increase in the tubewell irrigation over the study period. The percentage share of area irrigated by tubewells to the total gross area irrigated by all sources in the state has increased rapidly between 1986-87 and 2000-01. It was 34.66 percent in 1986-87, which became 46.31 percent in 2000-01 (Table-2.19 & 2.21). The growth of tube well irrigation in West Bengal is faster than any other irrigation system, because tube well irrigation provides less implemental hazards, better dependability and needs less investment as compared to large and medium irrigation projects (Tenth Five Year Plan, Government of West Bengal, 2002-07). Besides, the supply of water from tube wells to the crop fields is comparatively more assured and qualitative than any other irrigation systems (Sen, 1994).

West Bengal as a whole has witnessed continuous increase in gross area irrigated by the tubewells (both shallow and deep tubewells) over the study period. Very high growth in gross area irrigated by tubewells took place in the first sub-period between 1986-87 and 1993-94, i.e. only within a short span of seven years. But in the second sub-period between 1993-94 and 2000-01, the growth slowed down by more than six times (Table-2.10).

[10] In Murshidabad and Nadia in 1986-87 the gross area irrigated by dug wells was nil, but in 2000-01 only 4.48 hectares in Murshidabad and 2.82 hectares in Nadia were irrigated by dug wells, which are very negligible.

Table-2.10

Growth of Gross Area Irrigated by Tubewells

	GIA by Tube wells in Ha.			Percentage Growth		
Districts	1986-87	1993-94	2000-01	1986-87 to 93-94	1993-94 to 00-01	1986-87 to 2000-01
Bankura	37486	57079	53790	52.27	-5.76	43.49
Birbhum	35001	46062	44645	31.60	-3.08	27.55
Burdwan	107622	157514	183775	46.36	16.67	70.76
Darjeeling	585	2398	3098	309.91	29.21	429.64
Hooghly	76086	90020	107583	18.31	19.51	41.40
Howrah	6760	7017	8658	3.80	23.38	28.07
Jalpaiguri	5259	15954	16104	203.37	0.94	206.22
Koch Bihar	12534	34822	51208	177.82	47.06	308.55
Malda	61352	95231	99632	55.22	4.62	62.39
Midnapur	120189	155501	182424	29.38	17.31	51.78
Murshidabad	148875	199511	191759	34.01	-3.89	28.81
N.24 Pgs	116709	114724	113877	-1.70	-0.74	-2.43
Nadia	154563	176124	155803	13.95	-11.54	0.80
Purulia	-	12	4	BY-0	-66.67	BY-0
S.24 Pgs	10738	10389	13975	-3.25	34.51	30.14
W.Dinajpur	65208	147726	161299	126.55	9.19	147.36
W.Bengal	958967	1310084	1387633	36.61	5.92	44.70

Source: Report on Minor Irrigation Census, 1986-87, 1993-94 and 2000-01.

Note: BY - base year

Table-2.11

Growth of Irrigated Area in India

	Area In 000 Ha			Percentage Growth		
	1986-87	1993-94	2000-01	1986-87 to 1993-94	1993-94 to 2000-01	1986-87 to 2000-01
NIA by Tubewells	21046	27060	33277	28.58	22.97	58.12
GIA by All sources	55636	68255	75142	22.68	10.09	35.06

Source: Statistical Abstract of India, 1990, 1997 and 2003.

(a) Growth and Development of Tubewell Irrigation between 1986-87 and 1993-94:

Dhawan (1990) pointed out that the number of shallow tubewells increased by 130 percent in West Bengal between 1981 and 1988. Literature review showed that tubewell irrigation is most developed in the eastern districts of the state, namely North 24 Parganas, Nadia and Murshidabad (Swaminathan, 1998). In the first sub-period at district level, very high growth in gross area irrigated by tubewells has been

observed in north Bengal districts namely, Jalpaiguri, Koch Bihar, Dinajpur and Darjeeling. Medium growth in tubewell irrigation has been observed mainly in canal-dominated districts during this time period (Table-2.12 and 2.22). In some districts, high growth in irrigated area during the 1st sub-period took place partially due to relatively low base in the initial year of the study period.

In 1st sub-period period, growth of tubewell irrigation is more in West Bengal as compared to growth in India (Table-2.10 & 2.11), but the opposite scenario has been noticed in the 2nd sub-period. During 1st sub-period, the state experienced medium growth (36.61 percent), whereby India as a whole experienced low growth (22.68 percent), but during 2nd sub-period both West Bengal and India witnessed low growth.

Table-2.12

Growth of Gross Area Irrigated by Tube wells between 1986-87 and 1993-94.

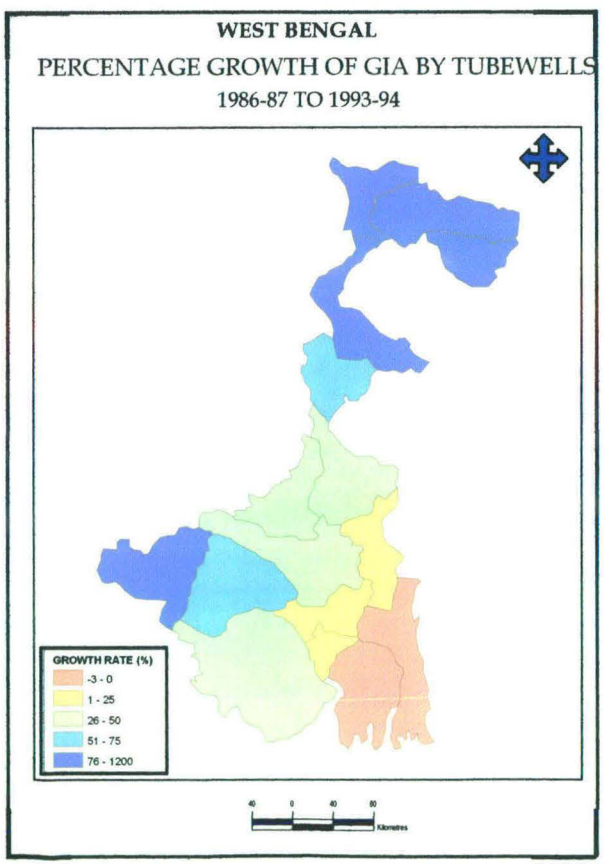
Category	Very High (More than 75%)	High (75 - 50%)	Medium (50 - 25%)	Low (25 - 0%)	Negative
Districts	Darjeeling, Jalpaiguri, Koch Bihar, Dinajpur	Bankura and Malda	Birbhum, Burdwan, Midnapur, Murshidabad	Hooghly, Howrah, Nadia	N. 24 Parganas, S.24 Parganas

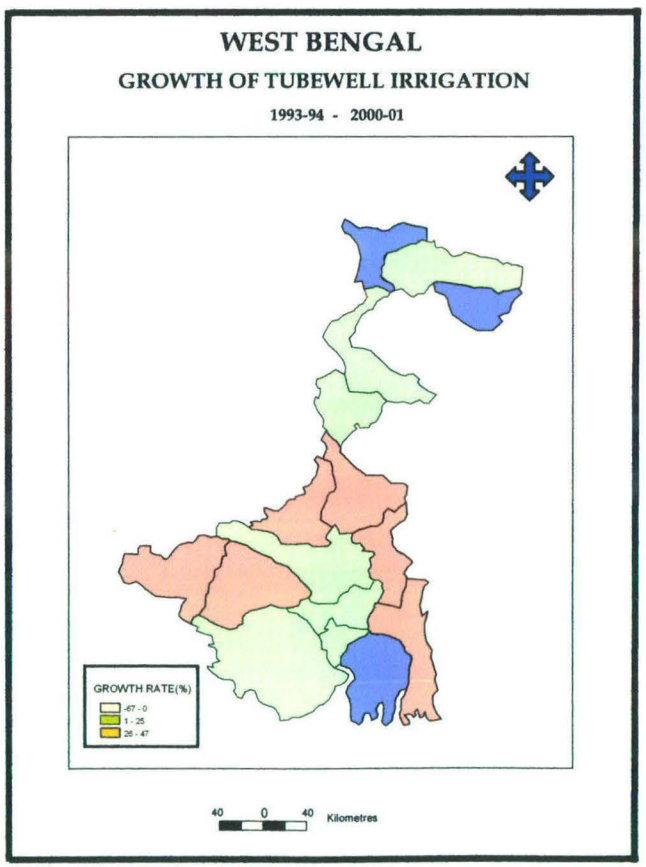
(b) Growth and Development of Tubewell Irrigation between 1993-94 and 2000-01:

In the 2nd sub period, the growth of tubewell irrigation slowed down across all the districts as well as in the state. In this sub period, none of the districts witnessed very high or high growth in tubewell irrigation. Medium growth has been found in two north Bengal districts, namely Koch Bihar and Darjeeling. Number of the districts experienced low and very low growth in tubewell irrigation. Even, some districts witnessed negative growth in this sub-period (Table-2.10 & 2.13).

Map-2.1

GROWTH OF TUBEWELL IRRIGATION





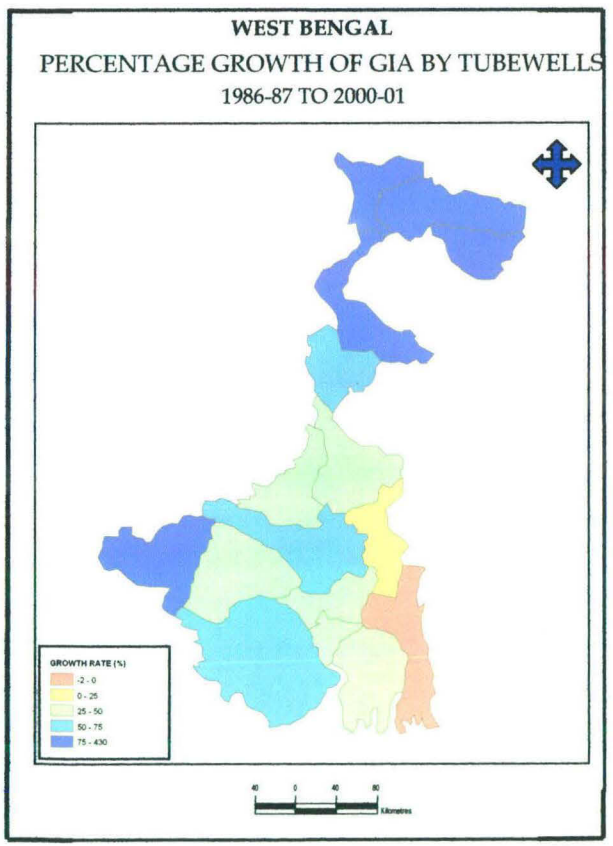


Table-2.13

Growth of Gross Area Irrigated by Tubewells between 1993-94 and 2000-01.

Category	Very High Growth (More than 75 %)	Moderate High (75 - 50 %)	Medium (50 - 25 %)	Low (25 - 10 %)	Very Low (10 - 0 %)	Negative Growth
Districts	Nil	Nil	Darjeeling, Koch Bihar, S.24 Parganas	Burdwan, Hooghly, Howrah, Midnapur	Jalpaiguri, Malda, Dinajpur	Bankura, Birbhum, Murshidabad, N.24 Parganas, Nadia, Purulia

Over the study period between 1986-87 and 2000-01, very high growth in tubewell irrigation has taken place in the northern districts of West Bengal (Map-2.1). In contrast, the southern districts of the state experienced lower growth, because in the second half of the 1970s and early 1980s the highest growth in tubewell irrigation took place in this part of the state. It has also been observed that the two eastern districts- North 24 Parganas and Nadia have witnessed respectively negative growth and marginal increase in growth of tubewell irrigation and the canal-dominated districts (Burdwan and Birbhum) have witnessed medium growth over the study period.

Table-2.14

Growth of Gross Area Irrigated by Tubewells between 1986-87 and 2000-01.

Category	Very High Growth (More than 75 %)	Moderate High (75 – 50 %)	Medium (50 – 25 %)	Low (25 – 0 %)	Negative Growth
Districts	Darjeeling, Jalpaiguri, Koch Bihar, Dinajpur	Burdwan, Malda, Midnapur	Bankura, Hooghly, S.24 Pgs, Murshidabad, Howrah, Birbhum,	Nadia	N.24 Parganas

2.4.4 SURFACE MINOR IRRIGATION:

Decline in growth of gross area irrigated by surface minor irrigation systems has been observed in West Bengal over the study period. But the decline in growth of irrigated area in the first sub-period is higher than the second sub-period.

Reduction in area irrigated by surface minor systems occurred because of the fact that the number of surface lift schemes has been reduced and many surface flow schemes have become derelict and nonexistent due to silting, lack of maintenance and conversion for other uses (Water Investigation and Development Department, Government of West Bengal, 2003). At district level, both in first and second sub-period as well as over the whole study period majority of the districts witnessed decline in growth of surface minor irrigation (Table-2.15).

So far as the number surface minor irrigation schemes is concerned, the decline in growth of number of surface lift schemes is greater than the surface flow schemes (more than twice) over the study period in West Bengal (Table-2.17). Most of the districts witnessed decline in growth of surface lift schemes as well as surface flow schemes.

Table-2.15

Growth of Gross Irrigated Area by Surface Minor Schemes

Districts	GIA by S.Minor Schemes in Ha			Percentage Growth		
	1986-87	1993-94	2000-01	1986-87 to 93-94	1993-94 to 00-01	1986-87 to 2000-01
Bankura	109147	96501	705456	-11.59	-26.90	-35.37
Birbhum	83429	57492	35876	-31.09	-37.60	-57.00
Burdwan	83982	54378	28301	-35.25	-47.95	-66.30
Darjeeling	17442	6422	8995	-63.18	40.06	-48.43
Hooghly	58189	36941	33022	-36.52	-10.61	-43.25
Howrah	53995	43405	75031	-19.61	72.86	38.96
Jalpaiguri	13997	22695	29031	62.14	27.92	107.41
Koch Bihar	3423	4242	4209	23.93	-0.79	22.95
Malda	26479	14963	15243	-43.49	1.87	-42.43
Midnapur	105462	90770	70067	-13.93	-22.81	-33.56
Murshidabad	37810	26237	18665	-30.61	-28.86	-50.64
N.24 Pgs	6050	6461	7013	6.79	8.54	15.92
Nadia	9080	9157	11200	0.85	22.31	23.35
Purulia	83314	68079	62872	-18.29	-7.65	-24.54
S.24 Pgs	50218	42979	63892	-14.42	48.66	27.23
W.Dinajpur	27110	22810	19133	-15.86	-16.12	-29.42
W.Bengal	769127	603532	553097	-21.53	-8.36	-28.09

Source: Report on Minor Irrigation Census, 1986-87, 1993-94 and 2000-01.

Table-2.16

Growth of Gross Area Irrigated by Surface Minor Schemes between 1986-87 and 2000-01.

Increase in Growth	Decline in Growth
Jalpaiguri, Purulia, Nadia and North 24 Parganas	Burdwan, Bankura, Birbhum, Darjeeling, Hooghly, Howrah, Koch Bihar, Malda, Midnapur, Murshidabad, South 24 Parganas and Dinajpur.

Table-2.17

Growth of the Number of Surface Minor Schemes between 1986-87 and 2000-01.

	1986-87			2000-01			Growth (%)		
Districts	S.Flow	S.lift	S.Minor	S.Flow	S.lift	S.Minor	S.Flow	S.lift	S.Minor
Bankura	6671	15344	22015	13110	2036	15146	96.52	-86.73	-31.20
Birbhum	744	20815	21559	7434	8760	16194	899.19	-57.91	-24.89
Burdwan	1163	24104	25267	1452	4151	5603	24.85	-82.78	-77.82
Darjeeling	569	57	626	305	99	404	-46.40	73.68	-35.46
Hooghly	3055	11802	14857	204	8960	9164	-93.32	-24.08	-38.32
Howrah	2241	12360	14601	474	9381	9855	-78.85	-24.10	-32.50
Jalpaiguri	266	193	459	373	807	1180	40.23	318.13	157.08
Koch Bihar	75	1948	2023	-	1016	1016	-100.00	-47.84	-49.78
Malda	1307	5724	7031	350	4036	4386	-73.22	-29.49	-37.62
Midnapur	23197	71192	94389	1875	34356	36231	-91.92	-51.74	-61.62
Murshidabad	1147	6068	7215	1808	1785	3593	57.63	-70.58	-50.20
N.24 Pgs	43	1785	1828	969	1026	1995	2153.49	-42.52	9.14
Nadia	-	334	334	38	340	378	BY-0	1.80	13.17
Purulia	15231	357	15588	19467	311	19778	27.81	-12.89	26.88
S.24 Pgs	2263	32687	34950	1566	24912	26478	-30.80	-23.79	-24.24
W.Dinajpur	5892	2301	8193	3	4864	4867	-99.95	111.39	-40.60
W.Bengal	63864	207071	270935	49428	106840	156268	-22.60	-48.40	-42.32

Source: Report on Minor Irrigation Census, 1986-87 and 2000-01.
Note: BY - base year

2.4.5 GROWTH TREND OF GROSS IRRIGATED AREA BY ALL SOURCES ACROSS DISTRICTS:

During the study period between 1986-87 and 2000-01, West Bengal as a whole has experienced low growth in gross area irrigated by all sources (0.50 percent per annum). This increase in growth has been possible due to the increase in gross area

irrigated by all sources in West Bengal in the first sub-period only, because the state as a whole in the second sub-period has witnessed decline in growth (Table-2.18).

Table-2.18

Annual Compound Growth Rate (%) of Total Gross Area Irrigated (in 000 ha) by All Sources

Districts	1986-87	1993-94	2000-01	Annual Compound Growth (%)		
	Total GIA	Total GIA	Total GIA	1986-87 to 1993-94	1993-94 to 2000-01	1986-87 to 2000-01
Bankura	330.94	361.68	278.04	1.12	-3.23	-1.08
Birbhum	299.31	294.31	266.59	-0.21	-1.23	-0.72
Burdwan	487.79	531.04	504.82	1.07	-0.63	0.21
Darjeeling	20.93	9.46	21.58	-9.45	10.86	0.19
Hooghly	226.40	221.03	219.65	-0.30	-0.08	-0.19
Howrah	66.66	55.23	93.79	-2.32	6.84	2.16
Jalpaiguri	28.24	47.06	109.18	6.59	11.09	8.82
Koch Bihar	18.16	41.46	58.67	10.87	4.44	7.60
Malda	87.84	110.21	114.87	2.88	0.52	1.69
Midnapur	407.32	434.03	411.75	0.80	-0.66	0.07
Murshidabad	241.69	275.39	260.63	1.65	-0.69	0.47
N & S 24 Pgs	183.72	199.45	214.86	1.03	0.93	0.98
Nadia	163.64	185.52	167.01	1.58	-1.31	0.13
Purulia	111.43	94.29	94.20	-2.07	-0.01	-1.04
W.Dinajpur	92.58	170.72	180.47	7.95	0.70	4.26
W.Bengal	2766.64	3030.87	2996.12	1.15	-0.14	0.50

Source: (i) Statistical Abstract of West Bengal, 1994-95, 1997-98 and 2001-02.
(ii) Report on Minor Irrigation Census, 1986-87, 1993-94 and 2000-01.

At district level, in the first sub-period between 1986-87 and 1993-94, majority of the districts in West Bengal experienced increase in growth of gross area irrigated by all sources but high annual growth has been observed in the three north Bengal districts, namely Koch Bihar, Dinajpur and Jalpaiguri. In Koch Bihar, though the percentage share of irrigated area by dug wells and surface minor structures to their total gross irrigated area by all sources decreased slightly, area irrigated by tubewells increased tremendously (Table-2.19 & 2.20). In Jalpaiguri, the percentage share of irrigated area by canals and dug wells to its total gross irrigated area reduced, but the percentage share of irrigated area by tubewells increased rapidly. In Dinajpur also, high annual growth took place due to the rapid expansion in tubewell irrigation. On the other hand, due to sharp decline in percentage share of area irrigated by canal and surface minor schemes to total

gross irrigated area, Darjeeling witnessed negative growth in the first sub-period. In case of Purulia and Hooghly, the negative growth has been observed due to decline in area irrigated by surface minor irrigation.

Table-2.19

Percentage Share of Area Irrigated by Major Sources to Total Gross Irrigated Area in 1986-87.

Districts	Canals	D.Well	Tubewells	S.Minor	Total Minor Irrigation
Bankura	53.94	1.75	11.33	32.98	46.06
Birbhum	60.17	0.26	11.69	27.87	39.83
Burdwan	60.63	0.09	22.06	17.22	39.37
Darjeeling	13.38	0.48	2.80	83.34	86.62
Hooghly	40.68	0.01	33.61	25.70	59.32
Howrah	8.85	-	10.14	81.01	91.15
Jalpaiguri	23.73	8.08	18.62	49.57	76.27
Koch Bihar	2.75	9.39	69.01	18.85	97.25
Malda	-	-	69.85	30.15	100.00
Midnapur	44.08	3.85	29.51	25.89	59.25
Murshidabad	22.76	-	61.60	15.64	77.24
N.24 Pgs	-	-	95.07	4.93	100.00
Nadia	-	-	94.45	5.55	100.00
Purulia	20.73	4.50	-	74.77	79.27
S.24 Pgs	-	-	17.62	82.38	100.00
W.Dinajpur	-	0.28	70.43	29.28	100.00
W.Bengal	36.93	1.16	34.66	27.80	63.62

Source: (i) Statistical Abstract of West Bengal, 1994-95
(ii) Report on Minor Irrigation Census, 1986-87.

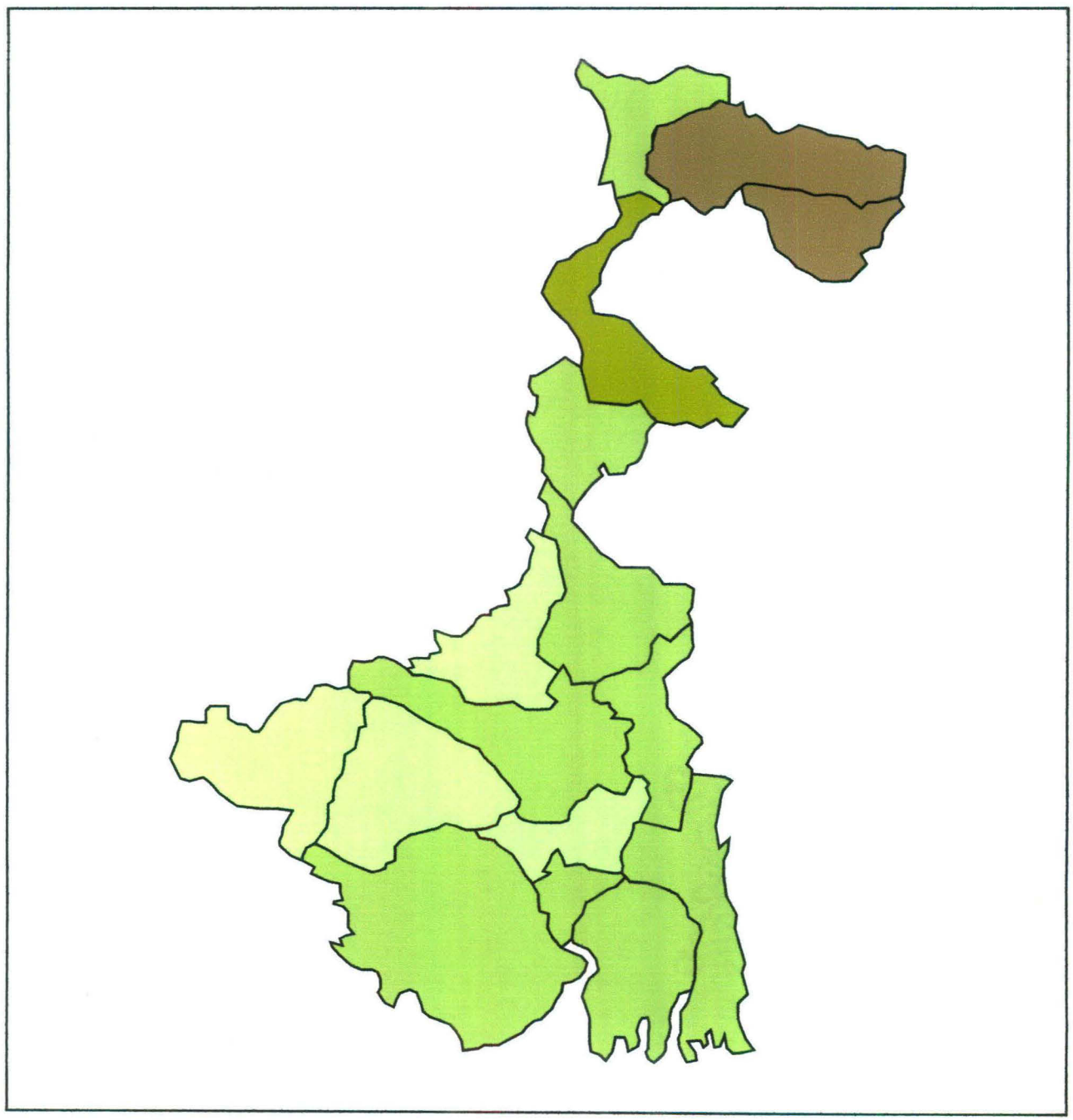
In the second sub-period between 1993-94 and 2000-01, again the high annual growth has been observed in the above-mentioned north Bengal districts. Many districts witnessed decline in growth of gross area irrigated in this sub-period. The highest decline in growth has been observed in Bankura due to the decline in percentage share of area irrigated by canals, dug wells and surface minor schemes (Table-2.20 & 2.21).

Over the whole study period, so far as the irrigation development is concerned, majority of the districts in West Bengal experienced positive growth. Comparatively higher growth in gross area irrigated by all sources has been observed in

Map-2.2

GROWTH TREND OF GROSS IRRIGATED AREA ACROSS DISTRICTS IN WEST BENGAL

1986-87 TO 2000-01



Annual Compund Growth Rate (in %)

- -1.08 - 0
- 0.00 - 2.5
- 2.50 - 5.0
- > 5

100 0 100 Kilometers

Table-2.20

Percentage Share of Area Irrigated by Major Sources to Total Gross Irrigated Area in 1993-94.

Districts	Canal	D.Wells	Tubewells	S.Minor	Total Minor Irrigation
Bankura	56.46	1.08	15.78	26.68	43.54
Birbhum	64.66	0.16	15.65	19.53	35.34
Burdwan	60.07	0.03	29.66	10.24	39.93
Darjeeling	6.34	0.43	25.35	67.88	93.66
Hooghly	42.48	0.07	40.73	16.71	57.52
Howrah	8.69	0.01	12.71	78.60	91.31
Jalpaiguri	13.81	4.07	33.90	48.22	86.19
Koch Bihar	1.21	4.58	83.98	10.23	98.79
Malda	-	0.02	86.41	13.58	100.00
Midnapur	40.95	1.86	35.83	20.91	58.60
Murshidabad	18.01	0.01	72.45	9.53	81.99
N.24 Pgs	-	0.02	94.65	5.33	100.00
Nadia	-	0.13	94.94	4.94	100.00
Purulia	22.16	5.62	0.01	72.20	77.84
S.24 Pgs	31.70	0.10	13.28	54.93	68.30
W.Dinajpur	-	0.08	97.15	2.77	100.00
W.Bengal	36.05	0.74	43.22	19.91	63.88

Source: (i) Statistical Abstract of West Bengal, 1997-98
(ii) Report on Minor Irrigation Census, 1993-94.

Table-2.21

Percentage Share of Area Irrigated by Major Sources to Total Gross Irrigated Area in 2000-01.

Districts	Canal	D.Wells	Tubewells	S.Minor	Total Minor Irrigation
Bankura	54.31	0.97	19.35	25.37	45.69
Birbhum	69.66	0.14	16.75	13.46	30.34
Burdwan	57.98	0.01	36.40	5.61	42.02
Darjeeling	41.71	2.24	14.36	41.69	58.29
Hooghly	35.97	0.02	48.98	15.03	64.03
Howrah	10.77	-	9.23	80.00	89.23
Jalpaiguri	52.85	5.81	14.75	26.59	47.15
Koch Bihar	2.73	2.82	87.28	7.17	97.27
Malda	-	-	86.73	13.27	100.00
Midnapur	37.13	1.54	44.30	17.02	62.87
Murshidabad	19.26	-	73.58	7.16	80.74
N.24 Pgs	-	-	94.20	5.80	100.00
Nadia	-	-	93.29	6.71	100.00
Purulia	28.98	4.27	-	66.74	71.02
S.24 Pgs	17.13	-	14.87	67.99	82.87
W.Dinajpur	-	-	96.40	3.60	100.00
W.Bengal	34.49	0.74	46.31	18.46	65.51

Source: (i) Statistical Abstract of West Bengal, 2001-02
(ii) Report on Minor Irrigation Census, 2000-01.

the northern districts of the state (Map-2.2), which are backward in terms of percentage share of total gross irrigated area to total gross cropped area and come under unirrigated or low irrigated category (Table-2.22 & 2.23).

2.5 DISPARITY IN IRRIGATION DEVELOPMENT ACROSS DISTRICTS:

Over the whole study period no major changes have been observed across districts as far as the irrigation status is concerned[11]. Malda and North 24 Parganas are the two districts that have shifted from unirrigated or low irrigated to moderately irrigated category (Table-2.22). Both the districts are primarily irrigated by tubewells throughout the whole study period. The noticeable fact is that all the unirrigated or low irrigated districts, which were lagging behind, have witnessed increase in percentage share of gross irrigated area to gross cropped area over the study period (Table-2.23) and except Jalpaiguri, all other districts in this category (unirrigated) are mainly irrigated by tubewells.

Highly irrigated districts are either canal dominated or having mixed irrigation systems of irrigation. All the districts in this category have witnessed decline in their percentage share of gross irrigated area to total gross cropped area during 1986-87 to 2000-01.

To see the variations or inequalities within the districts in terms of percentage share of gross irrigated area (GIA) to total gross cropped area (GCA), Coefficient of Variance has been calculated for the three years 1986-87, 1993-94 and 2000-01. Coefficient of Variance has become lower and lower over the study period (Table – 2.24), which indicates that the variations or inequalities have reduced within the districts over the study period. This happened because of the fact that most of the backward districts have experienced increase in percentage share of gross irrigated area over time on the one hand and on the other hand, highly irrigated four districts- Hooghly, Birbhum, Bankura and Burdwan have witnessed decline in percentage share of gross irrigated area to total gross cropped area over the study period.

[11] Irrigation status has been determined based on the percentage share gross irrigated area by all sources in a districts to its total gross cropped area. For details see Chapter-I (Framework of Analysis).

Table-2.22

Irrigation Status and Dominated Irrigation Systems across Districts in West Bengal.

% GIA to GCA	Irrigation Status	1986-87	Mainly Irrigated by	1993-94	Mainly Irrigated by	2000-01	Mainly Irrigated by
1. Less than 25%	Unirrigated	Koch Bihar Jalpaiguri West Dinajpur Darjeeling Malda North & South 24 Pgs	Tubewells Mixed (Sm, Ca) Tubewells Surface Minor Tubewells Tubewells	Koch Bihar Jalpaiguri West Dinajpur Darjeeling S. 24 Pgs	Tubewells Mixed (Sm, Tw) Tubewells Surface Minor Mixed (Sm, Ca)	Koch Bihar Jalpaiguri U. Dinajpur D.Dinajpur Darjeeling S.24 Pgs	Tubewells Mixed (Ca, Sm) Tubewells Tubewells Mixed (Ca, Sm) Tubewells.
2. 25% to 50%	Moderately Irrigated	Nadia Purulia Murshidabad Midnapur Howrah	Tubewells Surface Minor Tubewells Mixed (Ca,Tw,Sm) Surface Minor	Malda N. 24 Pgs Nadia Purulia Murshidabad Midnapur Howrah	Tubewells Tubewells Tubewells Mixed (Sm, Ca) Tubewells Mixed (Ca, Tw) Surface Minor	Malda N. 24 Pgs Nadia Purulia Murshidabad Midnapur	Tubewells Tubewells Tubewells Mixed (Sm, Ca) Tubewells Mixed (Tw, Ca)
3. More than 50%	Highly Irrigated	Hooghly Birbhum Bankura Burdwan	Mixed (Ca,Tw,Sm) Canals Mixed (Ca, Sm) Canals	Hooghly Birbhum Bankura Burdwan	Mixed (Ca, Tw) Canals Mixed (Ca, Sm) Mixed (Ca, Tw)	Howrah Hooghly Birbhum Bankura Burdwan	Surface Minor Mixed (Tw, Ca) Canals Mixed (Ca, Sm) Mixed (Ca, Tw)

Note: Arrow indicates the shifting of a district from one category to another.
Ca - Canals, Tw - Tubewells, Sm - Surface Minor.

Moderately Irrigated: Seven districts; four districts are tubewell dominated and two districts are having mixed irrigation systems.

Highly Irrigated: Four districts; two districts are canal dominated and two districts are having mixed irrigation systems.

Table-2.23

Percentage Share of Gross Irrigated Area to Total Gross Cropped Area.

1986-87		1993-94		2000-01	
Districts	% GIA_GCA	Districts	% GIA_GCA	Districts	% GIA_GCA
Burdwan	77.72	Burdwan	75.15	Burdwan	71.48
Bankura	77.20	Bankura	74.53	Howrah	68.76
Birbhum	72.25	Birbhum	66.95	Birbhum	63.76
Hooghly	66.75	Hooghly	51.84	Hooghly	63.23
Howrah	49.48	Murshidabad	40.93	Bankura	60.71
Midnapore	39.73	W.Bengal	38.50	Murshidabad	39.85
Murshidabad	36.83	Howrah	36.09	W.Bengal	37.78
W.Bengal	36.98	Midnapore	34.76	Midnapore	31.61
Purulia	31.96	Nadia	31.51	Purulia	30.94
Nadia	28.93	N.24 Pgs	29.75	Malda	29.74
N & s 24 Pgs	22.94	Purulia	27.52	N.24 Pgs	28.90
Malda	21.74	Malda	27.21	Nadia	27.94
Darjeeling	14.10	W.Dinajpur	25.98	U.Dinajpur	26.90
W.Dinajpur	13.81	S.24 Pgs	16.73	Jalpaiguri	23.39
Jalpaiguri	6.23	Jalpaiguri	11.25	Darjeeling	22.88
Koch Bihar	3.87	Koch Bihar	9.47	D.Dinajpur	21.90
		Darjeeling	8.23	S.24 Pgs	20.20
				Koch Bihar	12.94

Source: (i) Statistical Abstract of West Bengal, 1978 to 89, 1994-95, 2001-02
(ii) Report on Minor Irrigation Census, 1986-87, 1993-94 and 2000-01.

Table-2.24

Coefficient of Variation of Percentage Share of Gross Irrigated Area to Total Gross Cropped Area.

	1986-87	1993-94	2000-01
Coefficient of Variation (%)	68.18	60.93	51.02

2.6 CONCLUSION:

With sufficient acceleration in the implementation of land reforms and institutions of Panchyat Raj, West Bengal transformed its status from lagged in 1970s to star performer in 1980s. The 1980s, the decade that immediately followed the take over by the left saw a remarkable renaissance in the fortunes of the average Bengali Farmers. Agricultural growth in West Bengal in the 1980s was mainly because of the growth in the production of boro paddy and it was based on an expansion of irrigation by private shallow

tubewells. Public investment in the form of electrification has been crucial input in the development of ground water irrigation. From overall observations and analysis, the following distinguished facts have come out in respect of growth and development of irrigation in West Bengal between 1986-87 and 2000-01.

- Despite of the increase in potential created by the surface minor irrigation systems, actual area irrigated by surface minor schemes has declined (-28.09 percent) over the study period on the one hand and on the other hand, continuous increase has been observed in case of both potential created and actual area irrigated by tubewells in the state.
- Only tubewell irrigation has witnessed increase in percentage share of gross irrigated area in West Bengal. In 1986-87, the percentage share of area irrigated by tubewells to the total gross irrigated area in the state was 34.66 percent, which became 43.22 percent in 1993-94 and 46.31 percent in 2000-01. All other sources have witnessed decline in percentage share.
- The northern districts of the state, namely Darjeeling, Koch Bihar, Jalpaiguri and Dinajpur have experienced very high growth in tube well irrigation over the study period in comparison to other districts. The eastern districts (N.24 Parganas, Nadia and Murshidabad), which witnessed high growth before the study period, experienced low growth between 1986-87 and 2000-01. Even N.24 Parganas has witnessed decline in growth (-2.43 percent) over the study period.
- The overall growth of canal irrigation has slowed down. The state as a whole has witnessed very low growth in gross area irrigated by canals. Though a number of districts have experienced increase in area irrigated by canals, these are districts where canal is not important or primary source of irrigation. The set of districts (Bankura, Burdwan, Midnapur, Murshidabad), which are having large area under canal irrigation have witnessed decline in growth during the study period. The area irrigated by dug wells has reduced over the time though few districts witnessed increase in growth of gross irrigated area.
- Decline in number surface minor schemes (-42.32 percent) and dug wells (-37.88 percent) has been observed over the study period. But the number of shallow and deep tubewells has experienced high growth, respectively 64 percent and 65 percent.

- Variations or inequalities within the districts in terms of percentage share of gross irrigated area (GIA) to total gross cropped area (GCA) over the study period have declined. The Coefficient of Variation in 1986-87 was 68.18 percent, which decline to 51.02 percent in 2000-01. It happens because of the fact that most of the backward districts have enjoyed increase in percentage share of gross irrigated area to total gross cropped area over the study period but highly irrigated districts have witnessed decline.

CHAPTER-III

IRRIGATION SYSTEMS AND CHANGES IN TRENDS OF AREA, YIELD AND PRODUCTION OF MAJOR CROPS

3.1 INTRODUCTION:

Adoption of a scientific cropping pattern optimally suited to a region is necessary to augment the growth of agricultural production and productivity[1]. With the development of agriculture, cropping pattern has been changed to cope with the changing conditions and to meet the ever-changing demands of growing population. Acreage allocation decisions of farmers in a region are based on agronomic, economic, technological, institutional and social factors. The cropping tends to change in tune with changes in one or some of these factors (Dhindsa and Sharma, 1995; Neena, 1998 and Phanindra, 2000). The introduction of new seeds, fertilizers, irrigation, insecticides and pesticides, machinery etc has not only led to intensification of farming but also resulted in large-scale diversification of crops and the benefits have accrued to the whole farming community (De, 2000).

The change in cropping of a region may show a shift from traditional varieties of crops to new high yielding varieties of crops, which are relatively more remunerative than the earlier ones, or some new crops may also be introduced in the existing cropping pattern. Such type of changes in cropping pattern may lead to redistribution of land resources to different enterprises, which ultimately have a bearing on accelerating the growth of crop efficiency in the region[2]. Farmers adopt crop diversification as an instrument to achieve two alternative objectives: (1) profit maximization and (2) adoption of product mix that reduces variability in agricultural income typically associated with yield and price fluctuations due to the lack of credits and insurance facilities (Chadha, Sen and Sharma, 2004). Change in

[1] Cropping pattern is commonly defined as the percentage share of various crops in the gross cropped area of a region at a particular point of time, usually one year.

[2] See Dhindsa and Sharma (1995), 'Analysis of Cropping Pattern Changes in Punjab during 1965-66 to 990-91', Indian Economic Review, pp 69-87.

cropping pattern is an integral part of popular mode of diversification, which has far reaching impact on development of agriculture and rural poverty. A suitable cropping pattern provides maximum aggregate production with minimum cost (Neena, 1998).

After many years of economic planning, agriculture sector in India has experienced two important crop revolutions- the 'green revolution' and the 'yellow revolution' (Goswami et al, 2004)[3]. Since the beginning of these crop revolutions, Indian agriculture has undergone considerable transformations. One of these changes is cropping pattern of the country. Not only have there been aggregate changes but there have also been wide variations in the cropping pattern of different regions/states. Many studies have been carried out about such changes, but relatively less is known about West Bengal- the state endowed with fertile plain land and abundant water resources.

The main objectives of this chapter are:

(i) to assess the change in cropping pattern across districts in West Bengal during 1986-87 to 2000-01,

(ii) to see the level of diversification over the study period and

(iii) to examine the relative contribution of area and yield of individual crops to their output growth across districts with different systems of irrigation in West Bengal.

The discussion has been organized into six sections. Section 2 describes the area changes in individual major crop to gross cropped area at the district level with different systems of irrigation. Section 3 discusses about the level crop diversification across districts in West Bengal during 1986-87 to 2000-01. Section 4 analyses the growth trends in yield of major crops at district level. The focus of section 5 is to assess the impact of relative contribution of area and yield in output growth of each and every major individual crop. This has been done by comparing the compound growth rate of area acreage, yield and output of various crops.

[3] Green revolution aimed at achieving self-sufficiency in food grains and the yellow revolution in edible oilseeds.

3.2 INTER DISTRICT VARIATIONS IN AREA UNDER MAJOR CROPS OR CROP GROUPS:

There are two sources of crop diversification: (i) area augmentation and (ii) crop substitution. Area augmentation comes through utilization of fallow lands and rehabilitation of degraded lands, or increasing cropping intensity (Joshi et al, 2004). Rice the staple of West Bengal is rightly considered the most important crop in West Bengal. In West Bengal most of the districts (12 districts) have more than 60% of their gross cropped area (GCA) under rice cultivation throughout the study period (Table-3.1).

Table-3.1

Percentage Share of Rice to Gross Cropped Area.

Districts	1986-87	1993-94	2000-01
Burdwan	83.49	85.73	82.51
Birbhum	74.80	84.44	76.11
Bankura	84.09	86.24	86.38
Midnapur	88.26	86.11	85.11
Howrah	85.89	91.96	83.06
Hooghly	67.84	66.63	57.37
24 Parganas	81.00	83.83	79.22
Nadia	46.61	49.53	38.35
Murshidabad	46.01	53.08	34.41
Dinajpur	70.42	71.04	68.46
Malda	61.89	59.83	57.41
Jalpaiguri	61.74	60.49	55.88
Darjeeling	33.22	38.17	36.16
Koch Bihar	69.05	69.66	64.35
Purulia	82.73	85.87	86.11
W.Bengal	71.24	73.78	68.55

Source: Statistical Abstract of West Bengal, 1994-95, 1997-98 and 2001-02.

To see the specialization in rice cultivation over the study period, all the districts in West Bengal have been divided into given below three categories based on the percentage share of area under rice to gross cropped area (Table-3.2).

No major changes have taken place across districts as far as the rice specialization is concerned. The only change is that Dinajpur (primarily irrigated by tubewells) has shifted from highly specialized category to moderately specialized category over time. Majority of the districts as well as the state as a whole have witnessed decline in percentage share of rice cultivated area to total gross cropped area during the study period due to continuous decline in percentage share of area under aman and aus rice (Table-3.1 and Fig-3.I). Highly specialized districts in rice

Table-3.2

Specialization in Rice across Districts in West Bengal.

% Share of rice to GCA	1986-87	1993-94	2000-01
Highly Specialized: more than 70%	Burdwan, Birbhum, Bankura, Midnapur, Howrah, 24 Pgs, Dinajpur, Purulia	Burdwan, Birbhum, Bankura, Midnapur, Howrah, 24 Pgs, Dinajpur, Purulia	Burdwan, Birbhum, Bankura, Midnapur, Howrah, 24 Pgs, Purulia
Moderately Specialized: 70-50%	Hooghly, Malda, Jalpaiguri, Koch Bihar	Hooghly, Malda, Jalpaiguri, Koch Bihar, Murshidabad	Hooghly, Malda, Jalpaiguri, Koch Bihar, Dinajpur
Low Specialized: less than 50%	Nadia, Murshidabad, Darjeeling	Nadia, Darjeeling	Nadia, Darjeeling, Murshidabad

Fig-3.I

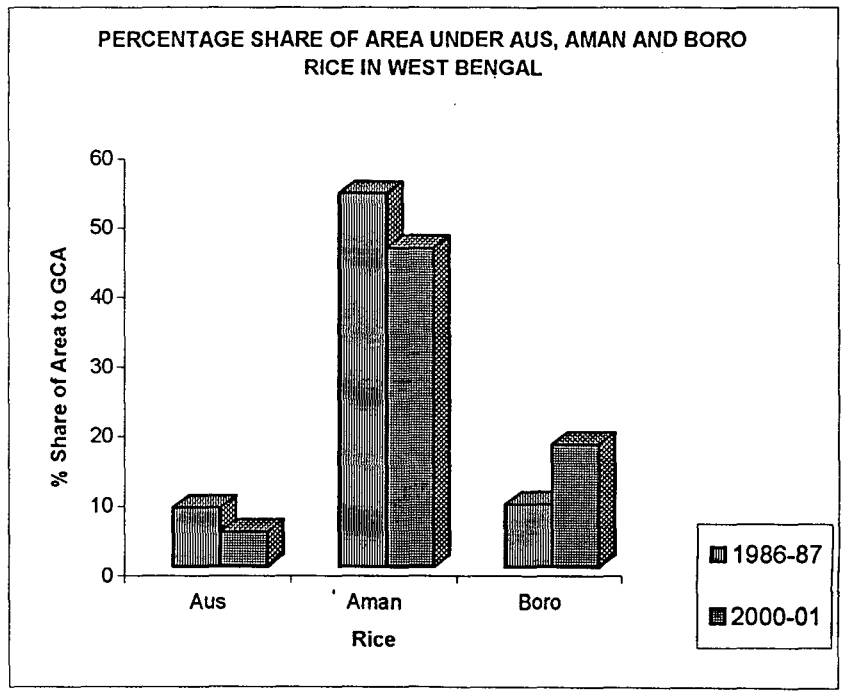


Table-3.3

Percentage Share of Major Individual Crop to Gross Cropped Area across Districts in West Bengal during 1986-97 to 2000-01.

	Aus			Aman			Boro			Wheat			Maize			Gram		
Districts	*1986-87*	*1993-94*	*2000-01*	*1986-87*	*1993-94*	*2000-01*	*1986-87*	*1993-94*	*2000-01*	*1986-87*	*1993-94*	*2000-01*	*1986-87*	*1993-94*	*2000-01*	*1986-87*	*1993-94*	*2000-01*
Burdwan	4.05	4.37	2.66	62.60	59.00	48.73	16.84	22.361	31.12	1.10	0.31	0.89	0.03	-	-	0.18	0.01	0.20
Birbhum	2.90	2.37	1.20	61.60	69.06	62.62	10.31	13.012	12.29	7.29	2.91	6.43	0.14	0.39	0.10	1.01	0.86	3.09
Bankura	6.60	6.99	5.00	71.38	70.31	72.79	6.11	8.9429	8.58	3.62	1.85	1.92	0.47	0.35	0.09	0.07	0.14	-
Midnapur	3.95	6.17	5.87	70.76	62.51	58.67	13.55	17.432	20.57	1.26	0.82	1.04	0.11	0.08	0.13	0.04	-	0.05
Howrah	2.75	1.44	0.59	64.22	56.21	46.99	18.93	34.314	35.48	0.59	0.13	0.73	0.07	-	-	-	-	-
Hooghly	2.54	2.98	2.65	50.97	45.40	29.13	14.33	18.246	25.59	3.07	0.26	0.46	-	-	-	-	-	-
24 Parganas	3.12	2.87	4.00	66.52	65.52	53.42	11.37	15.45	21.80	1.81	0.83	1.90	-	0.01	-	0.24	0.03	0.14
Nadia	17.72	11.91	8.93	16.44	21.15	4.70	12.45	16.48	24.71	9.25	8.77	10.11	0.02	0.19	0.05	4.92	1.04	3.05
Murshidabad	15.42	9.51	7.45	23.94	34.12	10.38	6.64	9.45	16.59	15.85	13.61	20.72	0.05	0.25	0.06	2.56	0.59	1.59
Dinajpur	8.74	4.85	1.12	57.80	56.00	49.35	3.88	10.18	17.99	6.37	4.90	6.61	0.03	0.03	-	0.60	0.12	0.30
Malda	14.72	6.74	3.47	35.12	37.88	35.55	12.05	15.21	18.38	9.40	12.15	12.79	2.13	1.56	0.88	3.17	0.74	1.97
Jalpaiguri	12.91	14.24	13.56	48.72	45.77	40.88	0.11	0.48	1.44	5.63	3.59	5.70	0.46	0.53	0.36	0.04	-	-
Darjeeling	8.22	7.22	5.73	25.00	30.61	30.01	-	0.35	0.42	0.54	2.35	3.50	28.57	19.48	13.68	-	-	-
Koch Bihar	20.66	17.92	6.72	47.92	49.27	51.37	0.47	2.47	6.26	7.56	4.45	5.56	0.02	-	-	-	-	-
Purulia	1.23	2.39	0.89	81.18	82.81	84.89	0.32	0.67	0.33	2.55	0.67	0.95	4.79	4.06	4.63	0.17	0.03	0.03
W.Bengal	8.45	6.78	4.97	53.79	53.89	45.91	9.00	13.12	17.68	5.30	3.85	5.37	0.99	0.66	0.45	0.93	0.24	0.69

Contd.

	Other Rabi Pulses			Rapeseeds & Mustard			Til			Jute			Potato			Chillies		
Districts	*1986-87*	*1993-94*	*2000-01*	*1986-87*	*1993-94*	*2000-01*	*1986-87*	*1993-94*	*2000-01*	*1986-87*	*1993-94*	*2000-01*	*1986-87*	*1993-94*	*2000-01*	*1986-87*	*1993-94*	*2000-01*
Burdwan	1.08	0.18	0.42	4.33	6.62	6.98	1.69	1.10	0.74	2.49	1.03	1.49	4.88	4.51	5.96	0.16	0.20	0.31
Birbhum	1.30	1.18	1.65	10.98	6.80	8.54	0.72	0.41	0.26	0.19	0.07	0.02	2.56	1.91	3.06	0.07	0.09	0.12
Bankura	0.96	0.19	0.15	2.31	4.06	3.03	4.04	2.93	2.86	0.44	0.12	0.09	2.47	3.26	4.69	0.16	0.21	0.28
Midnapur	1.71	1.15	1.20	0.79	2.39	1.93	1.60	2.16	2.42	1.30	0.70	0.59	2.88	4.42	4.64	0.70	0.68	0.71
Howrah	5.12	0.85	0.29	0.45	1.44	1.25	1.63	1.90	1.69	2.38	1.37	4.99	2.75	1.96	6.74	0.15	0.13	0.22
Hooghly	0.35	0.07	0.32	4.22	2.25	3.66	3.45	7.15	4.84	7.87	7.15	8.61	12.53	15.85	23.20	0.18	0.16	0.23
24 Parganas	2.27	1.84	2.12	3.06	4.58	4.82	0.50	0.96	0.82	7.42	4.18	6.52	0.74	0.81	1.39	2.05	1.91	1.98
Nadia	11.65	6.66	5.15	5.41	10.29	13.65	1.03	1.66	2.56	17.38	17.50	21.80	1.17	0.53	0.59	0.42	0.49	0.77
Murshidabad	7.67	4.49	6.02	7.95	7.85	9.94	0.69	0.82	0.72	14.45	15.43	21.56	1.25	0.97	1.36	0.34	0.58	0.66
Dinajpur	1.75	1.78	1.18	6.73	8.57	7.85	0.95	0.18	1.11	9.70	8.78	10.27	0.60	0.99	1.59	0.49	1.10	0.86
Malda	7.99	7.63	3.16	5.17	4.52	9.01	0.12	0.10	0.08	5.96	5.48	6.21	0.27	0.49	0.62	0.10	0.27	0.80
Jalpaiguri	1.30	0.38	0.92	1.61	1.74	1.78	0.22	0.26	0.28	10.95	8.99	9.49	0.68	1.79	3.06	0.51	0.81	1.07
Darjeeling	0.81	0.87	1.17	0.07	0.70	0.11	0.13	0.35	0.32	2.49	2.17	2.33	2.83	5.91	7.53	0.07	0.17	0.42
Koch Bihar	2.43	1.12	1.76	1.60	1.23	1.79	0.26	0.55	0.13	12.86	14.22	18.54	2.02	1.99	2.69	0.21	1.14	1.10
Purulia	2.27	1.05	0.56	0.17	0.44	0.16	0.32	0.47	6.73	0.03	-	-	0.34	0.35	0.30	0.26	0.38	0.36
W.Bengal	3.28	2.04	1.92	3.91	4.78	5.50	1.15	1.44	1.62	6.86	5.97	7.73	2.29	2.90	3.78	0.52	0.68	0.78

Source: Statistical Abstract of West Bengal, 1994-95, 1997-98 and 2001-02.

cultivation throughout the study period are either primarily irrigated by canals or having mixed irrigation systems[4]. But most of the districts with moderate and low specialization in rice cultivation have tubewell dominated irrigation system throughout the study period. The lowest percentage share of rice-cultivated area was in Darjeeling during the study period. It is a hilly district, where small part of the cultivable area is suitable for rice cultivation. Between 1986-87 and 1993-94, the percentage share of area under aman rice remained almost constant in the state. This percentage share, however, has declined between 1993-94 and 2000-01.

Aus and aman rice have witnessed a decline in percentage share to their gross cropped area in most of the districts over the study period (Table-3.3). But the situation for boro rice is reverse. All the districts, except Hooghly, have experienced an increase in percentage share of area under boro rice. Boro paddy is entirely HYV seed based with hundred percent irrigation in most cases, which gives higher yield and net return in comparison to aus and aman. This crop does not depend on the uncertainty of monsoon rainfall. Boro, in fact, is grown on a relatively small portion of total area under rice, where irrigation and water control, modern technology and farming systems are assured (Nandi and Siddhanta, 2000).

During 1986-87 to 1993-94, West Bengal as a whole as well as majority of the districts witnessed decline in percentage share of area under wheat. Between 1993-94 and 2000-01, percentage share of area under wheat in West Bengal has increased, because all the districts experienced increase in share of area under wheat to their gross cropped area. Over the whole study period, percentage share of area under wheat is almost stagnant. Canal dominated districts Burdwan and Birbhum and few districts irrigated by mixed systems of irrigation (Bankura, Midnapur, Hooghly and Purulia) have witnessed decline in percentage share. But districts primarily irrigated by tubewells have experienced increase in percentage share over the study period.

[4] All the districts in West Bengal have been categorized under different systems of irrigation in chapter-II. See table-2.22.

Table-3.4

Growth Trend of Percentage Share of Area under Aus, Aman and Boro Rice between 1986-87 to 2000-01.

Crops	Decline in percentage share to gross cropped area	Increase in percentage share to gross cropped area
Aus	Burdwan, Birbhum, Bankura, Howrah, Nadia, Murshidabad, Dinajpur, Malda, Darjeeling, Koch Bihar, Purulia	Midnapur, Hooghly, 24 Parganas and Jalpaiguri
Aman	Burdwan, Midnapur, Howrah, Hooghly, Dinajpur, 24 Parganas, Nadia, Murshidabad, Jalpaiguri	Birbhum, Bankura, Malda, Darjeeling, Koch Bihar and Purulia
Boro	Hooghly	All other districts.
Total Rice	Burdwan, Midnapur, Howrah, Hooghly, Malda 24 Parganas, Nadia, Koch Bihar, Dinajpur, Murshidabad, Jalpaiguri	Birbhum, Bankura, Darjeeling and Purulia

Note: In table-6, the decline and increase in percentage share to gross cropped area have been determined comparing the percentage share of area under aus, aman, boro and total rice in 2000- 01 with the percentage share of area under aus, aman, boro and total rice in 1986-87.

Maize cultivation in West Bengal is not developed. The percentage share of area under maize to total gross cropped area in the state during the study period has continuously declined. In most of the districts the percentage share of area under maize is very low. Darjeeling is the only districts, where area under maize is higher in comparison to other districts throughout the study period. All the districts, except Murshidabad, have witnessed decline in percentage share of maize cultivated area during 1986-87 to 2000-01.

In West Bengal as a whole, the percentage share of area under gram and other rabi pulses has declined during the study period because majority of the districts categorized under canal, tubewell and mixed systems of irrigation have witnessed decline in share of area under these two crops. A dismal scenario of pulses is attributed to the technological stagnation and supply side constraints for their

production. Study showed that the net profit from pulses is invariably lower than that from their competing crops and lower profitability in comparison to rice and wheat due to their poor yield performance. Here one thing should be mentioned that output prices of pulses are much higher than those of cereals, but yield of pulses is so low that higher output prices could not make them more profitable than the competing crops (Joshi and Saxena, 2002)[5]. Probably lack of assured market is another factor for the poor performance of pulses in West Bengal. Markets for pulses are thin and fragmented in comparison to rice, oilseeds and vegetables. On the other hand, the farmers often do not actually receive the minimum prices announced by the Government. The benefits of sharp rise in retail prices of pulses are often not shared by the producers due to lack of an appropriate market mechanism. The fall of prices as a consequence of trade liberalization adversely affects the producers (Chand, 2000).

In case of rapeseeds and mustard and til continuous increase in percentage share of area has been observed in West Bengal over the study period. In 1986-87 the percentage shares of these two crops were respectively 3.91 percent and 1.15 percent, which rose to 5.50 percent and 1.62 percent in 2000-01 (Table-3.3). Rapeseeds and mustard and til are the high value crops, the cost of cultivation is less in comparison to rice and these two crops also give the release of land days per year caused by the short duration nature of new technology (Nandi and Siddhanta, 2000). During 1986-87 to 2000-01, though few districts primarily irrigated by canals or having mixed systems of irrigation have witnessed decline in percentage share of area under til, tubewell-dominated districts have enjoyed increase in percentage share[6]. In case of rapeseeds and mustard, all the districts (except Birbhum) have experienced increase in percentage share to gross cropped area.

The percentage share of area under jute has increased marginally in the state over the study period. Districts primarily irrigated by canals and few districts with mixed systems of irrigation have witnessed decline in percentage share. But

[5] See Joshi and Saxena (2002), 'a profile of pulses production in India: facts trends and opportunities', Vol. 57 No. 3, IJAE, pp 326-39.

[6] Burdwan, Birbhum, Bankura, Jalpaiguri and Koch Bihar have witnessed decrease in percentage share of area under til. Burdwan and Birbhum are primarily irrigated by canals but Bankura and Jalpaiguri are having mixed systems of irrigation.

tubewell-dominated districts have enjoyed increase in share of area under jute to their total gross cropped area (Table-3.5).

Table-3.5
Growth Trend of Percentage Share of Area under Jute to Gross Cropped Area across Districts during 1986-87 to 2000-01.

Crop	Decline in percentage share	Increase in percentage share
Jute	Burdwan, Birbhum, Bankura, Midnapur, 24 Parganas, Jalpaiguri, Drajeeling, Purulia.	Howrah, Hooghly, Nadia, Murshidabad, Dinajpur, Malda, Koch Bihar.

In the state as a whole, the percentage share of area under potato and chillies has increased over the study period. In case of potato, all the districts (except Nadia and Purulia) have experienced increase in percentage share of area. In Hooghly, it has become almost double over the study period. The continuous increase of potato-cultivated area in Hooghly can be assigned to higher production and profit in comparison to other crops and high demand in Kolkata Metropolitan City. Study showed that over the past two decades potato yields in the state have increased from about 15 to 25 tonnes per hectare. Farmers attribute this growth in potato productivity to more intensive use of inorganic fertilizers, better HYV seeds and improved crop management (Bardhan Roy et al, 1998)[7]. In case of chillies, except 24 Parganas all other districts have experienced increase in percentage share to their gross cropped area over the study period.

From the above discussion, it is clear that the area acreage has increased in favour of boro rice and commercial crops namely oilseeds (rapeseeds and mustard, til), jute, potato and chillies in expense of aus, aman rice and pulses (Fig-II). This is because of the fact that incomes accruing to rural households from commercial crops are more (Mukhopadhyay, 1997).

[7] See Bardhan Roy, Walker, Khatana, Saha, Verma, Kadian and Bowen (1998), 'Intensification of Potato Production in Rice based Cropping Systems: A Rapid Rural Appraisal in West Bengal'. This article was collected from Internet.

As far as the major crop groups are concerned, in West Bengal as a whole, cereals and pulses have witnessed decline in percentage share of area over the study period. But the scenario is reverse for oilseeds. At district level, only three districts have experienced slight increase in share of area under cereals to gross cropped area during 1986-87 to 2000-01[8]. Remaining districts have witnessed decline in percentage share of area (Table-3.6). Majority of the districts where tubewell is the primary source of irrigation or having mixed systems of irrigation, have witnessed decrease in percentage share area under pulses. But the reverse situation has been observed for oilseeds over the study period. The gain in percentage share of oilseeds to gross cropped area across different districts in West Bengal is attributed to various incentives for oilseeds cultivation, such as, policy induced, increase in prices of major oilseeds etc in 1980s (De, 2000). And the percentage share of area under fibre crops in the state has increased marginally (Fig-3.III).

Table-3.6

Percentage Share of Major Crop Groups to Gross Cropped Area during 1986-87 to 2000-01.

	Total Cereals		Total Pulses		Total Oilseeds		Fibre Crops	
Districts	1986-87	2000-01	1986-87	2000-01	1986-87	2000-01	1986-87	2000-01
Burdwan	84.64	83.42	1.43	0.76	6.13	7.96	2.61	1.52
Birbhum	82.26	82.68	2.51	4.83	11.88	8.95	0.29	0.10
Bankura	88.29	88.56	1.42	0.28	6.55	6.00	1.03	0.15
Midnapur	89.65	86.29	2.10	1.60	2.97	5.57	1.40	0.67
Howrah	86.56	83.80	5.94	0.29	2.23	3.89	2.38	4.99
Hooghly	70.90	57.83	0.35	0.43	8.17	9.67	7.87	8.61
24 Parganas	82.82	81.12	3.07	2.45	3.73	6.14	7.53	6.71
Nadia	55.96	48.55	17.11	9.54	7.43	18.22	17.64	21.98
Murshidabad	63.44	55.28	10.59	9.07	9.16	10.87	14.48	21.72
Dinajpur	77.16	75.27	2.52	1.83	8.65	9.43	10.43	10.83
Malda	75.50	71.88	11.63	9.35	6.04	9.24	6.11	6.34
Jalpaiguri	68.17	62.14	1.41	1.41	2.08	2.66	11.48	9.60
Darjeeling	70.35	65.85	1.01	2.01	0.34	0.42	2.49	2.33
Koch Bihar	77.00	70.06	2.58	2.31	2.92	2.78	13.10	19.03
Purulia	91.25	91.99	6.08	6.14	1.86	0.92	0.06	0.07
W.Bengal	78.07	74.63	4.68	3.46	5.61	7.55	7.08	7.90

Source: Statistical Abstract of WB, 1994-95 and 2000-01.

[8] Birbhum, Bankura and Purulia have witnessed decline in percentage share of area under cereals.

Fig-3.II

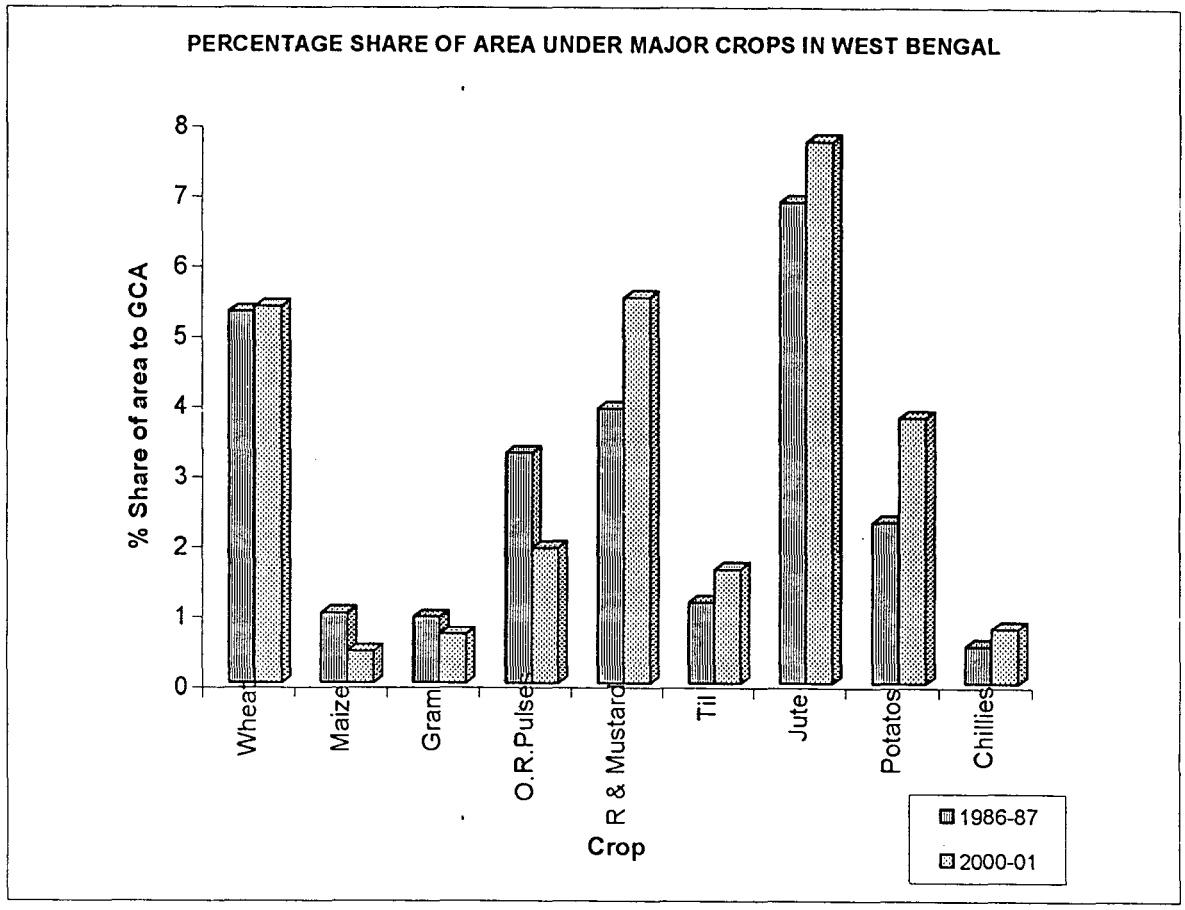


Fig-3.III

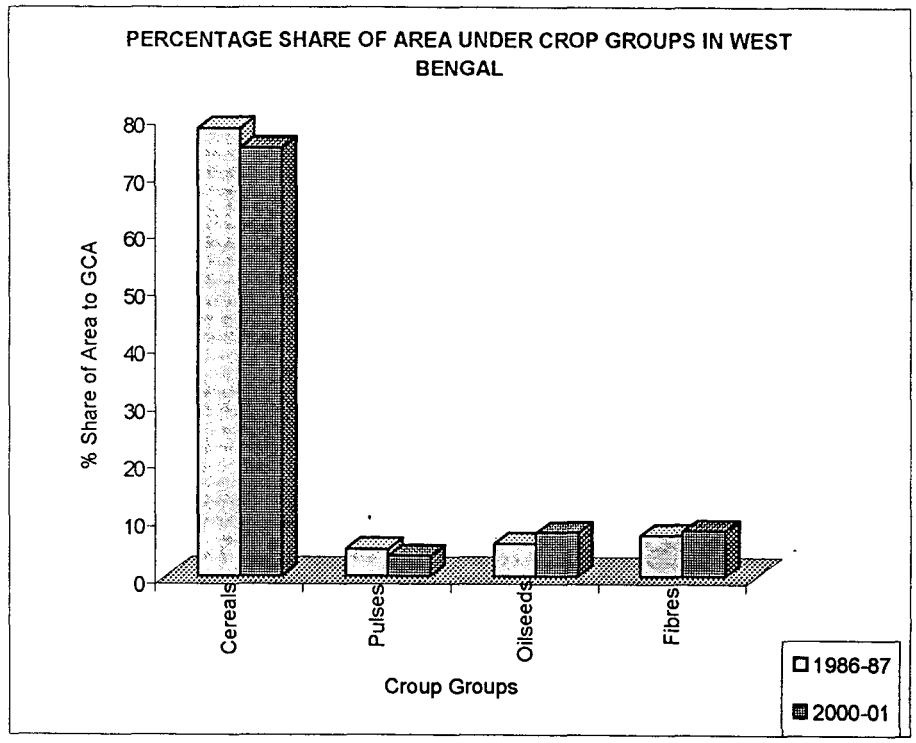


Table-3.7

Changes in Cropping Pattern during 1986-87 to 2000-01 in West Bengal.

Increase in percentage share of area of crop / crop groups to gross cropped area (gaining crops)	Decrease in percentage share of area of crop /crop groups to gross cropped area (declining crops)
1. Boro 2. Rapeseeds and Mustard 3. Til 4. Jute 5. Potato 6. Chillies 7. Oilseeds 8. Fibre Crops	1. Aus 2. Aman 3. Maize 4. Gram 5. Other Rabi Pulses 6. Cereals 7. Pulses

Table-3.8

Changes in Cropping Pattern across Districts during 1986-87 to 2000-01.

Districts	Gaining crops	Declining crops
1. Burdwan	Boro, Gram, R& M, Potato, Chil	Aus, Aman, Maize, Wheat, Til, Jute
2. Birbhum	Aman, Boro, Pulses, Potato, Chil	Aus, Wheat, Maize, R & M, Til
3. Bankura	Aman, Boro, R & M, Potato, Chil	Aus, Wheat, Maize, Pulses, Til, Jute
4. Midnapur	Aus, Boro, R & M, Til, Potato, Chil	Aman, Wheat, Maize, Pulses, Jute
5. Howrah	Boro, R & M, Til, Jute, Potato, Chil	Aus, Aman, Wheat, Maize, Pulses
6. Hooghly	Boro, Til, Jute, Potato, Chil	Aus, Aman, Wheat, Pulses, R & M
7. 24 Parganas	Aus, Boro, Wheat, R & M, Til, Potato, Chil.	Aman, Pulses, Jute
8. Nadia	Boro, Wheat, R & M, Chil, Jute	Aus, Aman, Pulses, Potato
9. Murshidabad	Boro, Wheat, R & M, Til, Jute, Potato, Chil.	Pulses, Aus, Aman
10. Dinajpur	Boro, Wheat, R & M, Til, Jute, Potato, Chil	Pulses, Aus, Aman
11. Malda	Aman, Boro, Wheat, R & M, Jute, Potato, Chil	Aus, Maize, Pulses, Til
12. Jalpaiguri	Aus, Boro, Wheat, R & M, Til, Potato, Chil	Aman, Maize, Pulses, Jute
13. Darjeeling	Aman, Boro, Wheat, R & M, Til, Potato, Chil	Aus, Maize, Jute
14. Koch Bihar	Aman, Boro, R & M, Potato, Chil	Aus, Wheat, Maize, Other Rabi Pulses, Til.
15. Purulia	Aman, Boro, Til, Chil	Aus, Wheat, Maize, Pulses, Potato, Jute.
West Bengal	Boro, Wheat, R & M, Til, Jute, Potato and Chil	Aus, Aman, Maize and Pulses

Note: (i) Chil indicates chillies

(ii) Pulses include gram and other rabi pulses

3.3 LEVEL OF CROP DIVERSIFICATION ACROSS DISTRICTS IN WEST BENGAL:

The level of crop diversification during the study period 1986-87 to 2000-01 across districts has been analyzed by using Herfindal Index. Since the Herfindal Index is a measure of concentration and it is bounded by zero and one, it has been transformed by subtracting it from 1 (one) that is 1-HI, which indicates higher the value, more the diversification. Diversification level has been determined by calculating percentage change in transformed Herfindal Index value for different districts between 1986-87 and 2000-01. There are wide changes in the level of crop diversification across districts in West Bengal over time. The calculated values of transformed Herfindal Index have been given in table-3.9.

Table-3.9

Transformed Herfindal Index

Districts	1986-87	1993-94	2000-01	% Change in HI 1986-87 to 2000-01
Burdwan	0.57	0.59	0.66	14.58
Birbhum	0.59	0.50	0.58	-1.98
Bankura	0.48	0.49	0.46	-4.66
Midnapur	0.48	0.57	0.61	27.00
Howrah	0.55	0.56	0.65	18.09
Hooghly	0.69	0.72	0.78	13.10
24 Parganas	0.54	0.54	0.66	22.69
Nadia	0.87	0.86	0.85	-2.32
Murshidabad	0.86	0.81	0.85	-0.31
Dinajpur	0.64	0.66	0.70	10.02
Malda	0.82	0.80	0.81	-1.08
Jalpaiguri	0.73	0.76	0.80	9.62
Darjeeling	0.85	0.86	0.88	3.86
Koch Bihar	0.70	0.70	0.69	-2.18
Purulia	0.34	0.31	0.27	-19.24
W.Bengal	0.68	0.68	0.74	8.34

Higher index value (above 0.70) has been observed in most of the districts primarily irrigated by tubewells (Nadia, Murshidabad, Dinajpur and Koch Bihar) and in two districts irrigated by mixed systems of irrigation (Jalpaiguri and Hooghly) over the study period. This fact indicates that all these districts are agriculturally more diversified in comparison to other districts in West Bengal.

Purulia is the lowest diversified district throughout the study period and it comes under moderately irrigated category supplemented by mixed systems of irrigation (surface minor and canal irrigation)[9]. Extension of tubewell irrigation facilities in West Bengal has largely been instrumental in bringing drastic changes in cropping pattern. Tubewell irrigation from the beginning of 1980s have motivated farmers to cultivate high yielding and high value crops, such as boro rice, oilseeds, potato and chillies in place of coarse cereals (gram, arhar and other rabi and kharif pulses), which had to be sown earlier in large areas due to unavailability and lack of such facilities for cultivation of high value crops. As a result, the area acreage has increased in favour of commercial crops in expense of aus and aman rice and pulses.

Majority of the districts have experienced increase in transformed Herfindal Index value over the study period. It indicates that all these districts have become agriculturally more diversified. During 1986-87 to 2000-01, comparatively higher percentage increase in transformed Herfindal Index value has been observed in Midnapur, Howrah, Hooghly and Jalpaiguri, which all are having mixed systems of irrigation. Number of districts primarily irrigated by tubewells (Nadia, Murshidabad, Malda and Koch Bihar), canals (Birbhum) and mixed systems of irrigation (Purulia and Bankura) have witnessed decline in index value over the study period. It means crop concentration has increased in all these districts. West Bengal as a whole has become more diversified over the study period. The diversification status across districts over the study period has been shown in table-3.10.

From tables-3.9 & 3.10 and the above discussion, it can be said that Nadia, Murshidabad, Malda and Koch Bihar, where tubewell is the primary source of irrigation and Jalpaiguri and Hooghly with the mixed systems of irrigation are the highly diversified districts. The only two districts primarily irrigated by canal (Burdwan and Birbhum) in the state are moderately diversified districts. But the level of diversification is more in moderately diversified districts. The two low diversified

[9] If the highest percentage share of gross area irrigated by a irrigation source to total gross irrigated area by all sources in a district is below 60 percent and the 2nd or 3rd or 4th source of irrigation systems contribute 20 percent or above for at least two points of time during the study period, the district has been categorized under mixed category. See chapter-I and table 2.22 in chapter-II for more details.

districts Bankura and Purulia irrigated by mixed systems of irrigation have become less diversified over time.

Table-3.10

Crop Diversification Status across Districts in West Bengal.

Index Value	1986-87	1993-94	2000-01
Highly Diversified (Above 0.70)	Nadia, Murshidabad, Malda, Darjeeling, Jalpaiguri, Koch Bihar	Nadia, Murshidabad, Malda, Darjeeling, Jalpaiguri, Koch Bihar, Hooghly	Darjeeling, Nadia, Murshidabad, Jalpaiguri, Hooghly, Dinajpur
Moderately Diversified (0.50-0.70)	Hooghly, Birbhum, Burdwan, Howrah, Dinajpur, 24 Parganas	Birbhum, Burdwan, Howrah, Dinajpur, 24 Parganas, Midnapur	Koch Bihar, Howrah, Burdwan, Midnapur, Birbhum
Low Diversified (Below 0.50)	Bankura, Midnapur, Purulia	Bankura, Purulia	Bankura and Purulia

3.4 GROWTH IN YIELD OF MAJOR CROPS ACROSS DISTRICTS IN WEST BENGAL:

The state as a whole over the study period has experienced increase in yield growth for all the major crops except maize. The highest growth has been observed for rapeseeds and mustard (3.38 percent per annum) followed by aus rice, til, wheat, aman rice and so on (Table-3.11).

In case of boro rice, few districts irrigated by mixed systems have witnessed decline in yield growth over the study period[10]. All other districts primarily irrigated by canals and tubewells (except 24 Parganas) have enjoyed increase in yield growth. But both the canal-dominated districts Burdwan and Birbhum have experienced higher yield growth of boro rice than the tubewell-dominated districts.

Though the highest yield growth of rapeseeds and mustard has been observed in Midnapur irrigated by mixed systems (a growth rate of 7.22 percent per annum), comparatively higher growth has been observed in tubewell-dominated districts followed by canal-dominated districts Birbhum and Burdwan.

[10] Midnapur, Howrah, Purulia and Jalpaiguri with mixed systems of irrigation have witnessed decline in yield growth of boro rice.

During 1986-87 to 2000-01, Howrah and Purulia are the two districts where decline in yield growth of potato has been observed and both these districts are having mixed systems of irrigation. All the North Bengal districts (Jalpaiguri, Koch Bihar, Dinajpur and Darjeeling) have experienced higher growth in yield of potato as compared to the remaining districts in the state. All these districts have enjoyed high growth in tubewell irrigation over the study period[11].

Number of districts have witnessed decline in yield growth of gram and maize. Though the highest growth in yield of maize has been observed in tubewell dominated district Malda (9.34 percent per annum), relatively higher yield growth of maize has been noticed in mixed systems and canal-dominated districts Purulia, Bankura, Jalpaiguri, Burdwan and Birbhum in comparison to remaining districts.

The highest growth in yield of aus rice has been observed in Purulia irrigated by mixed systems (8.43 percent per annum) followed by Koch Bihar (primarily irrigated by tubewell), Jalpaiguri (mixed systems), Darjeeling (primarily irrigated by surface minor schemes) etc. All the districts in West Bengal except Burdwan have experienced increase in yield growth of aman rice over the study period.

3.5 GROWTH RATES OF AREA, YIELD AND PRODUCTION:

The output growth rate, as we know, can be decomposed into growth rate in area and growth rate in yield. Yield growth largely depends on technological progress. In a situation, where output growth is largely due to acreage growth, not due to yield growth, it can be considered as a reflection of the low level of technological progress in the cultivation of that crop (Phanindra, 2000). In order to present an overall picture of the relative growth of production, area and yield of various crops, the annual compound growth rates of production, area and yield have been calculated over the study period from 1986-87 to 2000-01.

[11] Very high growth in tubewell irrigation has been observed in Darjeeling (429.64 percent), Koch Bihar (308.55 percent), Jalpaiguri (206.22 percent) and Dinajpur (147.36 percent) over the study period. See table-2.14 in chapter-II.

Table-3.11

Annual Compound Growth (%) of Production, Area and Yield of Major Crops Across Districts in West Bengal during 1986-87 to 2000-01.

	Aus			Aman			Boro			Wheat			Maize			Gram		
Districts	*P*	*A*	*Y*	*P*	*A*	*Y*	*P*	*A*	*Y*	*P*	*A*	*Y*	*P*	*A*	*Y*	*P*	*A*	*Y*
Burdwan	-2.28	-2.13	-0.16	-1.33	-0.94	-0.39	7.55	5.37	2.07	1.81	-0.65	2.42	-4.83	NG	4.67	10.89	1.74	8.72
Birbhum	-5.18	-6.06	0.85	2.38	0.18	2.19	2.64	1.33	1.28	2.35	-0.82	3.20	2.58	-2.85	3.48	7.79	8.35	-0.61
Bankura	0.73	-1.50	2.29	3.55	0.61	2.91	3.47	2.94	0.52	-2.32	-3.96	1.70	-7.22	-10.86	4.67	NG	NG	4.16
Midnapur	8.51	4.22	4.13	3.51	-0.04	3.55	4.27	4.37	-0.10	3.30	-0.05	3.38	-1.29	2.52	-3.35	3.72	4.08	0.82
Howrah	-15.39	-10.36	-5.49	-1.08	-2.12	1.06	3.86	4.68	-0.78	4.08	1.61	2.13	TY-0	TY-0	TY-0	-	-	-
Hooghly	-0.31	0.48	-0.82	-2.27	-3.75	1.54	5.10	4.41	0.66	-11.13	-12.51	1.70	-	-	-	-	-	-
24 Parganas	2.33	2.49	0.02	3.73	-0.86	4.60	5.35	5.50	-0.20	1.08	1.06	-0.68	-	-	-	-4.83	-3.23	-1.53
Nadia	-2.19	-4.40	2.30	-7.46	-8.19	0.80	5.45	5.44	0.02	1.78	1.03	0.73	9.36	8.16	2.43	-1.53	-2.98	1.49
Murshidabad	-4.55	-5.09	0.56	-4.92	-5.82	1.05	7.76	6.73	0.96	4.77	1.91	2.81	5.08	2.08	2.43	-1.11	-3.37	2.33
Dinajpur	-9.51	-13.18	1.95	1.87	-0.60	2.52	12.91	12.17	0.64	5.12	0.79	4.42	-19.54	-9.42	-1.19	-7.30	-4.18	-5.86
Malda	-6.46	-10.10	4.07	2.03	-0.24	2.27	2.81	2.73	0.07	5.19	1.89	3.24	2.27	-6.41	9.34	0.86	-3.66	4.71
Jalpaiguri	6.74	0.56	6.14	2.05	-1.03	3.10	16.88	20.37	-2.73	3.02	0.30	2.72	4.11	-1.50	5.84	TY-0	TY-0	TY-0
Darjeeling	-0.82	-5.66	5.14	-1.17	-1.92	0.75	BY-0	BY-0	BY-0	18.29	10.65	7.32	-10.77	-8.15	-2.85	-	-	-
Koch Bihar	-2.02	-7.93	6.43	2.89	0.25	2.63	20.85	20.05	0.57	1.69	-2.42	3.80	-9.42	-4.82	-1.19	-	-	-
Purulia	4.52	-3.27	8.43	1.43	-0.64	2.09	-1.10	-0.68	-0.18	-3.91	-7.70	3.86	4.71	-1.20	6.03	-12.98	-12.01	-2.04
W.Bengal	-0.27	-3.38	3.22	1.69	-0.78	2.49	5.81	5.31	0.48	3.18	0.46	2.50	-6.63	-5.20	-1.46	0.00	-1.76	1.78

Note: (i) P- Production, A- Area and Y- Yield.
(ii) TY-Terminal Year 2000-01 and BY- Base Year 1986-87.

Contd.

	Rapeseeds & Mustard			Til			Jute			Potato			Chillies		
Districts	*P*	*A*	*Y*	*P*	*A*	*Y*	*P*	*A*	*Y*	*P*	*A*	*Y*	*P*	*A*	*Y*
Burdwan	7.05	4.34	2.59	-3.85	-4.96	2.67	-0.22	-2.79	2.64	3.75	2.31	1.41	10.73	5.79	4.89
Birbhum	2.74	-1.72	4.53	-19.81	-6.92	-0.24	-10.19	-13.80	3.46	4.07	1.36	2.70	4.29	3.72	0.67
Bankura	3.56	2.45	1.03	-0.92	-1.97	-0.06	-8.07	-10.53	3.27	5.94	5.18	0.73	6.45	4.52	-0.24
Midnapur	15.60	7.95	7.22	6.93	4.33	5.20	-1.02	-4.23	3.33	6.47	4.81	1.59	5.89	1.37	4.44
Howrah	6.76	7.72	-1.54	4.69	0.32	8.32	7.58	5.53	1.97	6.60	6.72	-0.05	8.16	2.94	3.30
Hooghly	-0.60	-0.84	0.25	2.13	2.62	-0.35	18.89	0.81	2.25	4.87	4.68	0.18	3.72	2.08	-2.14
24 Parganas	6.52	4.03	1.05	2.99	4.29	0.31	1.25	-0.22	0.52	6.90	5.39	1.34	0.26	0.46	0.94
Nadia	8.59	7.26	1.24	5.63	7.17	2.10	3.09	2.03	1.04	-1.52	-4.43	3.12	8.85	4.76	-0.03
Murshidabad	6.03	1.58	4.39	4.22	0.31	4.51	4.20	2.88	1.28	4.60	0.59	4.01	9.50	4.90	4.09
Dinajpur	6.35	1.64	4.76	5.68	1.61	0.57	3.31	0.94	2.85	16.18	7.84	7.56	5.96	4.61	0.72
Malda	8.46	3.71	4.56	0.00	-3.58	2.79	2.72	-0.03	2.75	9.98	5.73	4.27	20.74	15.75	0.38
Jalpaiguri	3.26	0.92	2.46	10.41	1.89	5.90	1.85	-0.80	2.66	22.66	11.54	10.01	4.76	5.70	-2.11
Darjeeling	-	-	-	5.08	2.94	1.11	-3.81	-3.65	-0.34	9.21	3.82	5.10	10.41	10.41	4.01
Koch Bihar	6.54	0.55	5.95	-2.03	-4.83	2.05	4.40	2.39	1.98	11.28	1.80	9.29	18.68	12.18	5.03
Purulia	1.61	-1.29	2.66	-6.34	23.24	-0.22	-	-	-	-3.70	-2.03	-1.55	2.94	1.44	1.19
W.Bengal	6.32	2.83	3.38	1.98	2.82	2.76	3.40	1.21	1.70	5.67	4.00	1.61	5.67	3.23	1.25

Source: Statistical Abstract of West Bengal, 1994-95, 1997-98 and 2001-02.

Note: (i) P- Production, A- Area and Y- Yield.
(ii) TY-Terminal Year 2000-01 and BY- Base Year 1986-87.

In West Bengal as a whole, among cereals the highest annual output growth has been observed for boro rice (5.81 percent per annum) and the increase in growth of area has greater contribution than growth of yield towards output growth (Table-3.11). Aus rice has witnessed marginal decline in output growth during the study period due to only decline in area, because there is increase in yield growth over the same time. This positive yield growth of aus rice (an annual growth rate of 3.22 percent) is probably the outcome of more use of HYV seeds. During 1980-81 to 1996-97, the area under HYV seeds increased by 106 percent for aus paddy (Nandi and Siddhanta, 2000)[12]. The area under aus has declined due to the vagaries of monsoon, on which aus production to a large extent depends and on the other hand, the aman-potato-boro rice sequence appears to be more natural agronomic fit in West Bengal (Bardhan Roy et al, 1998). The aman rice has experienced increase in output growth between 1986-87 and 2000-01 in the state and it has been possible only because of the increase in yield growth. In fact, the area under aman rice has decreased over time. Aman rice has gradually declined in relative importance while boro has gone up. Unlike aman, boro rice cultivation has not involved any significant substitution of old and new technologies. The contribution of technology has remained constant in boro production along with increase in area under boro crop.

All the districts primarily irrigated by canals and tubewells (except 24 Parganas) have witnessed decline in output growth of aus rice. In all tubewell dominated districts this decline has come only due to decline in area[13]. In case of aman rice, most of the districts primarily irrigated by canals and tubewells or having mixed systems of irrigation have experienced increase in output growth and the contribution of increase in yield of aman rice is greater than increase in area towards output growth. Study showed that area under HYV seeds for aman rice has increased by 203 percent during 1980-81 to 1996-97 (Nandi and Siddhanta, 2000). On the other hand, all the districts (except Purulia) in West Bengal have experienced increase in output of boro rice and the increase in area has put greater contribution than that of yield in output growth. Even, some of the districts with mixed systems of irrigation

[12] See Nandi and Siddhanta (2000), 'Trends in West Bengal Agriculture', Vol. 3 No. 6, Encounter, pp 101-19.

[13] Positive yield growth of aus rice has been observed in all tubewell-dominated districts over the study period.

have witnessed decline in yield growth[14]. In Purulia, decline in output growth of boro rice has taken place due to decline in both area and yield. And it happens probably due to less assured and lower quality supply of water from tubewells. Most of the tubewells in Purulia are owned by the Government and majority of the Government owned tubewells are not working properly because of the lack of mechanical and electrical maintenance. Even some of them are awaiting for repairs or abandoned (SER Division, Planning Commission, Government of India, 2004). Comparatively higher output growth of boro rice has been observed in most of the tubewell dominated districts, particularly in Koch Bihar and Dinajpur over the study period[15].

In West Bengal as a whole, increase in yield of wheat has put greater contribution than that of area in output growth (3.18 percent per annum). All the districts primarily irrigated by canals and tubewells in the state have witnessed increase in output growth. In majority of the districts, increase in yield has greater contribution than that of area towards increased output growth. The state as well as most of the districts have declined in output growth of maize over the study period due to decline in both area and yield.

The output of total cereals has increased at a rate of 2.66 percent per annum in West Bengal during 1986-87 to 2000-01 (Table-3.12). Cereals have benefited immensely from technological change, policy environment and infrastructure development. All these factors remained favourable particularly to rice and wheat and adverse to coarse cereals (Chand and Kumar, 2002). Increase in output growth of total pulses has been possible only because of the increase in yield[16]. The production of pulses is relatively more risky than their competing crops. Even there is high fluctuation in yield and prices in comparison to their competing crops results in

[14] Midnapur, Howrah, 24 Parganas, Jalpaiguri and Purulia have witnessed decline in yield of boro rice between 1986-87 and 2000-01.

[15] Very high growth in tubewell irrigation has been observed in Koch Bihar (308.55 percent), Jalpaiguri (206.22 percent) and Dinajpur (147.36percent) over the study period. See table-2.14 in chapter-II.

[16] The increase in growth of yield could not be shown in the table-3.12 because, yield of total pulses is not available for 1986-87. Since output growth of total pulses is positive (0.68 percent per annum) in West Bengal as a whole and decline in area under total pulses (-1.79 percent per annum) has been observed over the study period, it can be said that increase in output growth has been possible only because of the increase in growth of yield.

instability in producer's income[17]. Therefore, risk-averse producers tend to prefer cultivation of more assured and stable cereals (rice and wheat) and oilseeds. The key constraint regarding the yield of pulses is non-availability of improved seed varieties. It is mainly due to low priority accorded by public and private seed sector for production and marketing of seeds of pulses.

Table-3.12

Compound Growth Rate (%) of Area under Major Crop Groups and their Production in West Bengal during 1986-87 to2000-01.

Crops	Production	Area
Cereals	2.66	0.03
Pulses	0.68	-1.79
Oilseeds	5.19	2.51
Fibres	3.37	1.15

Source: Statistical Abstract of WB, 1994-95 and 2001-02.

Note: The yield of cereals, pulses, oilseeds and fibres not available for 1986-87.

The output of total oilseeds increased at a rate 5.19 percent per annum in West Bengal, but the output growth of rapeseeds and mustard is higher than til. In case of rapeseeds and mustard, increase in yield has greater contribution than that of area towards its output growth in the state. But reverse scenario has been observed for til (Table-3.11). All the districts (except Hooghly) primarily irrigated by canals, tubewells or having mixed systems of irrigation have experienced increase in output growth of rapeseeds and mustard and in most of the districts increase in area has greater contribution than that of yield in output growth.

Both the canal-dominated districts Burdwan and Birbhum and two districts irrigated by mixed systems (Bankura and Midnapur) have witnessed decline in output growth of jute over the study period and this decline in output growth has come only due to decline in area.

Potato and chillies have registered high output growth (5.67 percent per annum individually) in the state over the study period and increase in area has put

[17] Yield fluctuation occurs due to biotic and abiotic stresses and price fluctuation comes due to variation in supply. See Joshi and Saxena (2002), 'A Profile of Pulses Production in India: Facts, Trends and Opportunities', Vol. 57 No. 3, IJAE, pp 326-39.

greater contribution than that of yield towards the increased production. The expansion of potato area in West Bengal has not come at the expense of alternate crops. Increasing potato area has been contemporaneous with the expansion of tubewell irrigation (Bardhan Roy et al, 1998). Majority of the districts primarily irrigated by canals, tubewells or having mixed systems of irrigation have experienced increase in output growth of potato between 1986-87 and 2000-01, but comparatively higher output growth has been observed in north Bengal districts (Koch Bihar, Jalpaiguri and Darjeeling) and increase in area under potato has higher contribution than yield. In case of chillies, all the districts have enjoyed increase in output growth. But overall higher output growth has been observed in tubewell dominated districts (Malda, Koch Bihar, Murshidabad and Nadia) as compared to mixed systems and canal-dominated districts and increase in area has put greater contribution than that of yield in output growth.

Fig-3.IV

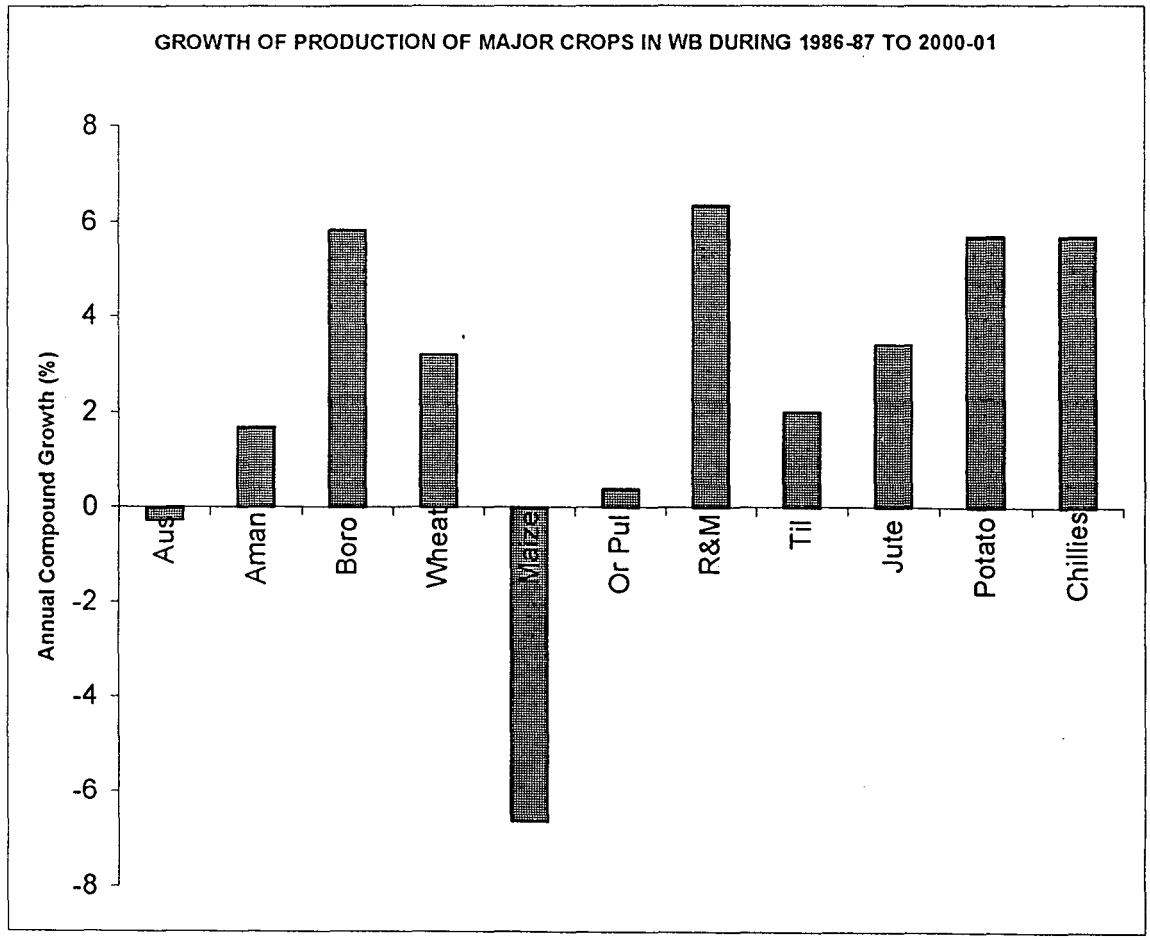


Fig-3.V

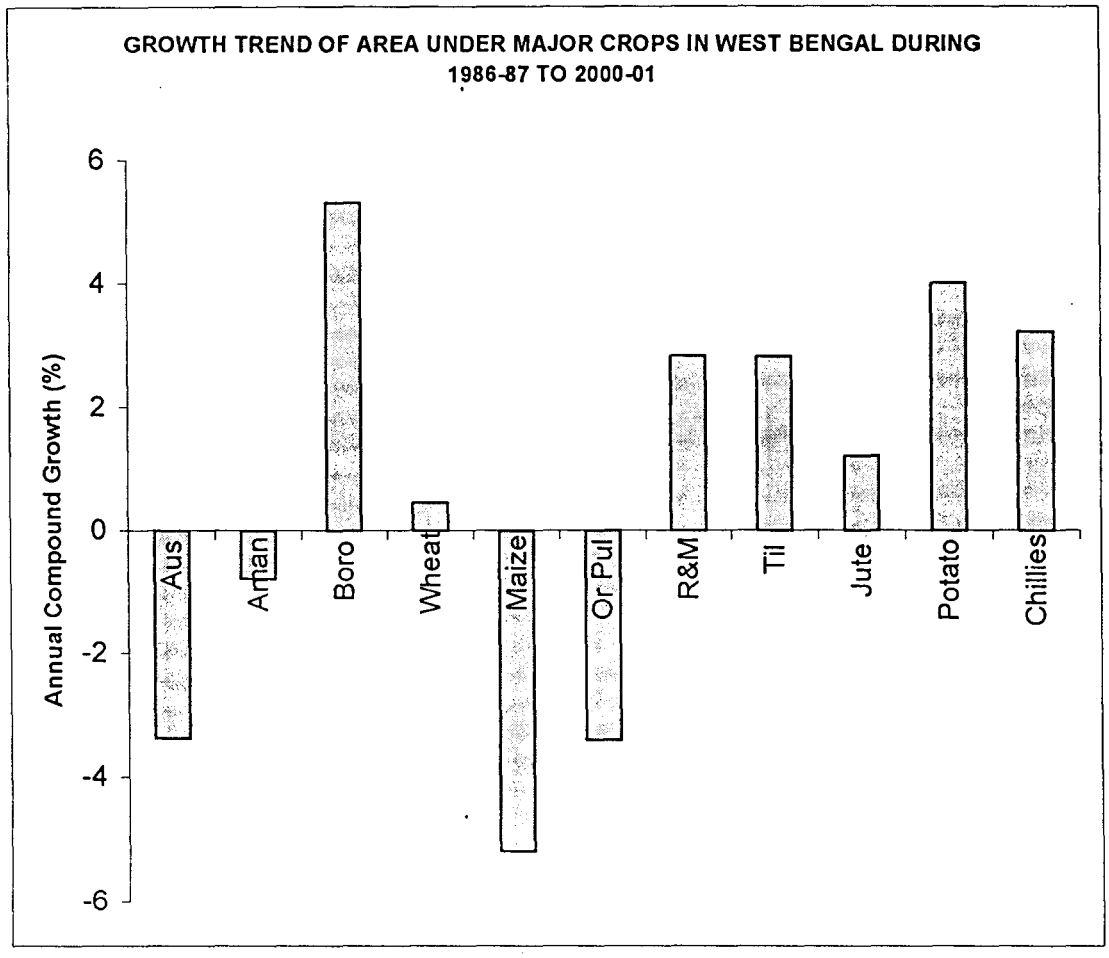
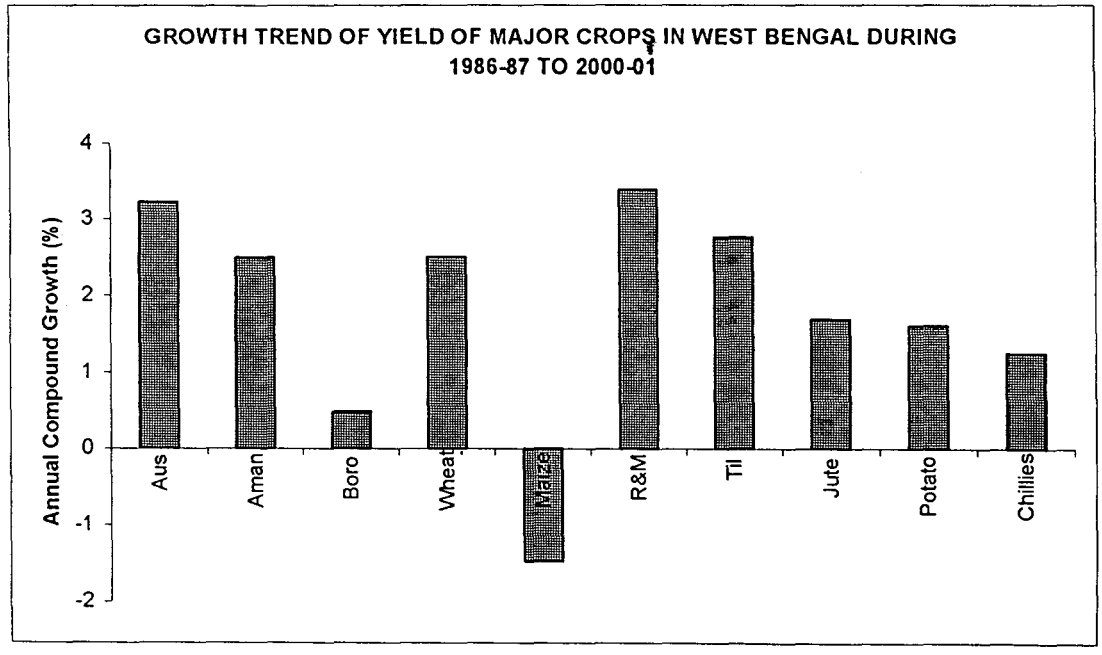


Fig-3.VI



3.6 CONCLUSION:

The investment made in the form of construction of ground water structures, mainly shallow and deep tubewells, spread of HYV seeds, supply of fertilizers, marketing facilities, use of machinery etc provided the impetus for dramatic growth and change not only in agricultural output but also in acreage allocation. The foregoing discussion brings out the facts that there exist great spatio-temporal variations in the acreage allocation under different crops across districts with different systems of irrigation. It can be said that there is a shift of area towards more commercial crops over the study period between 1986-87 to 2000-01.

- Majority of the districts primarily irrigated by canals, tubewells or having mixed systems of irrigation have witnessed decline in percentage share of rice cultivated area to total gross cropped area over the study period due to continuous decline in area under aus and aman rice. Highly specialized districts are either primarily irrigated by canals or having mixed systems of irrigation.
- The percentage share of area under rice in West Bengal has declined. It was 71.24 percent in 1986-87, which declined to 68.55 percent in 2000-01. The percentage share of area under boro rice has almost doubled. It was 9 percent in 1986-87 and rose to 17.68 percent in 2000-01.
- The share of area under wheat has remained almost stagnant in the state. Both the canal-dominated districts Burdwan and Birbhum and few districts with mixed systems of irrigation (Bankura, Midnapur, Hooghly and Purulia) have witnessed decline in percentage share of area. But increase in percentage share has been observed in districts, where tubewells are the main source of irrigation.
- The state as well as majority of the districts primarily irrigated by canals, tubewells or having mixed systems of irrigation have witnessed decline in percentage share of area under maize, gram and other rabi pulses.
- Tubewell-dominated districts have enjoyed increase in percentage share of area under til and jute over the study period, but canal-dominated districts have declined in percentage share for both the crops. In case of rapeseeds and

mustard, all the districts (except Birbhum) have experienced increase in percentage share of area.

- The state as well as most of the districts have enjoyed increase in share of area under total oilseeds during 1986-87 to 2000-01, but the situation is reverse for total cereals and pulses.
- In majority of the districts as well as in the state as a whole boro rice, potato, rapeseeds and mustard, til and chillies have gained in area acreage in expense of aus, aman, maize, gram and other rabi pulses.
- Nadia, Malda, Murshidabad and Koch Bihar where tubewell is the primary source of irrigation and Jalpaiguri and Hooghly with mixed systems of irrigation are the highly diversified districts. But the only two canal-dominated districts in the state Burdwan and Birbhum are moderately diversified districts.
- The level of diversification is more in moderately diversified districts Burdwan, Howrah, Midnapur and 24 Parganas. The two low diversified districts Bankura and Purulia irrigated by mixed systems of irrigation have become more specialized over time.
- All the districts primarily irrigated by canals and tubewells have experienced increase in yield growth of boro rice. Canal-dominated districts have enjoyed higher yield growth than tubewell-dominated districts, but the situation is reverse for rapeseeds and mustard.
- West Bengal as a whole has witnessed decline in output growth of aus rice (-0.27 percent per annum) over the study period due to only decline in area (-3.38 percent per annum), but increase in output growth (1.69 percent per annum) has been observed for aman rice and it has been possible due to only increase in yield growth. In all the tubewell-dominated districts decline in output growth of aus rice has taken place only due to decline in area.
- Most of the districts have experienced increase in output growth of aman rice and the increase in yield has put greater contribution than that of area towards output growth.
- Increase in output growth of wheat has been observed in all the districts primarily irrigated by canals and tubewells. In majority of the districts, increase in yield has higher contribution than that of area in output growth.

- All the districts with different systems of irrigation (except Hooghly) have experienced increase in output growth of rapeseeds and mustard and in majority of the districts increase in area has higher contribution than that of yield. In tubewell-dominated districts Koch Bihar, Dinajpur and Malda, increase in yield has put greater contribution than area towards increased output growth.
- The state as well as majority of the districts have enjoyed increase in output growth of potato and chillies. But overall higher output growth has been observed in tubewell-dominated districts as compared to mixed systems and canal-dominated districts and increase in area has greater contribution than that of yield in output growth during 1986-87 to 2000-01.

Crop diversification can be utilized to find out its contribution to the changing income and also to examine its long-term impact on resource base, such as productivity of land, use of other resources etc. The study could be also important in proper planning of area and cropping choice for the utilization of resources in best possible way.

CHAPTER-IV

CROP RETURNS AND COST OF PRODUCTION: AN ANALYSIS ACROSS IRRIGATION SYSTEMS

4.1 INTRODUCTION:

Changes in crop output have taken place in Indian agriculture due to the technological development in agriculture over about past four decades. A significant break through has, however, been achieved because of the introduction of HYV seeds with the continuous development of irrigation facilities and intensive application of complementary modern inputs. All these farm inputs have transformed the Indian agriculture from a traditional mode to modern state.

The new agriculture is basically characterized by capital-intensive technology in which assured and quality supply of irrigation water and use of modern biochemical inputs play a crucial role. Differences in irrigation development, relative importance of crops in cropping pattern, pace and level of agricultural innovations etc are some of the factors, which make inter regional as well as intra-regional disparities in income among different farmer groups (Saini, 1979).

In this chapter, we have three hypotheses. These are: (1) the districts primarily irrigated by tubewells would have higher cost of irrigation, particularly for crops which are fully irrigated, as compared to canal-dominated districts, (2) the tubewell-dominated districts due to better quality of water supply are more capital oriented, while canal-dominated districts are more labour oriented and (3) inspite of higher cost of production tubewell-dominated districts would perform better in terms of income-cost ratio as well as net return per unit of land.

The farm-size and productivity relation controversy in Indian agriculture is of some vintages. This controversy can be highlighted by three general sets of findings: (i) first set established an inverse relation between farm-size and productivity and declared that small farms are more productive than large farms (Sen, 1964; Bhattacharya and Saini, 1972), (ii) second group of studies showed the direct relation between farm-size and productivity (Rao, 1967; Rudra, 1968; Chattopadhay

and Rudra, 1976) and (iii) the third set of studies refers to the post green revolution period and reports an emerging positive relation between farm-size and productivity as a result of the advent of HYV seeds and modern techniques of cultivation, which was said to be size-biased. It is argued that large farms are more productive per unit of land because of their more intensive use of fertilizers and other modern inputs (Deolalikar, 1981).

The main objectives of this chapter are:

(i) to examine the cost of production as well as net return per unit land of aman local, aman HYV and boro rice across districts with different systems of irrigation during 1991-92 to 2000-01,

(ii) to analyze the structure of input use for these three crops at district level in West Bengal and

(iii) to assess the income inequality among different farmer groups across all the major crops in West Bengal.

The whole discussion has been organized into seven sections. Section 2 discusses the cost of different inputs as well as total cost of production for three major crops (anam local, aman HYV and boro rice) across farm-sizes and districts with different systems of irrigation in West Bengal. Section 3 examines the structure of input use for aman local, aman HYV and boro rice at district level. In section 4, net income and income-cost ratio of these three major crops have been analyzed. Section 5 discusses net income across major crops at state level. The focus of section 6 is to assess the inequalities in net income among different farmer groups during 1991-92 to 2000-01.

Data on cost of production and net income of different crops across districts in West Bengal have been collected from Study on Farm Management and Cost of Production of Crops. It adopts three stages simple random sampling (SRS). Block has been taken as the first, pair of villages as the second and the operational holdings as the ultimate stage of sampling. In 1991-92, the Farm Management Survey covers only 208 operational holdings of 26 villages in 11 districts (eight operational holdings from each village) and in 2000-01, it covers 620 operational holdings of 62

villages in 13 districts (ten operational holdings for each village)[1]. In each selected village sampled farmers have been classified in four size classes according to the operated area viz, (i) marginal with holding size of 1 ha or less, (ii) small with holding size of 1 to 2 ha, (iii) medium with holding size of 2 to 4 ha and (iv) big with holding size of 4 ha or above.

Study on Farm Management does not provide the data on cost of production and net income across all the districts for all major crops in the state. The number of sample districts varies across crops as well as years. Even for some crops number of sample districts very less[2]. So, in this chapter for our study three crops, i.e. aman local, aman HYV and boro rice have been selected because the total number of sample districts for these crops is more as compared to other crops in the state[3].

4.2 FARM-SIZE AND INPUT USE:

Progressive agriculture demands improvement in inputs and methods. Irrigation, HYV seeds, better manures and fertilizers, plant protection chemicals, use of machinery etc are various aspects of agricultural inputs. The green revolution in agriculture has been characterized basically as capital-intensive technology in which hybrid seeds, use of chemical fertilizers and plant protection chemicals, existence or creation of assured irrigation etc play a significant role. Even though the new agricultural technology is size-neutral, the access to capital and use of inputs for small and large farms has not been the same and accordingly the distribution of gains between them has been uneven (Dutt and Sundharam, 1999).

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[1] In 1991-92 the districts covered by the Farm Management are 24 Parganas, Howrah, Burdwan, Hooghly, Midnapur, Nadia, Murshidabad, Malda, Dinajpur, Jalpaiguri and Koch Bihar and in 2000-01 these were Jalpaiguri, Koch Bihar, Dinajpur, Malda, Murshidabad, Nadia, 24 Parganas, Howrah, Burdwan, Birbhum, Bankura, Purulia and Midnapur.

[2] In 1991-92, the number of sample districts was four for aus local rice (Nadia, Dinajpur, Jalpaiguri and Koch Bihar) and two for til (Burdwan and Midnapur). In 2000-01, there are only two sample districts for aus local rice (Jalpaiguri and Purulia), aus HYV rice (Bankura and Purulia) and til (Murshidabad and Midnapur).

[3] Five districts have been taken for aman local and eight districts for aman HYV as well as boro rice individually.

4.2.1 AMAN (LOCAL) RICE:

In general both in 1991-92 and 2000-01, small and marginal farmers spend more as compared to medium and large farmers. Per acre total input cost for marginal and small farms is higher than the medium and big farms in most of the districts in 1991-92 as well as 2000-01 (Table-4.1)[4]. Over the study period, the highest per acre average total cost of production has been observed in 24 Parganas (dominated by tubewell irrigation) followed by Howrah and Midnapur (both are having mixed irrigation system)[5].

In case of cost of family labour, marginal and small farmers have used more family labour than medium and big farmers. This indicates a lower valuation of own labour by small and marginal farmers (Deolalikar, 1981). But opposite scenario has been observed in case of hired human labour in all the five districts in both 1991-92 and 2000-01. Sen (1962) offered a general explanation of this observed phenomena in terms of low opportunity cost of family labour in a labour surplus economy and the resultant variations in the input of human labour over different farm-sizes. Aman local rice is a kharif crop. It is sown in rainy season. As a result, it needs seldom irrigation. In 1991-92, Midnapur is the only districts, where an irrigation charge of 4.81 rupees per acre for marginal farm has been observed. In 2000-01, maximum cost of irrigation per unit of land has been observed for medium farms (551.72 rupees per acre) in Dinajpur.

4.2.2 AMAN (HYV) RICE:

There is no big farm under aman (HYV) rice in Koch Bihar, Murshidabad and 24 Parganas in 1991-92, where tubewells are the primary source of irrigation and per acre total cost of production for medium farm is greater in

[4] In 2000-01, per acre total cost of production with medium farm was higher than the marginal and small farms only in Dinajpur.

[5] If the highest percentage share of gross irrigated area by a single irrigation source to total gross irrigated area by all sources in a district is more than 60 percent, the district will be classified according to that particular source and if the highest percentage share of gross irrigated area by a irrigation source to total gross irrigated area by all sources in a district is below 60 percent and the 2nd or 3rd or 4th source of irrigation systems contribute 20 percent or above for at least two points of time during the study period, the district has been categorized under mixed category. See chapter one and table-2.22 in chapter-II.

Table-4.1

Per Acre Cost of Different Inputs and Total Production Cost of Aman Local Rice across Districts in West Bengal

		1991-92					2000-01				
Districts	Paid-out Cost	Marginal	Small	Medium	Big	Average	Marginal	Small	Medium	Big	Average
Jalpaiguri	H.Labour (Hired)	-	81.08	-	500	82.77	1564	1352	1350	1350	1392.56
	Bio-Chemical	220.83	304.04	272.2	118.23	235.23	900.5	833.24	743.53	637.22	774.33
	Irrigation Charges	-	-	-	-	-	-	-	-	-	-
	F.Labour	929.73	944.25	787.24	310.67	838.17	244.4	232.4	242.4	191.6	228.92
	Total Cost	2195.77	2313.39	2010.56	1745.64	2145.75	4423.27	4099.1	3813.17	3739.21	3991.57
Dinajpur	H.Labour (Hired)	437.09	403.4	431.69	-	421.45	-	1099.13	2068.88	-	1187.93
	Bio-Chemical	248.81	211.15	158.05	-	197.44	323.53	780.03	853.44	-	771.75
	Irrigation Charges	-	-	-	-	-	-	183.91	551.72	-	226.95
	F.Labour	185.45	188.6	177.12	-	183.38	2205.75	808.13	-	-	753.49
	Total Cost	1805.98	1655.3	1564.77	-	1649.22	4955.42	4738.92	5138.15	-	4802.36
Howrah	H.Labour (Hired)	895.37	788.41	-	-	882	2248.2	2392.2	-	-	2266.69
	Bio-Chemical	217.23	203.21	-	-	215.48	195.74	573.16	-	-	244.14
	Irrigation Charges	-	-	-	-	-	98.64	-	-	-	85.98
	F.Labour	391.59	389.39	-	-	391.32	455.4	213.3	-	-	424.32
	Total Cost	3360.41	2796.94	-	-	3289.97	6071.97	5350.22	-	-	5979.31
Midnapur	H.Labour (Hired)	614.65	702.63	-	-	627.22	1480	1650.5	2016	1838.5	1757.63
	Bio-Chemical	181.77	205.13	-	-	185.11	771.92	960.44	654.76	1050.83	896
	Irrigation Charges	4.81	-	-	-	4.12	-	-	-	-	-
	F.Labour	668	211.18	-	-	602.74	1421	1260	706.5	565.5	913.92
	Total Cost	2666.89	2189.15	-	-	2598.64	5524.6	5997.05	5134.59	5178.97	5403.02
24 Parganas	H.Labour (Hired)	919.72	739.55	1184.96	-	943.68	1376.7	2312.05	2496	-	1882.55
	Bio-Chemical	244.01	187.57	198.37	-	212.11	201.55	188.81	200	-	197.3
	Irrigation Charges	-	-	-	-	-	-	-	-	-	-
	F.Labour	661.96	882.97	316	-	622.91	2362.75	1406.6	1222	-	1846.31
	Total Cost	3579.72	3333	2958.5	-	3308.49	6464.99	6371.72	5438.89	-	6238.2

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

Table-4.2

Per Acre Cost of Different Inputs and Total Production Cost of Aman HYV Rice across Districts in West Bengal.

Districts		1991-92					2000-01				
	Input cost	Marginal	Small	Medium	Big	Average	Marginal	Small	Medium	Big	Average
Jalpaiguri	H.Labour (Hired)	-	344.44	-	208.33	85.04	1939.6	2077.2	1980	2227.6	2074.68
	Bio-Chemical	500.73	670.81	316.23	287.73	465.75	1137.54	1191.84	1055	1200	1152.32
	Irrigation Charges	-	-	-	-	-	-	-	-	-	-
	F.Labour	1061.47	627.77	710.24	597.67	869.36	266.03	286.03	275.23	375.23	307.18
	Total Cost	2839.3	2964.84	2050.9	2237.32	2644.7	5353.08	6037.23	5259.06	5593.33	5589.5
Koch Bihar	H.Labour (Hired)	746.6	735.83	680.44	-	726.02	1371.6	1470.6	1543.05	1476	1445.44
	Bio-Chemical	219.6	198.69	223.55	-	212.75	395.65	455.71	465.15	541.6	439.6
	Irrigation Charges	-	-	6.43	-	1.61	-	-	-	-	-
	F.Labour	198.11	169.33	15.28	-	141.61	546.75	482.4	377.1	634.5	498.79
	Total Cost	2221.6	2379.58	2190.7	-	2273.12	4622.33	4692.35	4629.69	5255.5	4697.42
Dinajpur	H.Labour (Hired)	-	573.52	-	-	573.52	1078.32	1123.87	1915	-	1127.47
	Bio-Chemical	-	566.16	-	-	566.16	1069.55	1038.16	1300	-	1059.46
	Irrigation Charges		88.23	-	-	88.23	379.64	229.37	480	-	301.75
	F.Labour	-	231.61	-	-	261.61	904.53	831.7	774	-	861.5
	Total Cost	-	2748.15	-	-	2748.15	5755.98	5445.7	6368.83	-	5607.1
Malda	H.Labour (Hired)	2153.04	1421.29	-	-	1787.16	1152.29	1389.83	1521.96	-	130.56
	Bio-Chemical	249.12	109.99	-	-	179.55	638.69	860.33	788.44	-	732.66
	Irrigation Charges	-	-	-	-	-	327.7	171.19	79.06	-	224.07
	F.Labour	373.04	261.29	-	-	317.16	683.96	560.34	201.04	-	527.39
	Total Cost	4241.92	3162.02	-	-	3701.97	4750.88	4973.59	4725.44	-	4799.44
Murshidabad	H.Labour (Hired)	1251.57	1398.92	1801.98	-	1317.74	2269.02	2389.74	1902.72	-	2271.75
	Bio-Chemical	626.22	588.18	573.59	-	615.1	1080.78	1140.89	863.31	-	1077
	Irrigation Charges	49.08	-	-	-	35.99	19.08	24.29	92.93	-	32.33
	F.Labour	539.22	364.93	-	-	468.42	604.03	348.26	344.56	-	446.55
	Total Cost	5066.14	4753.02	4852.38	-	4989.27	6202.7	6285.52	5544.03	-	6144.9
Burdwan	H.Labour (Hired)	1347.91	1497.97	-	-	1422.94	2464.69	2679.37	-	-	2527.31
	Bio-Chemical	521.35	542.42	-	-	531.88	626.85	631.31	-	-	628.15
	Irrigation Charges	125.91	72.96	-	-	99.44	-	-	-	-	-
	F.Labour	230.46	19.6	-	-	125.03	277.04	92.79	-	-	223.3
	Total Cost	4203.36	3957.94	-	-	4080.65	5267.7	5553.7	-	-	5351.12
Midnapur	H.Labour (Hired)	815.46	964.42	-	-	835.32	1734.77	2028.2	2273.97	2085.3	1871.12
	Bio-Chemical	292.44	393.64	-	-	305.34	1201.24	1014.02	1189.45	1326.7	1165.48
	Irrigation Charges	11.32	2.59	-	-	10.16	79.71	140.65	-	-	81.28
	F.Labour	836.18	760.06	-	-	826.03	1248.2	875.83	848.02	709.99	1096.44
	Total Cost	3558.22	3653.89	-	-	3570.97	6919.38	6301.84	6586.21	6136.36	6705.01
24 Parganas	H.Labour (Hired)	371.87	487.71	914.88	-	486.55	1614.19	2577.45	2275.17	-	1961.55
	Bio-Chemical	330.08	320.83	301.68	-	323.32	747.17	535.26	496.15	-	648.13
	Irrigation Charges	-	-	-	-	-	-	-	-	-	-
	F.Labour	1340.3	1223.81	729.23	-	1214.57	2095.15	1130.53	1489.91	-	1759.44
	Total Cost	4345	4167.75	3821.92	-	4218.77	7132.49	6666.7	6567.07	-	6911.87

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

comparison to marginal and small farms in all these three districts (Table-4.2). The average total cost of production per unit land of aman HYV rice is higher in tubewell-dominated districts Murshidabad and 24 Parganas than canal-dominated districts Burdwan over the study period (Table 4.3).

Table-4.3
Per Acre Average Cost of Production of Aman HYV Rice across Districts in West Bengal (in Descending Order).

1991-92		2000-01	
Districts	Rank	Districts	Rank
Murshidabad	1	24 Parganas	1
24 Parganas	2	Midnapur	2
Burdwan	3	Murshidabad	3
Malda	4	Dinajpur	4
Midnapur	5	Jalpaiguri	5
Dinajpur	6	Burdwan	6
Jalpaiguri	7	Malda	7
Koch Bihar	8	Koch Bihar	8

In case of family labour, per acre imputed cost of family labour for aman (HYV) is inversely related to farm size in majority of the districts in 1991 as well as in 2000-01. But per acre cost of hired human labour is positively related to farm size in most of the districts in West Bengal.

In 1991-92, irrigation charge for aman (HYV) has been noticed only in four districts for marginal and small farms. In this year maximum irrigation charge per unit of land has been observed in canal-dominated district Burdwan followed by tubewell-dominated districts Dinajpur and Murshidabad and the lowest irrigation charge has been noticed in Midnapur (irrigated by mixed systems of irrigation). But in 2000-01, irrigation charge is the highest in Dinajpur, where tubewells are the primary source of irrigation followed by Midnapur having mixed systems of irrigation.

All farm sizes have been cropped with aman (HYV) rice in Jalpaiguri, Koch Bihar and Midnapur in 2000-01 and the highest cost of biochemical inputs (seeds, fertilizers, manures and plant protection chemicals) has been observed

for big farms in all these three districts. With technical progress biochemical inputs become much more important in determining land productivity and the use of biochemical inputs depends largely on cash and credit flows. The large farmers have greater access to both of these cash and credit flows than other farmers (Deolalikar, 1981)[6].

4.2.3 BORO RICE:

Our first hypothesis in this chapter is that the districts primarily irrigated by tubewells have higher cost of irrigation than canal-dominated districts. Since anam rice is cultivated in kharif season, it needs hardly irrigation. But boro rice is cultivated in summer season and it is totally dependent on irrigation. Therefore, to examine this hypothesis, boro rice is the most suitable crop in West Bengal.

Boro rice, in fact, is grown on a relatively small portion of total rice area, where irrigation and water control are assured (Nandi and Siddhanta, 2000)[7]. As we have seen, however, area under boro rice has been steadily increasing over the past two decades. Unlike aman, increase in boro production has not involved any significant substitution of old with new technologies. So, the use of all modern inputs in different farm sizes for boro rice is greater than aman local and aman HYV rice.

In general, the use of biochemical inputs per acre of boro rice is higher for small and marginal farms in most of the districts in 1991-92. But the reverse scenario has been observed in number of districts in 2000-01 (Table-4.4). The average cost of biochemical inputs per unit of land is higher in tubewell-dominated districts Koch Bihar, Murshidabad and Nadia as compared to canal-dominated district Burdwan during the study period. The cost of imputed family labour is more for marginal farms than other farm sizes in most of the districts.

In 1991-92, the cost of irrigation per acre of boro rice is higher in majority of the tubewell-dominated districts than the mixed systems and canal-

[6] See Deolalikar, Anil B. 'The Inverse Relationship between Productivity and Farm Size: A Test using Regional Data from India', American Journal of Agricultural Economics, vol. 63 No. 2, 1981, pp 275 - 79.

[7] In 1997-98, only 20 percent of total rice area was brought under boro rice cultivation in West Bengal and boro accounted for 27 percent of rice production.

Table-4.4

Per Acre Cost of Different Inputs and Total Production Cost of Boro Rice across Districts in West Bengal

		1991-92					2000-01				
Districts	Paid-out Cost	Marginal	Small	Medium	Big	Average	Marginal	Small	Medium	Big	Average
Koch Bihar	H.Labour (Hired)	-	-	1962.87	-	1962.87	1839.15	1588.5	1373.4	1022.85	1620.45
	Bio-Chemical	-	-	1414.23	-	1414.23	1256.73	1637.15	1504.6	1048.49	1330.16
	Irrigation Charges	-	-	3515.15	-	3515.15	3423.83	3217.81	2816.08	2909.09	3197.82
	F.Labour	-	-	-	-	-	1092.6	917.55	1011.6	647.55	1002.54
	Total Cost	-	-	10425.3	-	10425.32	10305.6	9985.4	9570.14	8035.44	9941.37
Dinajpur	H.Labour (Hired)	-	887.65	728.61	-	799.29	1482.4	1448.8	1720	-	1468.59
	Bio-Chemical	-	660.47	278.28	-	785.82	1325.97	1300.05	1375	-	1311.23
	Irrigation Charges	-	830.69	1147.98	-	1006.96	696.1	844.09	2120	-	832.11
	F.Labour	-	266.66	271.21	-	251.41	1390	1300.8	1040	-	1323.49
	Total Cost	-	5175.18	5057.33	-	5109.71	8487.1	8163.12	9535.58	-	8316.15
Malda	H.Labour (Hired)	1415.92	1618.69	1575.56	-	1489.26	1910.8	1930.4	2250.8	-	1998.5
	Bio-Chemical	412.17	628	568.65	-	489.4	786.38	726.02	920.12	-	804.28
	Irrigation Charges	821.6	345.82	300.75	-	640.37	1395.4	964.49	991.99	-	1118.74
	F.Labour	531.71	350.94	351.5	-	463.96	1441.2	1192.8	1007.2	-	1274.77
	Total Cost	5789.1	5196.37	5241.98	-	5569.68	8907.6	7889.64	8091.87	-	8460.37
Murshidabad	H.Labour (Hired)	1606.6	2056.87	-	-	1756.69	3022.2	2702.7	2130.75	2300.85	2527.81
	Bio-Chemical	572.87	572.5	-	-	572.74	1576.57	1402.28	1377.99	1451.54	1432.49
	Irrigation Charges	498.82	245.49	-	-	414.38	3129.35	2665.83	2927.2	2997.95	2884.93
	F.Labour	803.2	341.23	-	-	649.21	1003.95	846.45	557.55	-	734.93
	Total Cost	6141.66	6021.11	-	-	6101.48	12910.6	11563.6	10977.65	10494.1	11585.8
Nadia	H.Labour (Hired)	860.39	925.21	839.01	905.22	889.7	3311	-	-	-	3311
	Bio-Chemical	796.24	847.45	827.47	445.07	781.58	1502.69	-	-	-	1502.69
	Irrigation Charges	1078.27	953.68	780.32	530.11	890.06	1585.9	-	-	-	1585.9
	F.Labour	858.64	883.78	875.63	988.48	889.58	1009.5	-	-	-	1009.5
	Total Cost	6095.59	6377.61	5769.27	5227.92	6039.13	12316.7	-	-	-	12316.7
Burdwan	H.Labour (Hired)	1600.48	1438.09	-	-	1498.98	4008.5	4158	-	-	4076.83
	Bio-Chemical	684.04	743.36	-	-	721.12	1182.11	1503.54	-	-	1329.01
	Irrigation Charges	367.14	578.07	-	-	498.97	419.27	313.7	-	-	371.02
	F.Labour	71.01	31	-	-	46	1049	524	-	-	809.04
	Total Cost	5472.08	5350.23	-	-	5395.92	9883.46	9840.57	-	-	9863.85
24 Parganas	H.Labour (Hired)	1010.92	629.32	816.15	-	904.48	1768.8	2199.6	1209.6	-	1733.56
	Bio-Chemical	626.42	411.32	452.65	-	559.31	1351.68	1442.12	1464.01	-	1385.99
	Irrigation Charges	857.96	983.96	859.17	-	886.09	992.86	1072.35	716.21	-	954.87
	F.Labour	1982.64	1190.5	1894.88	-	1796.86	2801.4	2551.2	3237	-	2841.98
	Total Cost	7366.44	6083.18	6661.23	-	7002.91	10846.9	11925.9	10117.28	-	10880.4
Midnapur	H.Labour (Hired)	900.52	1061.53	-	-	923.52	1555	2414	2422.5	2150	1901.76
	Bio-Chemical	1056.47	1059.88	-	-	1056.96	1981.59	1761.75	1974.53	2130	1925.72
	Irrigation Charges	184.49	629.11	-	-	248.01	1787.68	1212.97	1004.46	700	1504.79
	F.Labour	1162.32	1462.3	-	-	1205.17	1860	970	688	1033.5	1467.4
	Total Cost	5645.44	7024.48	-	-	5842.44	11235.4	10019.7	9399.1	9723.15	10660.5

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

dominated districts (Midnapur and Burdwan). Also in 2000-01, in all the tubewell-dominated districts, the cost of irrigation is more than the canal-dominated districts Burdwan (Table-4.5). Higher average total cost of production has been observed in majority of the tubewell-dominated districts than mixed systems and canal-dominated districts over the study period (Table-4.6).

Table-4.5
Average Cost of Irrigation per Acre of Boro Rice across Districts in West Bengal.

	Cost of Irrigation (Rs.)		
Districts	1991-92	2000-01	Irrigation Systems
Koch Bihar	3515.15	3197.82	Tubewells
Dinajpur	1006.96	832.11	Tubewells
Malda	640.37	1118.74	Tubewells
Murshidabad	141.38	2884.93	Tubewells
Nadia	890.06	1585.9	Tubewells
Burdwan	498.97	371.02	Canals
24 Parganas	886.09	954.87	Tubewells
Midnapur	248.01	1504.79	Mixed

Table-4.6
Per Acre Average Total Cost of Production of Boro Rice across Districts in West Bengal (in Descending Order).

1991-92			2000-01		
Districts	Rank	Irrigation system	Districts	Rank	Irrigation system
Koch Bihar	1	Tubewell	Nadia	1	Tubewell
24 Parganas	2	Tubewell	Murshidabad	2	Tubewell
Murshidabad	3	Tubewell	24 Parganas	3	Tubewell
Nadia	4	Tubewell	Midnapur	4	Mixed
Midnapur	5	Mixed	Koch Bihar	5	Tubewell
Malda	6	Tubewell	Burdwan	6	Canal
Burdwan	7	Canal	Malda	7	Tubewell
Dinajpur	8	Tubewell	Dinajpur	8	Tubewell

4.3 STRUCTURE OF INPUT USE ACROSS DISTRICTS IN WEST BENGAL:

Our second hypothesis in this chapter is that the tubewell-dominated districts due to better quality of water supply are more capital oriented, while canal-dominated districts are more labour oriented. Accordingly in this section,

an attempt has been made to examine the percentage share of the cost of different inputs to total cost of production across districts with different systems of irrigation during 1991-92 to 2000-01 for three major crops aman (local), aman (HYV) and boro rice.

4.3.1 AMAN (LOCAL) RICE:

Percentage share of the cost of hired human labour to total cost of production has increased in majority of the districts for different farm sizes during 1991-92 to 2000-01 (Table-4.7) [8]. Dinajpur (primarily irrigated by tubewells) is the only district, where this share of hired human labour has declined over time. The decline in percentage share of the cost of family labour to total cost of production for different farm sizes has been observed in all the districts irrigated by mixed systems of irrigation (Jalpaiguri, Howrah and Midnapur) during the same time, but it has increased rapidly in tubewell-dominated districts (Dinajpur and 24 Parganas). Percentage share of hired labour as well as imputed family labour cost is higher in districts irrigated by mixed systems (Jalpaiguri, Howrah and Midnapur) than tubewell-dominated districts Dinajpur and 24 Parganas.

4.3.2 AMAN (HYV) RICE:

In majority of the districts, percentage share of the cost of hired human labour for different farm size categories has increased during 1991-92 to 2000-01[9]. Koch Bihar, Dinajpur and Malda are the three districts, where tubewells are the primary source of irrigation have declined in share of the cost of hired labour over the study period (Table-4.8). Canal-dominated districts Burdwan as well as majority of the tubewell-dominated districts (Koch Bihar, Dinajpur and Malda) have experienced increase in percentage share of imputed family labour over the study period. But both Midnapur and Jalpaiguri with mixed systems of irrigation have witnessed decline in share of the cost of imputed family labour.

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[8] There are only five districts under aman local rice cultivation in 1991-92 and 2000-01. These are Jalpaiguri, Dinajpur, Howrah, Midnapur and 24 Parganas. And out of these five districts, Jalpaiguri, Howrah, Midnapur and 24 Parganas have enjoyed increase in percentage share of cost of hired human labour to total production cost for all farm size categories.

[9] Five districts (Jalpaiguri, Murshidabad, Burdwan, Midnapur and 24 Parganas) out of eight have enjoyed increase in percentage share of the cost of hired human labour per acre to total cost of production for all farm sizes during 1991-92 to 2000-01.

Table-4.7

Percentage Share of the Cost of Different Inputs per Acre of Aman Local Rice to Total Cost of Production during 1991-92 to 2000-01.

		1991-92					2000-01				
Districts	Inputs	Marginal	Small	Medium	Big	Average	Marginal	Small	Medium	Big	Average
Jalpaiguri	H.Labour (Hired)	-	3.50	-	28.64	3.86	35.36	32.98	35.40	36.10	34.89
	Bio-Chemical	10.06	13.14	13.54	6.77	10.96	20.36	20.33	19.50	17.04	19.40
	Irrigation Charges	-	-	-	-	-	-	-	-	-	-
	F.Labour	42.34	40.82	39.16	17.80	39.06	5.53	5.67	6.36	5.12	5.74
	Others	47.60	42.54	47.31	46.79	46.12	38.76	41.02	38.74	41.73	39.98
Dinajpur	H.Labour (Hired)	24.20	24.37	27.59	-	25.55	-	23.19	40.27	-	24.74
	Bio-Chemical	13.78	12.76	10.10	-	11.97	6.53	16.46	16.61	-	16.07
	Irrigation Charges	-	-	-	-	-	-	3.88	10.74	-	4.73
	F.Labour	10.27	11.39	11.32	-	11.12	44.51	17.05	-	-	15.69
	Others	51.75	51.48	50.99	-	51.35	48.96	39.41	32.39	-	38.78
Howrah	H.Labour (Hired)	26.64	28.19	-	-	26.81	37.03	44.71	-	-	37.91
	Bio-Chemical	6.46	7.27	-	-	6.55	3.22	10.71	-	-	4.08
	Irrigation Charges	-	-	-	-	-	1.62	-	-	-	1.44
	F.Labour	11.65	13.92	-	-	11.89	7.50	3.99	-	-	7.10
	Others	55.24	50.62	-	-	54.75	50.63	40.59	-	-	49.47
Midnapur	H.Labour (Hired)	23.05	32.10	-	-	24.14	26.79	27.52	39.26	35.50	32.53
	Bio-Chemical	6.82	9.37	-	-	7.12	13.97	16.02	12.75	20.29	16.58
	Irrigation Charges	0.18	-	-	-	0.16	-	-	-	-	-
	F.Labour	25.05	9.65	-	-	23.19	25.72	21.01	13.76	10.92	16.91
	Others	44.91	48.89	-	-	45.39	33.52	35.45	34.23	33.29	33.97
24 Parganas	H.Labour (Hired)	25.69	22.19	40.05	-	28.52	21.29	36.29	45.89	-	30.18
	Bio-Chemical	6.82	5.63	6.71	-	6.41	3.12	2.96	3.68	-	3.16
	Irrigation Charges	-	-	-	-	-	-	-	-	-	-
	F.Labour	18.49	26.49	10.68	-	18.83	36.55	22.08	22.47	-	29.60
	Others	49.00	45.69	42.56	-	46.24	39.04	38.67	27.96	-	37.06

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 and 2000-01.

4.8

Percentage Share of the Cost of Different Inputs per Acre of Aman HYV Rice to Total Production Cost during 1991-92 to 2000-01.

Districts	Inputs	1991-92					2000-01				
		Marginal	Small	Medium	Big	Average	Marginal	Small	Medium	Big	Average
Jalpaiguri	H.Labour (Hired)	-	11.62	-	9.31	3.22	36.23	34.41	37.65	39.83	37.12
	Bio-Chemical	17.64	22.63	15.42	12.86	17.61	21.25	19.74	20.06	21.45	20.62
	Irrigation Charges	-	-	-	-	-	-	-	-	-	-
	F.Labour	37.38	21.17	34.63	26.71	32.87	4.97	4.74	5.23	6.71	5.50
	Others	44.98	44.58	49.95	51.11	46.30	37.55	41.11	37.06	32.01	36.77
Koch Bihar	H.Labour (Hired)	33.61	30.92	31.06	-	31.94	29.67	31.34	33.33	28.08	30.77
	Bio-Chemical	9.88	8.35	10.20	-	9.36	8.56	9.71	10.05	10.31	9.36
	Irrigation Charges	-	-	0.29	-	0.07	-	-	-	-	-
	F.Labour	8.92	7.12	0.70	-	6.23	11.83	10.28	8.15	12.07	10.62
	Others	47.59	53.61	57.74		52.40	49.94	48.67	48.48	49.54	49.25
Dinajpur	H.Labour (Hired)	-	20.87	-	-	20.87	18.73	20.64	30.07	-	20.11
	Bio-Chemical	-	20.60	-	-	20.60	18.58	19.06	20.41	-	18.89
	Irrigation Charges	-	3.21	-	-	3.21	6.60	4.21	7.54	-	5.38
	F.Labour	-	8.43	-	-	9.52	15.71	15.27	12.15	-	15.36
	Others	-	46.89	-	-	45.80	40.37	40.81	29.83	-	40.25
Malda	H.Labour (Hired)	50.76	44.95	-	-	48.28	24.25	27.94	32.21	-	2.72
	Bio-Chemical	5.87	3.48	-	-	4.85	13.44	17.30	16.69	-	15.27
	Irrigation Charges	-	-	-		-	6.90	3.44	1.67	-	4.67
	F.Labour	8.79	8.26	-	-	8.57	14.40	11.27	4.25	-	10.99
	Others	34.58	43.31	-	-	38.31	41.01	40.05	45.18	-	66.36

Murshidabad	H.Labour (Hired)	24.70	29.43	37.14	-	26.41	36.58	38.02	34.32	-	36.97
	Bio-Chemical	12.36	12.37	11.82	-	12.33	17.42	18.15	15.57	-	17.53
	Irrigation Charges	0.97	-	-	-	0.72	0.31	0.39	1.68	-	0.53
	F.Labour	10.64	7.68	-	-	9.39	9.74	5.54	6.21	-	7.27
	Others	51.32	50.52	51.04	-	51.15	35.95	37.90	42.22	-	37.71
Burdwan	H.Labour (Hired)	32.07	37.85	-	-	34.87	46.79	48.24	-	-	47.23
	Bio-Chemical	12.40	13.70	-	-	13.03	11.90	11.37	-	-	11.74
	Irrigation Charges	3.00	1.84	-	-	2.44	-	-	-	-	-
	F.Labour	5.48	0.50	-	-	3.06	5.26	1.67	-	-	4.17
	Others	47.05	46.11	-	-	46.59	36.05	38.72	-	-	36.86
Midnapur	H.Labour (Hired)	22.92	26.39	-	-	23.39	25.07	32.18	34.53	33.98	27.91
	Bio-Chemical	8.22	10.77	-	-	8.55	17.36	16.09	18.06	21.62	17.38
	Irrigation Charges	0.32	0.07	-	-	0.28	1.15	2.23	-	-	1.21
	F.Labour	23.50	20.80	-	-	23.13	18.04	13.90	12.88	11.57	16.35
	Others	45.05	41.96	-	-	44.64	38.38	35.60	34.54	32.83	37.15
24 Parganas	H.Labour (Hired)	8.56	11.70	23.94	-	11.53	22.63	38.66	34.65	-	28.38
	Bio-Chemical	7.60	7.70	7.89	-	7.66	10.48	8.03	7.56		9.38
	Irrigation Charges	-	-	-	-	-	-	-	-	-	-
	F.Labour	30.85	29.36	19.08	-	28.79	29.37	16.96	22.69	-	25.46
	Others	53.00	51.24	49.09	-	52.01	37.52	36.35	35.11	-	36.79

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

All the districts primarily irrigated by tubewells (except Dinajpur) or having mixed systems of irrigation have experienced increase in percentage share of the cost of biochemical inputs during the study period, but canal-dominated district Burdwan has declined in percentage share.

The cost of irrigation for aman HYV rice has been observed only in Dinajpur, Murshidabad and Midnapur in both 1991-92 and 2000-01. Midnapur (irrigated by mixed systems) and Dinajpur (primarily irrigated by tubewells) have enjoyed increase in percentage share of the cost of irrigation to total cost of production during the study period. Except Malda, in all other districts, the percentage share of other inputs has declined over time.

4.3.3 BORO RICE:

In majority of the districts, share of the cost of hired labour, imputed family labour and biochemical inputs per acre of boro rice to total production cost has increased over the study period (Table-4.9). Koch Bihar, Malda and Murshidabad where tubewells are the primary source of irrigation have declined in percentage share of hired labour for different farm sizes over the study period. On the other hand, rapid increase in percentage share of hired labour has been noticed in canal-dominated district Burdwan. Though tubewell-dominated districts (Dinajpur, Malda, Murshidabad and 24 Parganas) have experienced increase in percentage share of biochemical inputs (HYV seeds, fertilizers, manures and plant protection chemical), mixed systems (Midnapur) and canal-dominated (Burdwan) districts have remained almost stagnant in share of these inputs during the study period.

In canal-dominated district Burdwan, the percentage share of the cost of irrigation per unit of land to total cost of production has declined about three times over a short span of nine years from 1991-92 to 2000-01. Out of six tubewell-dominated districts, three districts have marginally declined in percentage share of the cost of irrigation for boro rice[10]. The remaining tubewell-dominated districts Malda,

[10] Koch Bihar, Nadia and Dinajpur primarily irrigated by tubewells have declined marginally in percentage share of the cost of irrigation to total production cost.

4.9

Percentage Share of the Cost of Different Inputs per Acre of Boro Rice to Total Cost of Production during 1991-92 to 2000-01.

		1991-92					2000-01				
Districts	Inputs	Marginal	Small	Medium	Big	Average	Marginal	Small	Medium	Big	Average
Koch Bihar	H.Labour (Hired)	-	-	18.83	-	18.83	17.85	15.91	14.35	12.73	16.30
	Bio-Chemical	-	-	13.57	-	13.57	12.19	16.40	15.72	13.05	13.38
	Irrigation Charges	-	-	33.72	-	33.72	33.22	32.23	29.43	36.20	32.17
	F.Labour	-	-	-	-	-	10.60	9.19	10.57	8.06	10.08
	Others	-	-	33.89	-	33.89	26.13	26.28	29.93	29.96	28.07
Dinajpur	H.Labour (Hired)	-	17.15	14.41	-	15.64	17.47	17.75	18.04	-	17.66
	Bio-Chemical	-	12.76	5.50	-	15.38	15.62	15.93	14.42	-	15.77
	Irrigation Charges	-	16.05	22.70	-	19.71	8.20	10.34	22.23	-	10.01
	F.Labour	-	5.15	5.36	-	4.92	16.38	15.94	10.91	-	15.91
	Others	-	48.88	52.03	-	44.35	42.33	40.05	34.40	-	40.65
Malda	H.Labour (Hired)	24.46	31.15	30.06	-	26.74	21.45	24.47	27.82	-	23.62
	Bio-Chemical	7.12	12.09	10.85	-	8.79	8.83	9.20	11.37	-	9.51
	Irrigation Charges	14.19	6.66	5.74	-	11.50	15.67	12.22	12.26	-	13.22
	F.Labour	9.18	6.75	6.71	-	8.33	16.18	15.12	12.45	-	15.07
	Others	45.04	43.36	46.65	-	44.65	37.88	38.99	36.11	-	38.58
Murshidabad	H.Labour (Hired)	26.16	34.16	-	-	28.79	23.41	23.37	19.41	21.93	21.82
	Bio-Chemical	9.33	9.51	-	-	9.39	12.21	12.13	12.55	13.83	12.36
	Irrigation Charges	8.12	4.08	-	-	6.79	24.24	23.05	26.67	28.57	24.90
	F.Labour	13.08	5.67	-	-	10.64	7.78	7.32	5.08	-	6.34
	Others	43.31	46.59	-	-	44.39	32.37	34.13	36.29	35.67	34.57

Nadia	H.Labour (Hired)	14.11	14.51	14.54	17.32	14.73	26.88	-	-	-	26.88
	Bio-Chemical	13.06	13.29	14.34	8.51	12.94	12.20	-	-	-	12.20
	Irrigation Charges	17.69	14.95	13.53	10.14	14.74	12.88	-	-	-	12.88
	F.Labour	14.09	13.86	15.18	18.91	14.73	8.20	-	-	-	8.20
	Others	41.05	43.39	42.41	45.12	42.86	39.85	-	-	-	39.85
Burdwan	H.Labour (Hired)	29.25	26.88	-	-	27.78	40.56	42.25	-	-	41.33
	Bio-Chemical	12.50	13.89	-	-	13.36	11.96	15.28	-	-	13.47
	Irrigation Charges	6.71	10.80	-	-	9.25	4.24	3.19	-	-	3.76
	F.Labour	1.30	0.58	-	-	0.85	10.61	5.32	-	-	8.20
	Others	50.24	47.84	-	-	48.76	32.63	33.95	-	-	33.23
24 Parganas	H.Labour (Hired)	13.72	10.35	12.25	-	12.92	16.31	18.44	11.96	-	15.93
	Bio-Chemical	8.50	6.76	6.80	-	7.99	12.46	12.09	14.47	-	12.74
	Irrigation Charges	11.65	16.18	12.90	-	12.65	9.15	8.99	7.08	-	8.78
	F.Labour	26.91	19.57	28.45	-	25.66	25.83	21.39	31.99	-	26.12
	Others	39.21	47.15	39.61	-	40.79	36.25	39.08	34.50	-	36.43
Midnapur	H.Labour (Hired)	15.95	15.11	-	-	15.81	13.84	24.09	25.77	22.11	17.84
	Bio-Chemical	18.71	15.09	-	-	18.09	17.64	17.58	21.01	21.91	18.06
	Irrigation Charges	3.27	8.96	-	-	4.24	15.91	12.11	10.69	7.20	14.12
	F.Labour	20.59	20.82	-	-	20.63	16.55	9.68	7.32	10.63	13.76
	Others	41.48	40.03	-	-	41.23	36.06	36.54	35.21	38.15	36.22

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

Murshidabad and 24 Parganas and Midnapur with mixed systems of irrigation have experienced increase in percentage share over the study period.

So, from the above discussion in this section, it can be inferred that tubewell-dominated districts are relatively more capital oriented, while canal-dominated district Burdwan is labour oriented.

4.4 INCOME-COST RATIO OF MAJOR CROPS ACROSS DISTRICTS IN WEST BENGAL:

Before the analysis, it is necessary to define the term '*net income*'. Here the net income has been defined as the surplus of gross value of output over paid out cost. Such a definition eliminates the problems of imputation value of non reproducible resources owned by the farm family serves as a good measure of disposable income available to the farmer for consumption in the farm household and investment on the farm (Saini, 1979).

4.4.1 AMAN (LOCAL) RICE:

In 1991-92, very high income-cost ratio has been observed in Jalpaiguri (having mixed systems of irrigation), because the paid out cost per acre of aman local rice was very low (675.65 rupees per acre) due to the low investment for hired human labour and biochemical inputs in comparison to other districts by the farmers (Table-4.10)[11]. But the net return over paid out cost was very high. On the other hand, maximum paid out cost per acre has been observed in Howrah (irrigated by mixed systems) because investment for hired labour and biochemical inputs by the farmers is more as compared to other districts in the state. The net returns as well as income-cost ratio are higher in mixed systems dominated districts than tubewell-dominated districts.

Over the study period the income-cost ratio of aman local rice has increased only in tubewell-dominated district 24 Parganas, but in all other districts it

[11] See table-4.1 'Per acre cost of different inputs and total production cost of aman local rice across districts in West Bengal'.

has declined (Table-4.11). This is because of the fact that the relative increase of net income is lower than that of paid out cost during the study period in all these districts.

Table-4.10
Income-Cost Ratio per Acre of Aman Local Rice across Districts in West Bengal.

	1991-92			2000-01		
Districts	Paid out Cost (Rs)	Net Income (Rs)	NI / PC	Paid out Cost (Rs)	Net Income (Rs)	NI / PC
Jalpaiguri	675.65	2051.75	3.04	2420.11	3387.66	1.40
Dinajpur	861.96	1512.75	1.76	2950.71	1620.21	0.55
Howrah	1738.19	2392.29	1.38	3516.02	1988.78	0.57
Midnapur	1241.8	1963.13	1.58	3249.43	1450.99	0.45
24 Parganas	1599.99	1620.51	1.01	2769.28	4011.63	1.45

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

Table-4.11
Rank of Income-Cost Ratio of Aman Local Rice and Irrigation Systems across Districts in West Bengal

1991-92			2000-01		
Districts	Rank	Irrigation System	Districts	Rank	Irrigation System
Jalpaiguri	1	Mixed	24 Parganas	1	Tubewell
Dinajpur	2	Tubewell	Jalpaiguri	2	Mixed
Midnapur	3	Mixed	Howrah	3	Mixed
Howrah	4	Mixed	Dinajpur	4	Tubewell
24 Parganas	5	Tubewell	Midnapur	5	Mixed

Over the study period, tubewell-dominated districts (24 Parganas and Dinajpur) have performed better in terms of income-cost ratio of aman local rice. In 1991-92 comparatively higher income-cost ratio has been observed in those districts which are having mixed systems of irrigation, whereas tubewell-dominated districts have experienced comparatively higher income-cost ratio in 2000-01.

If the extent of irrigation (percentage share of total gross irrigated area to total gross cropped area) across the districts is taken into consideration to see the performance (in terms of income-cost ratio) of different districts primarily grouped into unirrigated or low irrigated, moderately irrigated and highly irrigated category, it can be safely said that unirrigated districts (Jalpaiguri, 24 Parganas and

Dinajpur) have performed better as compared to moderately irrigated districts (Midnapur and Howrah) over the study period[12].

4.4.2 AMAN (HYV) RICE:

Higher net income per acre of aman (HYV) rice over paid out cost has been observed in tubewell-dominated districts followed by the districts (Jalpaiguri and Midnapur) having mixed irrigation systems and the lowest in canal dominated-district Burdwan in 1991-92 (Table-4.12).

In 2000-01, Midnapur and Jalpaiguri with mixed systems of irrigation and majority of the tubewell-dominated districts have experienced higher net income than canal-dominated district Burdwan.

Table-4.12

Income-Cost Ratio per Acre of Aman HYV Rice across Districts in West Bengal.

	1991-92			2000-01		
Districts	Paid out Cost (Rs)	Net Income (Rs)	NI / PC	Paid out Cost (Rs)	Net Income (Rs)	NI / PC
Jalpaiguri	886.59	2944.26	3.32	3520	4138.82	1.18
Koch Bihar	1173.9	2729.04	2.32	2502.23	4928.61	1.97
Dinajpur	1458.95	2599.84	1.78	3319.83	2375.09	0.72
Malda	2221.19	2158.21	0.97	3003.51	2012.49	0.67
Murshidabad	2606.87	5216.17	2.00	4098.23	2839.69	0.69
Burdwan	2550.22	2490.76	0.98	3687.49	2662.81	0.72
Midnapur	1638.67	2766.2	1.69	3877.23	2723.88	0.70
24 Parganas	1371.11	5181.04	3.78	3362.74	3933.89	1.17

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

In 1991-92, the income cost ratio of aman (HYV) rice is higher in most of the tubewell-dominated districts followed by the districts having mixed systems of irrigation and the lowest is in canal dominated district Burdwan (Table-4.13). This ratio has declined in all the districts over the study period. But still comparatively higher ratio has been observed in two tubewell-dominated districts

[12] The irrigation status of a district (unirrigated, moderately irrigated or highly irrigated) has been determined based on the percentage share of total gross irrigated area by all sources (canals, dugwells, tubewells and surface minor schemes) to total gross cropped area of that district. (i) Unirrigated – less than 25 percent, (ii) Moderately irrigated – 25 to 50 percent and (iii) Highly Irrigated - above 50 percent. For more details, see 'Analysis of Framework' in chapter-I and table-2.22

Koch Bihar and 24 Parganas and Jalpaiguri with mixed systems of irrigation in 2000-01. And over the whole study period, it is noticeable that income-cost ratio is higher in all the districts (Koch Bihar, Jalpaiguri, 24 Parganas and Dinajpur) where the percentage share of gross irrigated area to total gross cropped area is comparatively lower[13].

Table-4.13

Rank of Income-Cost Ratio of Aman HYV Rice and Dominating Irrigation Systems across Districts in West Bengal.

1991-92			2000-01		
Districts	Rank	Irrigation System	Districts	Rank	Irrigation System
24 Parganas	1	Tubewell	Koch Bihar	1	Tubewell
Jalpaiguri	2	Mixed	Jalpaiguri	2	Mixed
Koch Bihar	3	Tubewell	24 Parganas	3	Tubewell
Murshidabad	4	Tubewell	Dinajpur	4	Tubewell
Dinajpur	5	Tubewell	Burdwan	5	Canal
Midnapur	6	Mixed	Midnapur	6	Mixed
Burdwan	7	Canal	Murshidabad	7	Tubewell
Malda	8	Tubewell	Malda	8	Tubewell

4.4.3 BORO RICE:

In 1991-92, higher net income per acre of boro rice has been observed in majority of the tubewell-dominated districts followed by Midnapur (having mixed systems of irrigation) and the lowest is in canal-dominated district Burdwan (Table-2.14)[14].

Again in 2000-01, two tubewell-dominated districts Nadia and 24 Parganas have enjoyed higher net income followed by Midnapur (mixed irrigation systems) and Burdwan (canal-dominated). In this year, despite of higher investment towards important cost components like hired human labour, seeds, fertilizers, manures and plant protection chemicals, Koch Bihar could not achieve high net

[13] In 2000-01 in all these districts, percentage share of gross irrigated area to total gross cropped area is less than 30 percent. So, it can be said that these are low irrigated districts.

[14] Koch Bihar, Dinajpur, Malda, Murshidabad, Nadia and 24 Parganas are tubewell-dominated districts. Only in Nadia in 1991-92, net income per acre is lower than Midnapur and Burdwan.

income (only 166.87 rupees per acre) over paid out cost. This is due to the lower productivity (yield) of boro rice in Koch Bihar as compared to other districts[15].

Table-2.14

Income-Cost Ratio per Acre of Boro Rice across Districts in West Bengal.

	1991-92			2000-01		
Districts & I. System	Paid out Cost (Rs)	Net Income (Rs)	NI / PC	Paid out Cost (Rs)	Net Income (Rs)	NI / PC
Koch Bihar (TW)	7318.18	4912.11	0.67	6823.27	166.87	0.02
Dinajpur (TW)	2859.74	4729.08	1.65	4539.93	4424.41	0.97
Malda (TW)	2912.65	4672.38	1.60	4719.05	4911.33	1.04
Murshidabad (TW)	3503.35	4433.44	1.27	7617.44	5232.44	0.69
Nadia (TW)	3251.1	4100.15	1.26	7437.55	10125.33	1.36
Burdwan (CA)	3293.88	3868.43	1.17	6283.53	5242.47	0.83
24 Parganas (TW)	2971.19	5710.79	1.92	5044.83	6940.03	1.38
Midnapur (MI)	2806.68	4265.37	1.52	6100.13	5354.22	0.88
Birbhum (CA)	-	-	-	8862.01	3427.26	0.39
Bankura (MI)	-	-	-	5247.1	5932.03	1.13

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

Note: TW- primarily irrigated by tubewells, CA- primarily irrigated by canals and MI- mixed irrigation systems

Over the study period, all the districts have witnessed decline in income cost ratio because the relative increase of net income is lower than that of paid out cost. Comparatively higher income cost ratio has been observed in majority of the tubewell-dominated districts (Nadia, 24 Parganas, Malda and Dinajpur) followed by mixed systems and canal-dominated districts (Midnapur and Burdwan respectively).

4.5 NET INCOME ACROSS MAJOR CROPS IN WEST BENGAL:

In West Bengal as a whole in 1991-92, net income per acre of small and marginal farms is greater than medium and big farms for majority of the crops or it can be said net income is inversely related to farm size (Ttable-4.15a). This is mainly due to the fact that small and marginal farmers with their relative abundance of family labour could attain relatively higher net income per unit of land through increased input of human labour in farming (Sen, 1962; Saini, 1979). But net income

[15] In 2000-01, yield rate of boro rice in Koch Bihar was lower as compared to most of the districts in West Bengal. It was 2591 Kgs per hectare in Koch Bihar, whereas in Nadia it was 3429 Kgs per hectare.

is directly related to farm size in case of aus (HYV) rice in the state. This is probably due to greater adoption of modern inputs and techniques by the medium farmers. The use of modern inputs largely depends on cash and credit flows to which medium and large farmers have comparatively greater access (Verma and Bromley, 1987).

Table-4.15

Net Income (Rs) per Acre of Major Crops over Paid Out Cost in West Bengal.

(a) 1991-92

Crops	Marginal	Small	Medium	Big	Average
Aus local	1004.2	1144.32	948.85	-	1031.3
Aus HYV	1705.17	2282.28	2475.75	-	2172.68
Aman local	2365.29	2062.9	2022.65	1911.43	2223.17
Aman HYV	3742.55	3560.29	3169.1	3008.79	3580.43
Boro	4208.85	4158.34	4292.48	4100.86	4200.23
Jute	1988.7	2184.73	1764.95	1837.88	2011.36
Potato	6984.64	5433.07	4961.25	5400.47	6229.79
Wheat	936.53	1374.93	1504.05	514.51	1200.55
Mustard	1100.35	812.39	1183.9	697.19	990.29
Til	1538.77	2978.29	-	-	2258.53

(b) 2000-01

Crops	Marginal	Small	Medium	Big	Average
Aus local	2577.7	3453.93	3543.84	4858.61	3591.15
Aus HYV	2036.62	2790.18	597.96	3522.94	2058.38
Aman local	3030.19	2865.27	2506.57	2273.62	2746.82
Aman HYV	3294.23	2992.33	3334.53	2911.93	3191.12
Boro	5320.58	5078.01	5247.66	4024.68	5196.92
Jute	3536.9	2096.36	2267.9	-	2842.89
Potato	11021.9	12705.65	14175.16	13105.28	12394.52
Wheat	2519	2879.66	2360.62	2772.81	2642.58
Mustard	2442.15	3277.29	2882.53	3454.84	2854.2
Til	1508.45	3589.33	-	-	1975.37

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

The maximum net income per unit of land has been observed for potato in 1991-92, followed by boro rice. The highest net return per acre of potato is mainly due to the increase in yield over last two decades. Study showed that potato yield has increased from 15 to 25 tonnes per hectare in West Bengal and farmers attribute this growth in potato productivity to more intensive use of fertilizers, better seed quality and improved crop management (Bardhan Roy et al, 1998). Boro paddy is entirely HYV seed based, which gives higher yield as compared to aus and aman

rice. Boro rice, in fact, is grown on a relatively small portion of total gross cropped area, where irrigation and water control, use of modern technology and farming systems are assured (Nandi and Siddhanta, 2000).

Table-4.16

Rank of Different Crops (based on Average Net Income per Acre) in West Bengal during 1991-92 to 2000-01.

1991-92		2000-01	
Crops	Rank	Crops	Rank
Potato	1	Potato	1
Boro Rice	2	Boro Rice	2
Aman HYV rice	3	Aus local rice	3
Til	4	Aman HYV rice	4
Aman local rice	5	Jute	5
Aus HYV rice	6	Mustard	6
Jute	7	Aman local rice	7
Wheat	8	Wheat	8
Aus local rice	9	Aus HYV rice	9
Mustard	10	Til	10

Over the study period, though there are changes in relative positions of different crops in terms of average net income per unit of land, potato and boro rice have retained their top two positions respectively (Table-4.16). And both these two crops have continuously gained their area acreage over last one and half decades.

In 2000-01, marginal and small farmers have enjoyed higher net return over paid out cost than medium and big farmers for majority of the crops (Table-4.15b). But net income per acre is directly related to farm size for potato, mustard and aus local rice. In case of aus local rice, higher net return with medium and big farms over paid out cost has been achieved due to more investment for hired human labour and biochemical inputs as compared to marginal and small farms (Table-4.18 in Appendix). The higher net return per acre of boro rice from medium and big farms in 2000-01 has been obtained due to higher investment for biochemical inputs and irrigation. And in case of potato, it has been possible due to more investment towards hired human labour in big farms in comparison to other farm

sizes. Big farms predominantly depend on wage labour, because the size of family does not increase in proportion to the size of farm and withdrawal of family labour (even it remains unemployed) with increasing farm size is also there because of better socio-economic status and the low prestige of agricultural work (Glover and Mukhoti, 1966)[16].

4.6 INEQUALITIES IN NET INCOME AMONG FARMER GROUPS ACROSS MAJOR CROPS IN WEST BENGAL:

Due to the small sample-size for mixed irrigation systems and canal-dominated districts, it is not possible to examine the inequality among different farmer groups within the districts in West Bengal[17]. As a result, inequalities in terms of net income among different farmer groups have been analyzed across all the major crops in West Bengal at the state level during 1991-92 and 2000-01.

In 1991-92, big farmer groups earned the lowest income per unit of land for number of crops (aman local, aman HYV, boro rice, wheat and mustard). But marginal and medium farmer groups earned the highest net income for remaining crops in West Bengal. And the lower inequality in net income over paid out cost has been observed among the different farmer groups for unirrigated crops in comparison to irrigated crops in 1991-92 (Table-4.17)[18].

In 2000-01, big farmers have earned the highest net income for three crops (aus local, aus HYV and mustard). This happens probably due to the more use of biochemical inputs by the big farmers in comparison to other farmer groups. And in case of irrigated crops, except boro rice, income inequality among different farmer groups has decreased. But opposite scenario has been noticed for unirrigated crops like aus local, aus HYV, aman local and jute.

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[16] Glover, L. and Mukhoti, B. (1966), 'Agrarian Structure in Relation to Farm Investment Decisions and Agricultural Productivity in A Low Income Country- The Indian Case', Journal of Farm Economics, Vol. 48, No. 5, pp 1210-1215.

[17] In 1991-92 and 2000-01, there is only one canal-dominated district Burdwan, for which information is available in the Study on the Farm Management.

[18] Since aus local, aus HYV, jute, aman local and aman HYV are cultivated during the pre-kharif and kharif season. All these crops hardly need irrigation. So, it can be said these are unirrigated crops. On the other hand, potato, wheat and mustard are rabi crops and boro rice is summer crop. All these crop need irrigation.

Table-4.17

Inequalities in Net Income across Major Crops in West Bengal during 1991-92 to 2000-01.

1991-92

Crops	Marginal	Small	Medium	Big	Average	Highest Income	Lowest Income	(H-L)/ Average
Aus local	1004.2	1144.32	948.85	-	1031.3	Small	Medium	0.19
Aus HYV	1705.17	2282.28	2475.75	-	2172.68	Medium	Marginal	0.35
Aman local	2365.29	2062.9	2022.65	1911.43	2223.17	Marginal	Big	0.20
Aman HYV	3742.55	3560.29	3169.1	3008.79	3580.43	Marginal	Big	0.20
Boro	4208.85	4158.34	4292.48	4100.86	4200.23	Medium	Big	0.05
Jute	1988.7	2184.73	1764.95	1837.88	2011.36	Small	Medium	0.21
Potato	6984.64	5433.07	4961.25	5400.47	6229.79	Marginal	Medium	0.32
Wheat	936.53	1374.93	1504.05	514.51	1200.55	Medium	Big	0.82
Mustard	1100.35	812.39	1183.9	697.19	990.29	Medium	Big	0.49
Til	1538.77	2978.29	-	-	2258.53	Small	Marginal	0.64

2000-01

Crops	Marginal	Small	Medium	Big	Average	Highest Income	Lowest Income	(H-L)/ Average
Aus local	2577.7	3453.93	3543.84	4858.61	3591.15	Big	Marginal	0.64
Aus HYV	2036.62	2790.18	597.96	3522.94	2058.38	Big	Medium	1.42
Aman local	3030.19	2865.27	2506.57	2273.62	2746.82	Marginal	Big	0.28
Aman HYV	3294.23	2992.33	3334.53	2911.93	3191.12	Medium	Big	0.13
Boro	5320.58	5078.01	5247.66	4024.68	5196.92	Marginal	Big	0.25
Jute	3536.9	2096.36	2267.9	-	2842.89	Marginal	Small	0.51
Potato	11021.9	12705.65	14175.16	13105.28	12394.52	Medium	Marginal	0.25
Wheat	2519	2879.66	2360.62	2772.81	2642.58	Small	Medium	0.20
Mustard	2442.15	3277.29	2882.53	3454.84	2854.2	Big	Marginal	0.35
Til	1508.45	3589.33	-	-	1975.37	Small	Marginal	1.05

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

4.6 CONCLUSION:

From the above analysis and over all observation, following facts have come out.

- The imputed cost of family labour is inversely related to farm size, but hired human labour is directly related to farm size for all the three crops aman local, aman HYV and boro rice in majority of the districts in West Bengal.
- The use of modern inputs in most of the farm size categories for boro rice is greater than the aman local and aman HYV rice. The total cost of production per acre of boro rice is higher in majority of the tubewell-dominated districts as compared to mixed systems and canal-dominated districts.
- The cost of irrigation per unit land for boro rice is more for marginal farms in comparison to other farm sizes.
- Average cost of irrigation per unit of land is comparatively higher in tubewell-dominated districts, followed by the ones having mixed systems of irrigation and the lowest is in canal-dominated district Burdwan.
- Percentage share of the cost of hired human labour and biochemical inputs to total cost of production for most of the farm size categories has increased for all the three crops- anam local, aman HYV and boro rice in majority of the districts in West Bengal.
- The tubewell-dominated districts are more capital oriented, while canal-dominated district Burdwan is more labour oriented but less capital oriented.
- Net income as well as income-cost ratio are higher in tube-well dominated districts, followed by the ones having mixed irrigation systems and lowest is in canal-dominated district Burdwan. But the income-cost ratio has declined for all the three crops over the study period.
- Net income of small and marginal farmers is greater than medium and big farmers for most of the crops in West Bengal.
- But the net income per unit of land from potato and boro rice is higher than any other crop in the state and they have retained their top two positions respectively during the study period.

However, the study has several limitations. The study could not be carried out across all the districts and all the major crops due to the lack of available data and small number of sample districts for all these crops during the study period. The study could not also show the income inequalities among different farmer groups within and between the districts categorized under different systems of irrigation for all the major crops, which could suggest alternative paths of income generation in village households, like livestock and poultry. To overcome these limitations, further intensive and continuing research is essential. Therefore, Government should employ more surveyors to survey each and every district in West Bengal, so that further comprehensive and more prominent research regarding these aspects can be done in the context of the state's agricultural and rural economy to formulate scientific recommendations.

CHAPTER-V

CONCLUSIONS AND POLICY IMPLICATIONS

This study has attempted to bring out the impact of irrigation development on agricultural sector in West Bengal over a period of one and half decades from 1986-87 to 2000-01. Though the effect of irrigation is less pronounced in the high rainfall areas, such as West Bengal as compared to arid and semi-arid regions, the impact of irrigation is important and crucial to bring the change in cropping pattern and to incur more net income to different groups of farmers. Irrigation from large and medium dams was mainly supplemental to rainfall in monsoon season. Special emphasis has, therefore, been accorded to tubewell irrigation development in West Bengal due to two Reasons; firstly, Eastern India in general and West Bengal in particular had a relatively less exploited ground water table till the early 1980s; secondly, it provides less implemental hazards. It also needs less investment and is associated with a better quality of water supply.

With this given changing structure of irrigation in West Bengal, the broad focus of our study is to examine the differential impacts of different irrigation systems on cropping pattern, yield, cost of irrigation and net return.

5.1 SUMMARY AND CONCLUSIONS:

The available information regarding irrigation in West Bengal has several limitations. This study has examined and compared the data available from different Government sources. The growth and development of irrigation across districts in West Bengal during 1986-87 to 2000-01 shows the flowing facts.

- Despite of the increase in potential created by surface minor irrigation systems, actual area irrigated by surface minor has declined over time. However, continuous increase has been observed in case of both potential created and actual area irrigated by tubewells.

- Only tubewell irrigation has enjoyed increase in percentage share of irrigated area to total gross irrigated area in West Bengal over the study period, whereas all other sources have witnessed decline in percentage share.
- All the North Bengal districts (Darjeeling, Koch Bihar, Jalpaiguri and Dinajpur) have experienced very high growth in tubewell irrigation over the entire period. It may be noted that two (Jalpaiguri and Darjeeling) out these four districts were lees developed in terms of irrigation infrastructure in the base year. Three eastern districts, namely North 24 Parganas, Nadia and Murshidabad that experienced high growth till the first half of 1980s, witnessed low growth during 1986-87 to 2000-01.
- The growth of canal irrigation has slowed down. The state as a whole has enjoyed very low growth in gross irrigated area by canals.
- Variations or inequalities within the districts in terms of irrigation extent have declined over the study period, because most of the backward districts have registered higher growth in gross irrigated area compared to the more developed ones.
- In terms of the structure of irrigation, all the districts fall largely into three categories- (i) unirrigated, (ii) moderately irrigated and (iii) highly irrigated. Over the study period, no major shift has taken place in terms of reorganization of these categories. The only exception is Malda and North 24 Parganas have shifted from unirrigated to moderately irrigated category.

It is widely believed that unlike agriculturally advanced states in India, such as Punjab and Haryana, a major technological breakthrough has not taken place in West Bengal. We have examined this aspect by trying to identify the sources of output growth in individual crops. The output growth is jointly determined by the growth rate in area and growth rate in yield. However the two most profitable crops in West Bengal (potato and boro rice) have witnessed a greater growth in area compared to yield. This shows that the land allocation decisions made by the farmers depend to a large extent on profit considerations.

- Majority of the districts irrespective of their irrigation structures have experienced decline in percentage share of total area under rice over the study period. This trend is due to a continuous decline in percentage share of area

under aus and aman rice. However, the percentage share of boro rice has almost doubled from 9 percent in 1986-87 to 17.68 percent in 2000-01.

- There is a shift of area towards more commercial crops over the study period. In most of the districts as well as in the state, crops like boro rice, potato, rapeseeds and mustard, til and chillies have gained in area acreage in expense of aus and aman rice, gram and other rabi pulses.
- Majority of the highly diversified districts are tubewell dominated[1]. The two relatively less diversified districts Bankura and Purulia have become more specialized over time.
- All the districts primarily irrigated by canals and tubewells have experienced increase in yield growth of boro rice. Canal-dominated districts have enjoyed higher yield growth than tubewell-dominated districts.
- All the districts (except Hooghly) irrespective of irrigation systems have experienced an increase in output growth of rapeseeds and mustard. This increase is primarily determined by area increase under these crops. However, in tubewell-dominated districts Koch Bihar, Dinajpur and Mlda increase in yield has a greater contribution than that of area towards increased output growth.
- The state as well as most of the districts have enjoyed increase in output growth of potato and chillies. But this growth is higher in tubewell-dominated districts as compared to mixed systems and canal-dominated districts and the increase in area has greater contribution than that of yield.

A significant breakthrough in agricultural production in West Bengal has been achieved because of the introduction of HYV seeds with the continuous development of irrigation facilities and intensive use of complementary modern inputs. Differences in irrigation development, relative importance of remunerative crops in cropping pattern, pace and level of agricultural innovations etc are some of the factors, which determine the inter regional as well as intra-regional disparities across farm size categories. Analysis of the cost of production and crop returns across irrigation systems shows that

[1] Nadia, Malda, Murshidabad, Darjeeling and Jalpaiguri are highly diversified districts throughout the study period. Out of these five districts, except Jalpaiguri, all districts are tubewell dominated.

- The imputed cost of family labour is inversely related to farm size, whereas hired human labour is directly related to farm size for all the crops under analysis in majority of the districts in West Bengal[2].
- Share of hired human labour and biochemical input to total production cost in most of the farm size categories has increased for all the three crops aman local, aman HYV and boro rice[3].
- The cost of production for boro rice is more in most of the tubewell-dominated districts compared to that of the mixed systems and canal-dominated districts.
- Average cost of irrigation is comparatively higher in tubewell-dominated districts, followed by the mixed systems of irrigation and the lowest is in canal-dominated district Burdwan. The cost of irrigation for small and marginal farms is higher than the medium and big farms.
- Tubewell-dominated districts are comparatively more capital-oriented, while canal-dominated districts are more labour-oriented.
- Net income as well as income-cost ratio are higher in tube-well dominated districts, followed by the ones having mixed systems irrigation and the lowest is in canal-dominated district Burdwan. But the income-cost ratio has declined for all the three crops because the relative increase in net income is lower than that of paid out cost over the study period.
- Net income per unit of land from potato and boro rice is higher than any other crop in the state and they have retained their top two positions respectively during the study period.
- Inequality in net return for fully irrigated crop boro rice has increased over the study period.

5.2 POLICY IMPLICATIONS:

It has been noticed that over the study period, the disparity in irrigation extent has reduced. This reduction in disparity has been possible due to more emphasis and investment on minor irrigation, particularly for ground water structures (shallow and deep tubewells). The tubewell irrigation has developed rapidly

[2] In this chapter the analysis has been done for aman local, aman HYV and boro rice during 1991-92 to 2000-01.

[3] Since water availability is not a constraint in West Bengal, due to ample rainfall even local varieties (aman local rice) have witnessed an increased use of biochemical inputs.

in the state over the last two decades because of the existing ground water potential. The initial investment cost of ground water irrigation is beyond the reach of the majority of marginal and small farmers. But the cost of irrigation for marginal and small farmers is higher than the medium and big farmers because the former groups buy irrigation water from second groups. Therefore, to reduce the cost of irrigation particularly for small farmers, the existence of a well developed financial and banking infrastructure, which provides adequate credit at affordable rates of interest, may be crucial. Also, provision of adequate facilities for leasing out of pump sets etc at concessional rates to small and marginal farmers is an option that requires serious consideration. Though the ground water status of West Bengal is in a far better position compared to western states of the country, a volumetric pricing of state-tubewells should be called forth to prevent an indiscriminate future for ground water.

Considerable higher increase in area towards high value crops like potato, chillies and oilseeds has been observed in the state. Out of all these crops potato is the most profitable crop. So, more attention needs to be paid for evolving suitable production technologies for these crops. For encouraging the production of potato, chillies, fruits and other vegetables more cold storages should be set up in different regions across the state. In West Bengal many of the infrastructural components are deficient. Policies should be focused on rapid development of these facilities. These are: (i) good road network to connect rural with urban and market centers, so that agricultural commodities can be marketed easily with lower carrying cost, (ii) adequate power supply for cold storages in different locations close to production centers is also very necessary.

The structure of biochemical input has been changed for all the three crops aman local, aman HYV and boro rice over the study period. Government policies should primarily focus on stabilization and provide input and output price supports to ensure profitability for the farm product.

Income inequality among different farmer groups for unirrigated crops has increased. Therefore, appropriate institutional innovations are necessary to ensure farm income and efficient land and water management. West Bengal has already gone to some extent through its effective participatory managing systems of

panchayat. What is needed now is to broaden the ideology and action-frame for diversified farming systems. Cooperatives and group actions may lead to better opportunities for small farm holders to augment their farm income. This types of institutions may over come risk and uncertainty and establish strong vertical linkage between production and marketing.

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STATISTICAL APPENDIX

Table-2.25
Gross Area Irrigated (ha) by Major Sources, 1986-87.

Districts	Canal	D.Wells	Tubewells	S.Minor	Total Minor Irrigation	Total Gross Irrigated Area
Bankura	178500	5806	37486	109147	152439	330939
Birbhum	180100	783	35001	83429	119213	299313
Burdwan	295740	443	107622	83982	192047	487787
Darjeeling	2800	101	585	17442	18128	20928
Hooghly	92100	29	76086	58189	134304	226404
Howrah	5900	-	6760	53995	60755	66655
Jalpaiguri	6700	2283	5259	13997	21539	28239
Koch Bihar	500	1706	12534	3423	17663	18163
Malda	-	4	61352	26479	87835	87835
Midnapur	190200	15668	120189	105462	241319	431519
Murshidabad	55000	-	148875	37810	186685	241685
N.24 Pgs	-	-	116709	6050	122759	122759
Nadia	-	-	154563	9080	163643	163643
Purulia	23100	5013	-	83314	88327	111427
S.24 Pgs	-	-	10738	50218	60956	60956
W.Dinajpur	-	263	65208	27110	92581	92581
W.Bengal	1030640	32099	958967	769127	1760193	2790833

Source: (i) Statistical Abstract of West Bengal, 1994-95,
(ii) Report on Census of Minor Irrigation, 1986-87.

Table-2.26
Gross Irrigated Area (ha) by Major Sources, 1993-94.

Districts	Canal	D.Wells	Tubewells	S.Minor	Total Minor Irrigation	Total Gross Irrigated Area
Bankura	204200	3901	57079	96501	157481	361681
Birbhum	190300	457	46062	57492	104011	294311
Burdwan	319000	144	157514	54378	212036	531036
Darjeeling	600	41	2398	6422	8861	9461
Hooghly	93900	164	90020	36941	127125	221025
Howrah	4800	3	7017	43405	50425	55225
Jalpaiguri	6500	1914	15954	22695	40563	47063
Koch Bihar	500	1899	34822	4242	40963	41463
Malda	-	20	95231	14963	110214	110214
Midnapur	176400	8054	155501	90770	254325	430725
Murshidabad	49600	39	199511	26237	225787	275387
N.24 Pgs	-	23	114724	6461	121208	121208
Nadia	-	234	176124	9157	185515	185515
Purulia	20900	5302	12	68079	73393	94293
S.24 Pgs	24800	77	10389	42979	53445	78245
W.Dinajpur	-	188	147726	22810	170724	170724
W.Bengal	1091500	22460	1310084	603532	1936076	3027576

Source: (i) Statistical Abstract of West Bengal, 1997-98
(ii) Report on Census of Minor Irrigation, 1993-94

Table-2.27

Gross Area irrigated (ha) by Major Sources, 2000-01

Districts	Canal	D.Wells	Tubewells	S.Minor	Total Minor Irrogation	Total Gross Irrigated Area
Bankura	151000	2704	53789.69	70545.97	127039.66	278039.66
Birbhum	185700	370.39	44644.79	35875.82	80891	266591
Burdwan	292700	47.2	183774.5	28301.32	212123.02	504823.02
Darjeeling	9000	483.55	3098.39	8994.59	12576.53	21576.53
Hooghly	79000	47.35	107582.84	33022.29	140652.48	219652.48
Howrah	10100	-	8657.59	75031.21	83688.8	93788.8
Jalpaiguri	57700	6348.41	16104.36	29030.98	51483.75	109183.75
Koch Bihar	1600	1656.93	51208.27	4208.7	57073.9	58673.9
Malda	-	-	99631.69	15243.11	114874.8	114874.8
Midnapur	152900	6359.85	182424.3	70067.05	258851.2	411751.2
Murshidabad	50200	4.48	191759.11	18664.83	210428.42	260628.42
N.24 Pgs	-	-	113876.76	7012.9	120889.66	120889.66
Nadia	-	2.82	155803.23	11199.83	167005.88	167005.88
Purulia	27300	4025.91	4	62872.49	66902.4	94202.4
S.24 Pgs	16100	-	13974.72	63892.29	77867.01	93967.01
W.Dinajpur	6000	40.46	161298.58	19133.37	180472.41	180472.41
W.Bengal	1039300	22091.35	1387632.82	553096.75	1962820.92	2996120.92

Source: (i) Statistical Abstract of West Bengal, 2001-02
(ii) Report on Census of Minor Irrigation, 2000-01.

Table-4.18

Cost of Production per Acre of Major Crops in West Bengal in 1991-92.

Major Crops	Paid-out Cost	Marginal	Small	Medium	Big	Average
Aus Local	H.Labour (Hired)	301.52	177.5	514.79	-	341.84
	Bio-Chemical	364.9	354.73	320.83	-	343.54
	Irrigation Charges	-	17.79	38.75	-	21.35
	Total Paid-out Cost	945.23	1069.98	1194.42	-	1086.13
	F.Labour	624.66	972.45	263.56	-	604.33
	Total Cost	2079.39	2874.76	2030.55	-	2336.93
Aus HYV	H.Labour (Hired)	389.7	932.06	666.74	-	701.29
	Bio-Chemical	445.85	573.39	269.22	-	449.97
	Irrigation Charges	-	74.04	226.24	-	96.38
	Total Paid-out Cost	1135.98	1880.27	1289.4	-	1498.8
	F.Labour	688.23	313.23	88.23	-	356.09
	Total Cost	2519.9	3477.72	2272.49	-	2859.71
Jute	H.Labour (Hired)	1093.61	1006.42	1203.55	745.48	1063.94
	Bio-Chemical	280.73	271.7	362.09	381.85	297.43
	Irrigation Charges	47.11	28.43	25.34	149.65	41.71
	Total Paid-out Cost	1893.56	1715.83	2044.12	1714.73	1847.22
	F.Labour	811.53	701.05	610.89	1022.33	746.11
	Total Cost	3707.66	3445.61	3579.78	3628.33	3585.53
Aman Local	H.Labour (Hired)	729.22	606.52	649.61	500	679.71
	Bio-Chemical	235.55	219.43	202.38	118.23	224.18
	Irrigation Charges	24.55	60.65	55.56	-	38.72
	Total Paid-out Cost	1453.3	1321.25	1272.34	815.6	1379.21
	F.Labour	534.24	578.13	442.47	310.69	528.82
	Total Cost	2997.77	2821.97	2539.39	1745.64	2859.8
Aman HYV	H.Labour (Hired)	768.44	893.58	661.76	501.66	784.11
	Bio-Chemical	431.77	475.8	442.72	402.1	446.14
	Irrigation Charges	62.31	166.12	138.39	163.47	109.47
	Total Paid-out Cost	1753.67	1998.98	1659.95	1540.93	1811.64
	F.Labour	750.1	473.1	530.48	606.72	627.06
	Total Cost	3894.18	3924.17	3394.44	3245.02	3813
Potato	H.Labour (Hired)	1256.65	975.12	1077.5	1202.37	1153.6
	Bio-Chemical	4724.26	5237.57	4923.49	4232.62	4870.75
	Irrigation Charges	777.69	477.02	314.58	365.29	617.86
	Total Paid-out Cost	7692.28	7551.57	7063.11	6621.89	7527.49
	F.Labour	1478.62	1378.66	764.79	1268.76	1350.91
	Total Cost	13389.56	12627.96	11192.91	11249.84	12807.43

Wheat	H.Labour (Hired)	289.71	246.96	283	-	264.18
	Bio-Chemical	857.71	767.17	845.55	716.66	814.45
	Irrigation Charges	177.38	187	208.14	-	182.28
	Total Paid-out Cost	1747.77	1567.31	1715.38	1174.49	1653.8
	F.Labour	596.48	563.72	521.04	833.33	576.17
	Total Cost	3091.62	3037.41	3095.95	2494.56	3056.14
Mustard	H.Labour (Hired)	224.76	254.84	348.01	183.63	259.77
	Bio-Chemical	455.49	403.93	482.04	349.05	437
	Irrigation Charges	121.44	79.79	108.13	221.55	105.45
	Total Paid-out Cost	1223.8	1107.95	1285.79	1140.2	1187.6
	F.Labour	526.13	452.96	433.89	731.63	485.33
	Total Cost	2441.83	2179.46	2424.9	2386.45	2332.89
Til	H.Labour (Hired)	490.9	330	-	-	410.45
	Bio-Chemical	42.72	251.39	-	-	147.06
	Irrigation Charges	-	15	-	-	7.5
	Total Paid-out Cost	865.74	968.63	-	-	917.19
	F.Labour	654.54	466.69	-	-	560.62
	Total Cost	2197.35	2499.18	-	-	2348.27
Boro	H.Labour (Hired)	1131.06	1141.55	943.95	905.22	1096.93
	Bio-Chemical	845.18	882.68	829.67	445.07	841.11
	Irrigation Charges	631.76	704.32	971.85	530.11	707.06
	Total Paid-out Cost	3128.02	3339.65	3230.23	2562.1	3197.61
	F.Labour	939.65	642.47	614.08	988.48	785.65
	Total Cost	6024.74	6010.58	5812.17	5227.92	5956.79

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 1991-92 & 2000-01.

Table-4.19

Cost of Production per Acre of Major Crops in West Bengal in 2000-01.

Major Crops	Paid-out Cost	Marginal	Small	Medium	Big	Average
Aus Local	H.Labour (Hired)	1025.26	1237.7	1611.2	1591.2	1350.64
	Bio-Chemical	522.08	737.72	780.17	746.78	702.08
	Irrigation Charges	-	-	-	-	-
	Total Paid-out Cost	2137.44	2388.85	2818.6	2673.77	2490.56
	F.Labour	1060.63	409.86	224	223.2	469.86
	Total Cost	4350.97	4150.56	4540.79	4658.23	4390.78
Aus HYV	H.Labour (Hired)	691.93	1081.82	1800.11	-	1099.17
	Bio-Chemical	890.71	883.97	878.28	819.5	882.69
	Irrigation Charges	16.39	111.74	111.54	320	88.78
	Total Paid-out Cost	2345.27	2731.47	3573.75	1827.06	2785.02
	F.Labour	1863.75	1231.62	381.2	1960	1246.46
	Total Cost	5268.03	5307.21	5055.28	5050.28	5227.13
Jute	H.Labour (Hired)	3057.56	3471.95	3767.33	-	3324.99
	Bio-Chemical	613.46	611.49	685.61	-	627.03
	Irrigation Charges	52.97	45.02	52.25	-	50.38
	Total Paid-out Cost	4398.83	4797.22	5260.7	-	4691.23
	F.Labour	1145.82	769.14	455.15	-	893.78
	Total Cost	7566.36	7375.53	7748.6	-	7543.32
Aman Local	H.Labour (Hired)	1816.11	1907.09	1962.3	1644.85	1860.36
	Bio-Chemical	544.97	675.28	722.91	837.1	666.39
	Irrigation Charges	30.46	49.46	13.59	-	27.38
	Total Paid-out Cost	3056.32	3204.02	3176.46	2864.25	3106.73
	F.Labour	1057.92	695.75	460.55	400.64	711.47
	Total Cost	5731.6	5355.31	4998.47	4545.03	5278.38
Aman HYV	H.Labour (Hired)	1680.06	1816.94	1934.96	2045.46	1780.73
	Bio-Chemical	931.58	942.41	833.87	1040.29	924.21
	Irrigation Charges	89.8	93.02	59.39	68.73	84.79
	Total Paid-out Cost	3450.49	3534.55	3413.68	3665.71	3480.29
	F.Labour	1080.98	707.86	615.49	488.85	863.64
	Total Cost	6212.11	5836.82	5682.82	5791.11	5991.99
Potato	H.Labour (Hired)	1528.98	1590.46	1495.13	1702	1561.46
	Bio-Chemical	7090.86	6826	6442.35	6981.4	6874.79
	Irrigation Charges	1451.07	765.84	334.14	244	874.41
	Total Paid-out Cost	11243.78	10388.07	9401.32	10334.72	10516.84
	F.Labour	2440.6	1597.45	929.68	540	1639.04
	Total Cost	20016.65	18352.29	16772.27	17241.04	18524.58

Wheat	H.Labour (Hired)	979.7	1110.81	1031.91	1048.01	1049
	Bio-Chemical	1284.52	1243.11	1350.91	903.6	1263.89
	Irrigation Charges	616.68	542.11	476.17	128	528.76
	Total Paid-out Cost	3487.09	3450.62	3508.93	2511.79	3428.17
	F.Labour	860.55	521.41	316.47	255.04	564.24
	Total Cost	5965.74	5659.66	5418.6	4132.49	5620.46
Mustard	H.Labour (Hired)	676.25	1022.14	844.04	906.8	840.47
	Bio-Chemical	821.4	707.5	842.17	648	781.68
	Irrigation Charges	344.64	348.83	333.75	666.67	349.55
	Total Paid-out Cost	2410.79	2644.25	2560.17	2638.48	2530.55
	F.Labour	907.02	699.32	513.31	-	732.87
	Total Cost	4622.74	4925.09	4530.56	4281.28	4706.19
Til	H.Labour (Hired)	579.89	671.16	-	-	600.37
	Bio-Chemical	231.57	248.04	-	-	235.26
	Irrigation Charges	335.28	624.02	-	-	400.06
	Total Paid-out Cost	1537.86	1918.63	-	-	1623.28
	F.Labour	838.89	610.91	-	-	787.74
	Total Cost	3162.95	3914.39	-	-	3331.55
Boro	H.Labour (Hired)	2521.1	2557.89	2290.05	1877.51	2465.59
	Bio-Chemical	1478.58	1398.81	1374.45	1509.31	1431.15
	Irrigation Charges	1621.42	1614.4	2188.81	2273.98	1761.34
	Total Paid-out Cost	6510.51	6306.75	6639.74	6295.59	6470.21
	F.Labour	1500.55	1026.87	851.22	464.19	1182.45
	Total Cost	11161.47	10260.01	10533.67	9654.44	10702.7

Source: Study on Farm Management and Cost of Production of Crops in West Bengal, 2000-01.

Area under Crops by Districts in West Bengal in 1986-87

Area in '000 Ha

Districts	Aus	Aman	Boro	Wheat	Maize	Ragi	S. Millets	Gram	ORP	OKP	R & M	Linseed	Til	OO	Jute	Tea	Suga	Potato	Chillies	T. GCA
Burdwan	25.4	392.9	105.7	6.9	0.2	-	-	1.1	6.8	1	27.2	0.3	10.6	0.4	15.6	-	0.8	30.6	1	627.6
Birbhum	12	255.2	42.7	30.2	0.6	-	-	4.2	5.4	0.8	45.5	0.1	3	0.6	0.8	-	1.5	10.6	0.3	414.3
Bankura	28.3	306	26.2	15.5	2	0.5	-	0.3	4.1	1.5	9.9	0.8	17.3	0.1	1.9	-	0.2	10.6	0.7	428.7
Midnapur	42.9	768.4	147.2	13.7	1.2	-	0.2	0.4	18.6	3	8.6	0.6	17.4	5.7	14.1	-	2.3	31.3	7.6	1086
Howrah	3.7	86.5	25.5	0.8	0.1	-	-	-	6.9	1.1	0.6	-	2.2	0.2	3.2	-	-	3.7	0.2	134.7
Hooghly	8.6	172.9	48.6	10.4	-	-	-	-	1.2	-	14.3	-	11.7	1.7	26.7	-	-	42.5	0.6	339.2
24 Parganas	25	532.6	91	14.5	-	-	-	1.9	18.2	4.5	24.5	0.2	4	1.2	59.4	-	0.4	5.9	16.4	800.7
Nadia	100.2	93	70.4	52.3	0.1	-	-	27.8	65.9	0.9	30.6	5	5.8	0.6	98.3	-	1.4	6.6	2.4	565.6
Murshidabad	101.2	157.1	43.6	104	0.3	-	0.1	16.8	50.3	0.8	52.2	2.8	4.5	0.6	94.8	-	4.8	8.2	2.2	656.2
Dinajpur	58.6	387.4	26	42.7	0.2	0.7	0.8	4	11.7	1	45.1	5.4	6.4	1.1	65	0.3	0.2	4	3.3	670.3
Malda	59.5	141.9	48.7	38	8.6	-	1.8	12.8	32.3	0.2	20.9	2.8	0.5	0.2	24.1	-	0.7	1.1	0.4	404.1
Jalpaiguri	58.5	220.7	0.5	25.5	2.1	1.9	-	0.2	5.9	0.3	7.3	0.2	1	0.9	49.6	67	-	3.1	2.3	453
Darjeeling	12.2	37.1	-	0.8	42.4	11.3	0.6	-	1.2	0.3	0.1	0.2	0.2	-	3.7	32.6	-	4.2	0.1	148.4
Koch Bihar	97	225	2.2	35.5	0.1	-	3.7	-	11.4	0.5	7.5	2.5	1.2	2.5	60.4	0.2	-	9.5	1	469.5
Purulia	4.3	283	1.1	8.9	16.7	1.7	2.1	0.6	7.9	12.1	0.6	0.7	1.1	4.1	0.1	-	0.2	1.2	0.9	348.6
W.Bengal	637.4	4059.7	679.4	399.7	74.6	16.1	9.3	70.1	247.8	28	294.9	21.6	86.9	19.9	517.7	100.1	12.5	173.1	39.4	7546.9

Source: Statistical Abstract of West Bengal, 1994-95

Note: (i) ORP – other rabi pulses, OKP – other kharif pulses, OO – other oilseeds, R & M- rapeseeds and mustard

(ii) Area under some crops has not been given in the table, which are very negligible in the state. But they have been included in Total Gross Cropped Area.

Area under Crops by Districts in West Bengal in 1993-94

Area in '000 Ha

Districts	Aus	Aman	Boro	Wheat	Maize	Ragi	S.Millets	Gram	ORP	OKP	R & M	Linseed	Til	OO	Jute	Tea	Suga	Potato	Chillies	T GCA
Burdwan	30.9	416.9	158	2.2	-	-	-	0.1	1.3	0.2	46.8	-	7.8	0.9	7.3	-	0.6	31.9	1.4	706.6
Birbhum	10.4	303.6	57.2	12.8	1.7	-	-	3.8	5.2	0.9	29.9	0.4	1.8	0.2	0.3	-	1.5	8.4	0.4	439.6
Bankura	33.9	341.2	43.4	9	1.7	-	0.6	0.7	0.9	0.9	19.7	0.2	14.2	0.3	0.6	-	0.1	15.8	1	485.3
Midnapur	76.5	774.5	216	10.2	1	0.1	-	-	14.3	4.4	29.6	0.1	26.8	9.4	8.7	-	0.9	54.8	8.4	1239.1
Howrah	2.2	86	52.5	0.2	-	-	-	-	1.3	0.2	2.2	-	2.9	0.1	2.1	-	0.1	3	0.2	153
Hooghly	12.7	193.6	77.8	1.1	-	-	-	-	0.3	0.1	9.6	-	30.5	1.8	30.5	-	0.1	67.6	0.7	426.4
N.24 Pgs	23.2	191	85	7.3	0.1	-	-	0.2	7	5.1	36.3	-	7.1	0.5	34.9	-	0.2	5.9	2.9	407.4
S.24 Pgs	1.9	382.4	50.2	-	-	-	-	0.1	9.1	1.5	3.8	-	1.3	0.3	1.7	-	-	1.2	13.8	467.8
Nadia	70.1	124.5	97	51.6	1.1	-	0.9	6.1	39.2	9.7	60.6	1.7	9.8	2.1	103	-	2.2	3.1	2.9	588.7
Murshidabad	64	229.6	63.6	91.6	1.7	-	-	4	30.2	8.5	52.8	0.4	5.5	0.1	103.8	-	2.4	6.5	3.9	672.9
Dinajpur	31.9	368	66.9	32.2	0.2	0.3	0.2	0.8	11.7	9.8	56.3	1.9	1.2	0.8	57.7	-	-	6.5	7.2	657.1
Malda	27.3	153.4	61.6	49.2	6.3	-	3.6	3	30.9	15.8	18.3	1.3	0.4	0.2	22.2	-	2	2	1.1	405
Jalpaiguri	59.6	191.5	2	15	2.2	0.3	-	-	1.6	1.4	7.3	1.3	1.1	1.2	37.6	82.1	0.1	7.5	3.4	418.4
Darjeeling	8.3	35.2	0.4	2.7	22.4	11.3	0.5	-	1	1.1	0.8	0.5	0.4	-	2.5	20.1	-	6.8	0.2	115
Koch Bihar	78.5	215.8	10.8	19.5	-	-	1.4	-	4.9	6.9	5.4	3.2	2.4	2.6	62.3	-	-	8.7	5	438
Purulia	8.2	283.7	2.3	2.3	13.9	0.4	1.4	0.1	3.6	14.9	1.5	1.3	1.6	3.8	-	-	0.1	1.2	1.3	342.6
W.Bengal	539.6	4290.9	1044.7	306.9	52.3	12.4	8.6	18.9	162.5	81.4	380.9	12.3	114.8	23.4	475.2	102	10.3	230.9	53.8	7962.9
24 Parganas	25.1	573.4	135.2	7.3	0.1	-	-	0.3	16.1	6.6	40.1	-	8.4	0.8	36.6	-	0.2	7.1	16.7	875.2

Source: Statistical Abstract of West Bengal, 1997-98

Note: (i) ORP – other rabi pulses, OKP – other kharif pulses, OO – other oilseeds, R & M- rapeseeds and mustard

(ii) Area under some crops has not been given in the table, which are very negligible in the state. But they have been included in Total Gross Cropped Area.

Area under Crops by Districts in West Bengal in 2000-01

Area in '000 Ha

Districts	Aus	Aman	Boro	Wheat	Maize	Ragi	S. Millets	Gram	ORP	OKP	R & M	Linseed	Til	OO	Jute	Tea	Suga	Potato	Chillies	TGCA
Burdwan	18.8	344.1	219.8	6.3	-	-	-	1.4	3	0.4	49.3	0.2	5.2	1.5	10.5	-	0.4	42.1	2.2	706.2
Birbhum	5	261.8	51.4	26.9	0.4	-	-	12.9	6.9	0.3	35.7	0.4	1.1	0.2	0.1	-	0.8	12.8	0.5	418.1
Bankura	22.9	333.4	39.3	8.8	0.4	-	0.5	-	0.7	0.1	13.9	0.1	13.1	0.5	0.4	-	-	21.5	1.3	458
Midnapur	76.5	764.1	267.9	13.6	1.7	-	-	0.7	15.6	2.1	25.1	-	31.5	15.9	7.7	-	4.6	60.4	9.2	1302
Howrah	0.8	64.1	48.4	1	-	-	-	-	0.4	-	1.7	-	2.3	1.3	6.8	-	0.1	9.2	0.3	136.4
Hooghly	9.2	101.2	88.9	1.6	-	-	-	-	1.1	0.4	12.7	-	16.8	4.1	29.9	-	-	80.6	0.8	347.4
N.24 Pgs	28.4	136.4	109.1	13.6	-	-	-	1.1	10.4	1.3	40.3	-	4.2	4	55.8	-	1	8.5	2.9	418.3
S.24 Pgs	6.9	335.5	83.5	3.2	-	-	-	0.1	8.3	0.3	2.3	-	3	0.4	1.8	-	-	3.8	14.6	465.1
Nadia	53.4	28.1	147.7	60.4	0.3	-	0.1	18.2	30.8	6.4	81.6	4.7	15.3	7.3	130.3	-	1.8	3.5	4.6	597.7
Murshidabad	48.7	67.9	108.5	135.5	0.4	-	-	10.4	39.4	8.2	65	1.1	4.7	0.3	141	-	6.5	8.9	4.3	654.1
Dinajpur	8.1	356	129.8	47.7	-	0.6	0.6	2.2	8.5	2.5	56.6	3.2	8	1.1	74.1	-	0.4	11.5	6.2	721.4
Malda	13.4	137.3	71	49.4	3.4	-	0.9	7.6	12.2	16.2	34.8	0.3	0.3	0.3	24	-	5.4	2.4	3.1	386.2
Jalpaiguri	63.3	190.8	6.7	26.6	1.7	0.5	0.4	-	4.3	2.2	8.3	1	1.3	1.8	44.3	85.1	-	14.3	5	466.7
Darjeeling	5.4	28.3	0.4	3.3	12.9	11.3	0.5	-	1.1	0.8	0.1	-	0.3	0	2.2	18.1	-	7.1	0.4	94.3
Koch Bihar	30.5	233	28.4	25.2	-	-	0.7	-	8	2.5	8.1	0.5	0.6	3.4	84.1	-	-	12.2	5	453.6
Purulia	2.7	258.5	1	2.9	14.1	0.2	0.6	0.1	1.7	14.8	0.5	0.4	20.5	1.4	-	-	0.6	0.9	1.1	304.5
W.Bengal	394	3640.5	1401.8	426	35.3	12.6	4.3	54.7	152.4	58.5	436	11.9	128.2	43.5	613	103.2	21.6	299.7	61.5	7930
24 Parganas	35.3	471.9	192.6	16.8	-	-	-	1.2	18.7	1.6	42.6	-	7.2	4.4	57.6	-	1	12.3	17.5	883.4

Source: Statistical Abstract of West Bengal, 2001-02

Note: (i) ORP – other rabi pulses, OKP – other kharif pulses, OO – other oilseeds, R & M- rapeseeds and mustard

(ii) Area under some crops has not been given in the table, which are very negligible in the state. But they have been included in Total Gross Cropped Area.