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CHANGING CROPPING PATTERN AND IRRIGATION INTENSITY: A STUDY OF MURSHIDABAD DISTRICT, WEST BENGAL, INDIA

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ABSTRACT

Land use change, especially if done in a spatially explicit, integrated and multi-scale manner, is an important technique for the projection of alternative pathways into the future, for conducting experiments that test our understanding of key processes in land use changes. Land-use change should represent part of the complexity of land use systems. They offer the possibility to test the sensitivity of land use patterns to changes in selected variables. They also allow testing of the stability of linked social and ecological systems, through scenario building. As such the amount of area involved in change for Murshidabad district is calculated the crops of leading increases and decreased are marked. The intensity of land utilization is reflected in number of crops raised during the year. Among the various determinants of agriculture, it is assumed that irrigation positively affects the intensity of cropping. This study area has recorded in 10 years mid-land and across the Bhagirathi river of the district is significant increase in residential and agricultural area due to gain more land from water bodies, barren and vacant lands. It is observed from the study area, there is a grater variation in the changes in cropping pattern with changes irrigation intensity during the study period. About 80 % population depends directly upon land middle and eastern part of the district, is mainly use of the agricultural land and converted into residential and other uses for the growth and development of the facilities. Farmers have adopt modern technology i.e. fruits and vegetables drip irrigation facility, variety seeds material, increasing use by composting biomass, improved planting technology and micro irrigation systems, crop loans, good network of transports and markets, agricultural advisory centers and also available facilities in the study area. Therefore, recently cropping pattern is vastly changes look into irrigation and day by day positively increases.

Keywords: Crop combination, Cropping Pattern, Irrigation Intensity, Residuals

INTRODUCTION

Land is the most vital natural resource. It not only provides food crops but accounts for all types of minerals, therefore, it should be properly used. Here under, we will consider the concept related with the classification of land for agricultural purposes. By imposing land use

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

restrictions where open access had previously been the norm, government efforts to conserve natural resources can lead to land scarcity. For example, many newly created protected areas are populated, and managed as working landscapes, where the availability of land for cultivation is reduced by increasing population density and restrictions on land use (Brandon et al. 1998). These forces create competing demands for land use change. On the one hand, land may be more intensively cultivated, and on the other hand it may be targeted for ecosystem restoration. Land use allocation in an extensive agricultural system faced with a relative land scarcity. We frame our inquiry using Boserup's (1965) classic work that explicitly considered the role of fallows in the process of land use intensification under conditions of population increase and land scarcity. Her theory of land use change has been robust, and is supported with research findings throughout the world (e.g. Smith et al. forthcoming; Schelhas 1996; Netting 1993; Barlett 1982). However, policies restricting land use raise questions about the applicability of these ideas in areas targeted for natural resource conservation.

The development of a modern transport network, the provision of irrigation facilities played the most important part in bringing about the changes which took place in the composition and volume of production in agriculture in the district. In a way the importance of public investment in irrigation under the policy of selective intervention is indicated most clearly by the fact that the nationalist leaders, who were so critical of many other policies of the foreign rulers, complained that the expenditure on the development of irrigation facilities was insufficient. All attributed a strategic role to irrigation in augmenting agricultural production and have described the consequent changes as "commercialization", a "transformation". Rainfall in most parts India was inadequate and uncertain, it is but natural that an assured supply of water by means of irrigation would raise agricultural output. However, there has been little systematic and historical study of the impact of irrigation on increased agricultural production. Also there has been little systematic study of other, indirect benefits of irrigation to the Indian economy as a whole. This paper examines some the direct as well as the indirect effects of irrigation in the district during 2001-02 and 2011-12.

STUDY AREA

Geographically Murshidabad District is located between $23^0$43'30" and $24^0$50'20" north latitude and $87^0$4917' and $88^0$46' east longitude. It is the northern most segment of lower Gangetic plain. The district Murshidabad is bounded by Malda district in north by Jharkhand state boundary and Birbhum district in west, Burdhaman and Nadia districts in the south and India – Bangladesh international boundary in the east. The Bhagirathi River passes through the middle of the district from north to south. This district is divided into two parts by the river Bhagirathi. The western part having stiff clay soil, reddish in colour and undulated topography is called 'Rarh' and simultaneously the eastern part of the Bhagirathi containing alluvial and fertile soil is known as "Bagri."

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

Figure -1

OBJECTIVES

1. To study the crop combination of block wise changes.
2. To comparison of 2001-02 to 2011-12 (10 years) changes cropping pattern.
3. To identify the irrigation intensity of the district
4. To find out the irrigation intensity effects the cropping pattern

DATA SOURCE AND METHODOLOGY

For this research the source materials has based on secondary sources. The major secondary sources are District Statistical Handbook, District Census Handbook (Murshidabad, 2001-2011), District Gazetteers (Murshidabad), Round of NSSO data, Topographical maps (Survey of India), District Planning Series Maps (NATMO), Google Earth Imageries, Govt. of West Bengal and various government departmental documents, books, journals, conference papers; official websites etc. The data is analyzed both in **qualitatively and quantitatively** by the following statistical techniques.

Crop combination by Weaver (1954):

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

$$\delta^2 = \frac{\sum(d^2)}{n}$$

Where δ^2 = Standard Deviation.

d^2 = The sum of squares of individual deviation

n = Number of crops

$\sum$ = Summation value of d^2 in an areal unit.

Weaver considered all the crops having at least one per cent acreage of the total cropped land for analysis. Since we are interested in the relative size of standard deviations, the square root need not be extracted.

Using Weaver's method we can identify the crop combination of Murshidabad District.

Crops:

1% of Crop area	Rice	Jute	Wheat	Pulses
	47.47	15.66	12.08	8.27
	Veg. & Others	Mustard	Potato	
	8.14	7.47	0.91	
			(Year 2011-12)	

One Crop

Hypothetical %	100	Summation
Observed %	47.47	
Difference	52.53	
d^2	2759.40	= 2759.40
d^2	2759.40	= 2759.40

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

N 1

Second Crop

Hypothetical %	50.00	50.00	Summation
Observed %	47.47	15.66	
Difference	2.53	34.34	
d^2	6.40	1179.24	= 1185.64
$\underline{d^2}$	1185.64		= 592.82
N	2		

Three Crops

Hypothetical %	33.30	33.30	33.30	Summation
Observed %	47.47	15.66	12.08	
Difference	-14.17	17.64	21.22	
d^2	200.79	311.17	450.29	= 962.25
$\underline{d^2}$	962.25			= 320.75
N	3			

Four Crops

Hypothetical %	25.00	25.00	25.00	25.00	Summation
Observed %	47.47	15.66	12.08	8.27	
Difference	-22.47	9.34	12.92	16.73	
d^2	504.90	87.24	166.93	279.89	=1038.96
$\underline{d^2}$	1038.96				=259.74

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

N 4

Irrigation intensity of the study region truly reflects in agricultural development which is calculated on the basis of the formula.

Irrigation Intensity (II) = $\frac{GI}{GS} \times 100$

Where, GI is the gross irrigated area and GS is the Gross cropped area.

Residual of Irrigation Intensity and Cropping Intensity = : Yc = a+bx

$\sum Y = Na+b\sum X$

$\sum XY = a\sum+b\sum X^2$

RESULTS AND DISCUSSION

Changing Cropping Pattern (2001-02 to 2011-12):

Murshidabad district is generally agriculture based about 80% people is engaged in agriculture. In the 2001-02 and 2011-12 the cropping pattern of the district is converted to another cropping pattern due to climatic change, irrigational partiality, low market level, high costing of pestisides, divert economic opportunity, high level og migration of labour towards Kolkata and other states for construction, and over all low marginalized income. Uneven climatic change and probable cropping financial year replace the cropping pattern. Agricultural facilities, demands of markets, sources of other facilities, modern techniques in agriculture are developed and people are totally depended on agro-based system so that they change their cropping pattern for the sake of higher gain.

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

Table-1
Difference of Cropping Pattern during 2001-02 to 2011-12

Sl. No.	Name of the blocks	Aus paddy	Aman paddy	Boro paddy	Total paddy (Aus, Aman & Boro)	Jute	Wheat	Mustard	Potato	Pulses	Veg. & others	Over all Variation
1	Farakka	-1.88	-7.8	4.21	-5.46	9.88	-1.93	3.44	-0.63	2.51	-7.81	-5.47
2	Samserganj	-24.44	-11.34	17.15	-18.63	10.34	13.96	-5.34	-0.32	7.2	-7.21	-18.63
3	Suti-I	-9.2	-4.26	5.21	-8.25	4.06	1.77	-4.36	2.34	4.19	0.26	-8.24
4	Suti-II	-0.7	-5.22	-0.77	-6.7	11.62	4.71	-5.61	0.77	-0.73	-4.06	-6.69
5	Raghunathganj-I	-4.15	-1.25	-0.55	-5.96	1.81	16.31	-9.45	0.44	0.86	-4.01	-5.95
6	Raghunathganj-II	-6.93	3.82	2.63	-0.48	5.33	-1.02	-0.56	-0.6	0.88	-3.54	-0.47
7	Sagardighi	0.55	-11.54	0.78	-10.22	3.84	8.25	1.2	0.5	-3.51	-0.09	-10.24
8	Lalgola	-10.76	6.46	4.29	0	7.09	0.53	4.02	-0.96	-6.1	-4.56	0.01
9	Bhagwangola-I	1.53	4.96	-5.47	1.01	16.46	-3.05	-4.11	0.27	-5.3	-5.3	1
10	Bhagwangola-II	-11.14	9.84	6.91	5.62	-4.72	4.33	0.77	-0.9	0.06	-5.14	5.63
11	Raninagar-I	-7.24	-1.01	0.84	-7.41	4.24	10.68	-0.6	0.68	-4.15	-3.43	-7.4
12	Raninagar-II	-8.99	10.2	4.83	6.04	13.2	-14.77	0.46	0.54	0.9	-6.38	6.03
13	Murshidabad-Jiaganj	-1.34	0.53	2.67	1.87	8.49	1.48	-2.61	-0.02	-1.1	-8.1	1.87
14	Nabagram	0.93	-55.71	32.8	-21.97	1.57	16.45	3.61	0	0.17	0.16	-21.99
15	Khargram	0.35	-4.32	4.11	0.14	-0.39	3.96	-6.39	0.17	1.6	0.92	0.15
16	Burwan	0.95	-8.49	9.68	2.13	-1.07	3.42	-2.64	-0.6	-0.78	-0.47	2.13
17	Kandi	3.46	-31.25	26.26	-1.53	-3.04	1.86	0.93	0.91	0	0.863	-1.537
18	Bharatpur-I	-1.89	1.12	8.35	7.58	-3.89	-1.28	-3.58	1.87	-1.14	0.44	7.58
19	Bharatpur-II	-1.79	-60.63	40.62	-21.85	0.33	-1.14	16.85	0.15	1.66	4.01	-21.79

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

20	Beldanga-I	-3.75	-0.18	13.74	9.81	0.7	-2.35	-1.33	-0.02	-0.94	-5.86	9.82
21	Beldanga-II	-8.65	2.32	-1.89	-8.21	11.39	-0.2	3.85	0.33	-3.53	-3.62	-8.21
22	Nowda	5.15	-1.22	-0.1	3.83	3.79	-1.15	-0.84	-0.26	-5.04	-0.32	3.84
23	Hariharpara	-8.37	1.63	3.01	-3.71	8.26	1.48	-4.96	-0.67	0.28	-0.64	-3.69
24	Berhampore	-2.48	0.72	2.55	0.82	0.26	1.99	1.43	-0.08	-4.55	0.13	0.79
25	Domkal	-7.17	2.6	3.11	-1.46	19.22	-17.83	0.14	0.21	-1.03	57.75	55.54
26	Jalangi	17	17.74	1.71	36.45	-18.61	-15.17	0.02	0.69	-6.44	3.06	36.45

Source: District Statistical Handbook

The over all cropping variation portray that the some C.D. blocks of the district is highly varied in percent (Table-I). Domkal block recorded highest percentage of cropping pattern changes in positive (55.54%) followed by Jalangi (36.45%) and lowest variation is identified in Lalgola (0.01%) in positive and negative is in Raghunathganj-II (-0.47%). Highest negative variation is observed in Nabagram (-21.99%) followed by Bharatpur-II (-21.79%). Some important crops are also changes largely on block basis due to availability of all facilities related to development of agriculture and allied services.

CROP COMBINATION

The different methods applied in the delineation of crop combination regions can be summed up fewer than two headings. The first method for the demarcation of crop combination regions is the arbitrary choice method, e.g., the first crop only, the first-two crop only or the first-three crops, etc. The crop combinations delineated on arbitrary choice method are, however, not rational and judicious, as by applying arbitration the rest of the crops grown in the area are irrationally excluded without any consideration of their percentage weightings in the total cropped area. The study of analysis of crop combination in a region explains the crop complexities of that predominance vary. The distribution, nature, production and problems of crops are influenced by relief, slope climate, soil etc., besides physical/natural elements, human elements have also a close bearing on crop combination in a region because crops associate with one another not mere by chance but as a result of deliberate option.

But the choice is not exclusively arbitrary and is always a function of the geological setup and cultural factors associated with special dimensions of socio-economic systems. A study of crop combination and their regional diversification, as such is a probe into the extent of human response to the complex of aggregate environment within the specific conditions.

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

Among the human elements which influence crop combinations, the main factors are shifting of population and changing needs of man. Crops are very rarely grown singularly. It is rarely that a crop occupies a position of total isolation with other corps in a given areal unit at a given point of time. The crops grown in a region or in a real unit not only reflect the geographical factors of that region but also reveal the direction of agricultural land use with the help of which agricultural regions can be determined.

A quantitative analysis of this process is quite with reference to land use planning of India in diversified geological setting. According to James and Johns the regional characteristics of agriculture cannot be well understood without study of crop combination. In the field of agricultural geography Weaver (1954) was the first to use statistical techniques to establish the crop combination of the Middle West (USA) influenced by the studies of weaver various other scholars in different parts of the world studied crop combination in their regions. These scholars mostly made use of formula propounded by weaver and some scholars divides their own formulas by introducing some modification in Weaver's formula.

Table: 2
Ranking of Crops (2001-2011) by Crop combination method (Weaver, 1954)

Name of the crops	1st ranking Crops		2nd ranking Crops		3rd ranking Crops		4th ranking Crops		5th ranking Crops		6th ranking Crops		7th ranking Crops		8th ranking Crops		9th ranking Crops	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Aman Paddy	13	11	3	5	3	8	0	0	4	5	3	0	0	1	0	0	0	0
Jute	5	7	2	5	4	2	1	1	2	0	4	2	2	1	2	2	3	4
Wheat	3	1	5	5	1	7	3	3	3	4	6	2	2	4	2	1	0	1
Vegetables & others	2	1	1	0	6	2	8	8	2	8	2	10	5	2	0	0	0	0
Aus Paddy	1	0	3	1	3	2	5	5	4	3	3	2	1	3	5	9	2	1
Boro Paddy	1	4	7	6	3	1	2	2	0	0	5	4	4	1	4	1	0	0
Pulses	1	2	3	2	2	1	3	3	5	3	2	1	8	6	2	6	0	0
Mustard	0	0	2	2	4	3	4	4	6	3	1	5	3	6	6	5	0	0
Potato	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	2	21	20

Source: Calculated by the Researcher

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

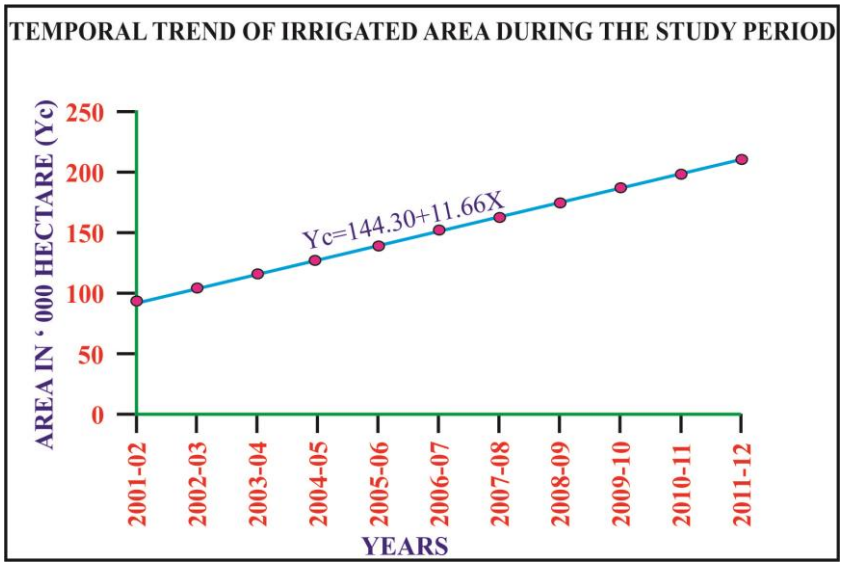
Ranking of crops are calculated by Weaver method in which number of blocks are covered by crop ranking. In first ranking crop 13 blocks out of 26 is under aman paddy in 2001 which is revised into 11 blocks in 2011. Boro paddy is highly practicised in 2011 than 2001 as it come first ranking crops of one to four blocks in 2011. Other ranking of crops are pictured in table no-2.

IRRIGATION INTENSITY

At present no proper development is possible in agriculture without irrigation. In agricultural development in the Murshidabad district the irrigation plays the most vital role. In the region the irrigation system is mainly based on shallow tube-wells and deep tube-wells as well as the factors like rainfall conditions, rise and fall of ground water and the nature of sub-soils which influence the irrigation efficiency. Irrigation is practiced in the District through the different sources.

As most of the rivers are non-perennial accepts the Bhagirathi and the Bhairab, alternative supply of water of agricultural land like canals tube-wells. (Shallow and Deep Tube-well both) and lift irrigation are essential. The decadal analysis shows an increase the various sources of irrigation. In 2001-02 the irrigated area is observed 1,13,032 hectare (30.96%) which increases 2,09,696 hectare (61.43%) in 2011-12. From the trend line (Yc = 144.30 + 11.66X), irrigated area is observed to increase sharply during the study period.

Figure-2



Irrigation intensity of the study region truly reflects in agricultural development which is calculated on the basis of the formula.

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

Irrigation Intensity (II) = $\frac{GI}{GS} \times 100$

Where, GI is the gross irrigated area and GS is the Gross cropped area.

In 2001-02 irrigation intensity in the Murshidabad District is found to be 16.73% which is promoted to 25.06% in 2011-12 due to an expansion of irrigation facilities during the study period. The Block wise distribution of the irrigation intensity reveals increase in almost all the Blocks of the District from the year 2001-02 to 2011-12. In 2001-02 the highest irrigation intensity is observed in the Blocks Farakka, Samserganj, Raghunathganj-II, Berhampore, Kandi, Burwan followed by Raghunathganj-I, Khargram, Bharatpur-II, Suti-I, Suti-II, Sagardighi, Lalgola, Bhagwangola-I, Bhagwangola-II, Murshidabad-Jiaganj, Nabagram, Bharatpur-I and Domkal respectively.

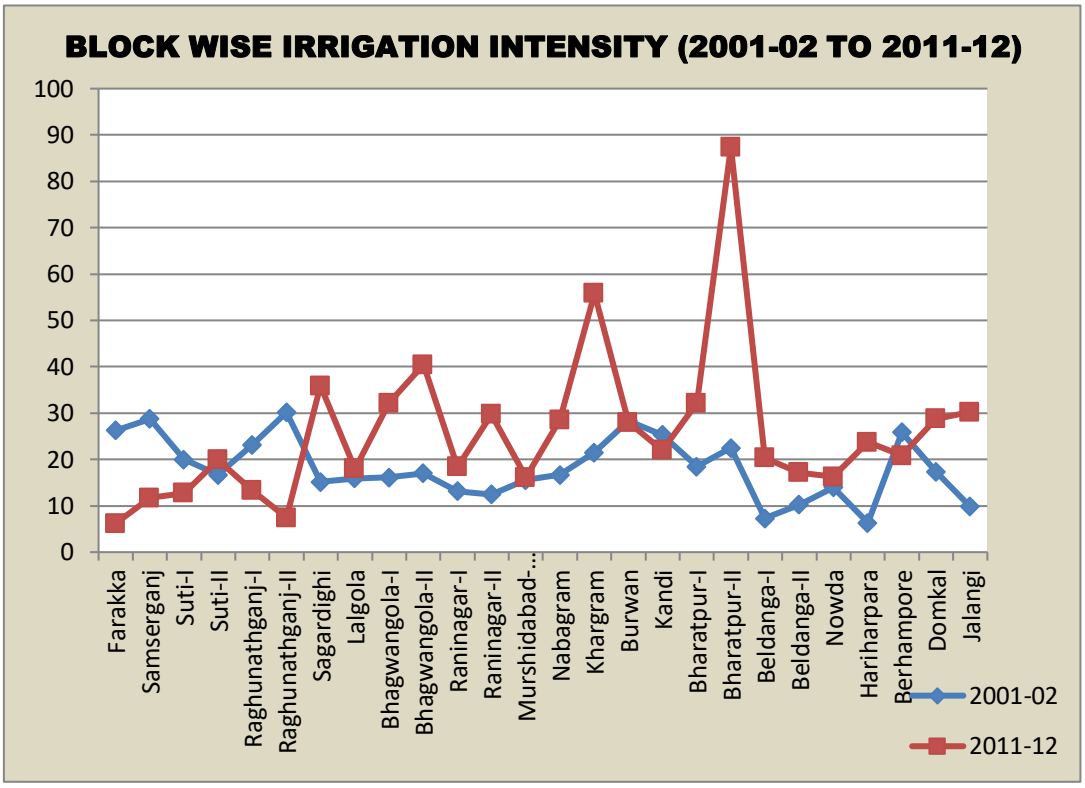
In 2011-12 an increase is marked in irrigation intensity mainly in the Blocks Raninagar-II, Jalangi, Domkal, Bhagwangola-I, Bhagwangola-II, Bharatpur-I, Bharatpur-II, Burwan, Khargram, Nabagram and Sagardighi followed by Berhampore, Hariharpara, Kandi, Beldanga-I, Beldanga-II, Nowda, Raninagar-I, Murshidabad-Jiaganj, Lalgola and Suti-II, respectively.

Interestingly it is observed that the Blocks Farakka and Samserganj, Suti-I, Raghunathganj-I and Raghunathganj-II reveal a decrease in irrigation intensity which is marked to the intervention of other economic activities, particularly Beedi (a kind of cigarette) making. The farmers are not interested to investment to irrigation, rather are more inclined towards the use of natural rain water.

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

Figure-3



RESIDUAL OF IRRIGATION INTENSITY AND CROPPING INTENSITY

Two residual maps are outlined for the year 2001-02 and 2011-12 to show the relationship between the cropping intensity and irrigation intensity. It is observed from the residual map of the year 2001-02 that the positive lines are passing through the Blocks Domkal, Berhampore, Raninagar-I, Raninagar-II, Lalgola, Raghunathganj-II, Suti-I, Suti-II, Samserganj, Farakka, Beldanga-I and Hariharpara because of the widespread use of high yielding varieties and chemical fertilizers, whereas the negative lines are passing mainly through the western part of the District. In 2011-12 the positive lines are passing through the eastern part of this District mainly in the blocks Jalangi, Raninagar-II, Berhampore, Hariharpara, Beldanga-I, Beldanga-II, Nowda, Bharatpur-II, Bhagwangola-I, Lalgola, Sagardighi, Raghunathganj-I and Raghunathganj-II whereas the negative lines are passing through the western part and northern part of this District. The zero lines, passing through the areas, reflect the perfect relation between cropping intensity and irrigation intensity.

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

Table No – 3

Residual showing the relationship between the irrigation intensity and cropping intensity (2001-02 & 2011-12)

Name of the Blocks	2001-02				2011-12			
	Irrigation intensity (%) (X)	Cropping Intensity (%) (Y)	Yc = (a+bx)	Y-Yc	Irrigation intensity (%) (X)	Cropping Intensity (%) (Y)	Yc = (a+bx)	Y-Yc
Farakka	26.24	152.12	170.18	-18.06	6.19	183.39	307.11	-123.72
Samserganj	28.75	279.24	158.94	120.30	11.71	289.04	292.12	-3.09
Suti-I	19.98	200.58	198.14	2.44	12.75	217.97	289.32	-71.35
Suti-II	16.65	403.58	213.01	190.57	19.93	224.76	269.83	-45.07
Raghunathganj-I	23.15	114.79	183.96	-69.17	13.29	412.80	287.84	124.96
Raghunathganj-II	30.16	188.83	152.64	36.19	7.42	331.81	303.78	28.03
Sagardighi	15.12	91.51	219.82	-128.31	35.89	230.00	226.352	3.47

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

Lalgola	15.91	316.54	216.29	100.24	17.99	334.07	275.10	58.96
Bhagwangola-I	16.10	162.19	215.46	-53.27	2.14	272.29	236.0	35.59
Bhagwangola-II	17.01	201.03	211.37	-10.35	40.43	205.57	214.19	-8.62
Raninagar-I	13.16	334.87	228.58	106.30	18.37	256.38	274.06	-17.69
Raninagar-II	12.43	316.13	231.87	84.26	29.72	316.46	243.26	73.21
Murshidabad-Jiaganj	15.57	243.39	217.84	25.55	16.10	262.94	280.22	-17.28
Nabagram	16.70	131.93	212.77	-80.84	28.57	110.13	246.39	-136.26
Khargram	21.49	163.98	191.37	-27.39	55.83	140.18	172.39	-32.22
Burwan	28.37	101.47	160.63	-59.16	28.00	205.34	247.93	-42.59
Kandi	25.30	145.41	174.35	-28.94	21.99	147.70	264.25	-116.55

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

Bharatpur-I	18.45	125.49	204.94	-79.45	32.17	155.69	236.62	-80.93
Bharatpur-II	22.47	137.16	187.01	-49.85	87.40	104.77	86.72	18.05
Beldanga-I	7.28	260.64	24.84	5.80	20.35	302.92	268.70	34.23
Beldanga-II	10.22	216.46	241.72	-25.26	17.16	295.25	277.35	17.90
Nowda	13.99	217.23	224.90	-7.67	16.27	303.40	279.77	23.63
Hariharpara	6.33	208.50	259.09	-50.59	23.74	307.24	259.48	47.77
Berhampore	25.86	179.20	171.84	7.36	20.79	464.09	267.50	196.59
Domkal	17.35	227.97	209.88	18.09	28.75	208.29	245.91	-37.62
Jalangi	9.83	234.70	243.49	-8.79	30.20	312.56	241.96	70.60

Source: i) Principal Agricultural Office, Berhampore, Murshidabad District

ii) Calculated by Scholar

Figure-4

ISSN: 2455-8834

Volume:03, Issue:07 "July 2018"

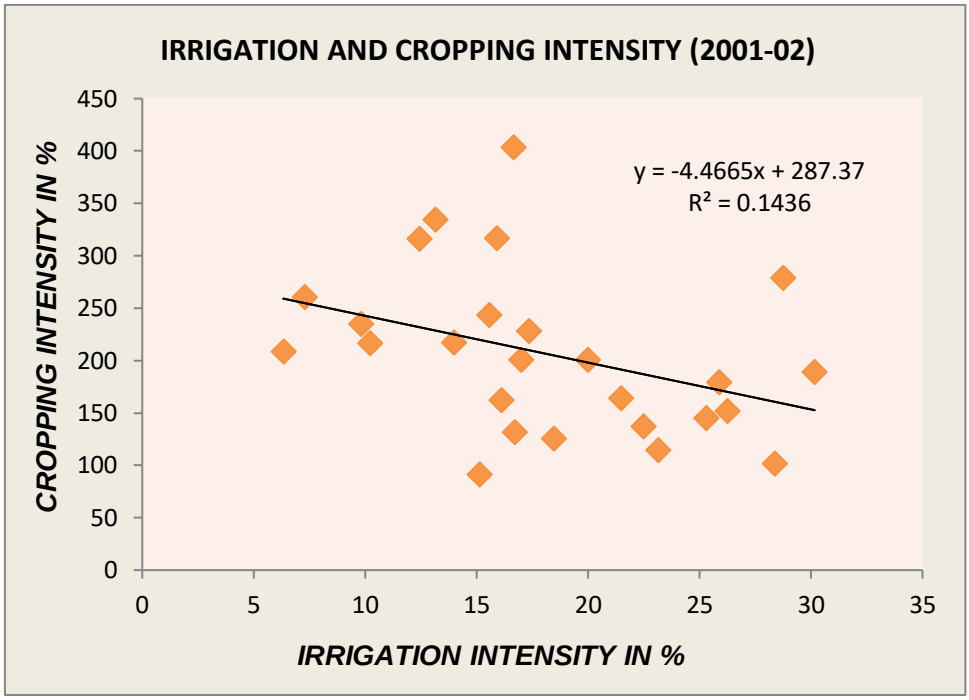
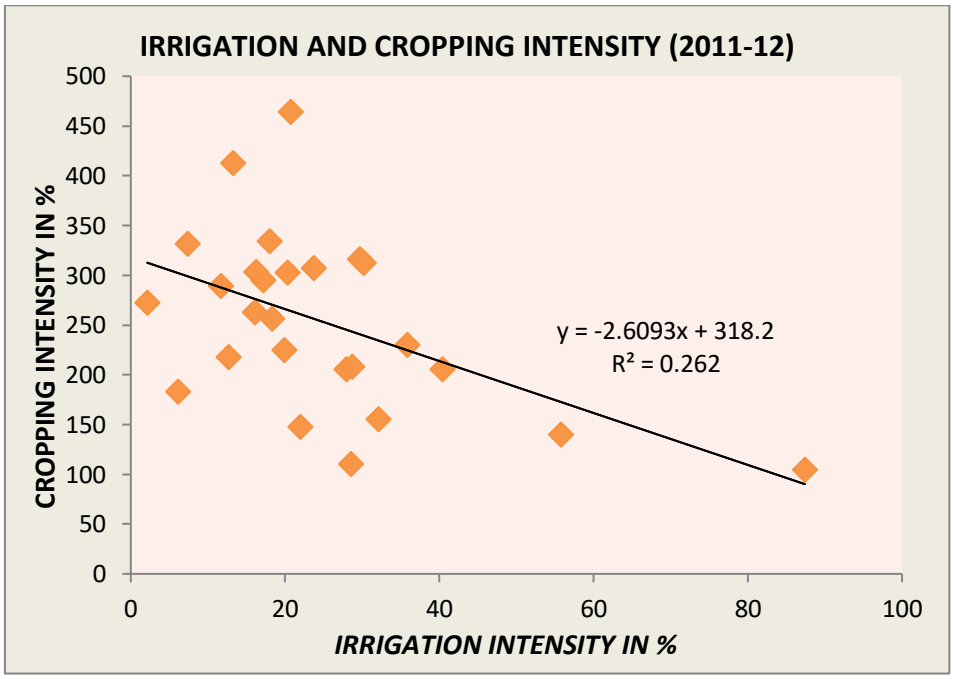


Figure-5



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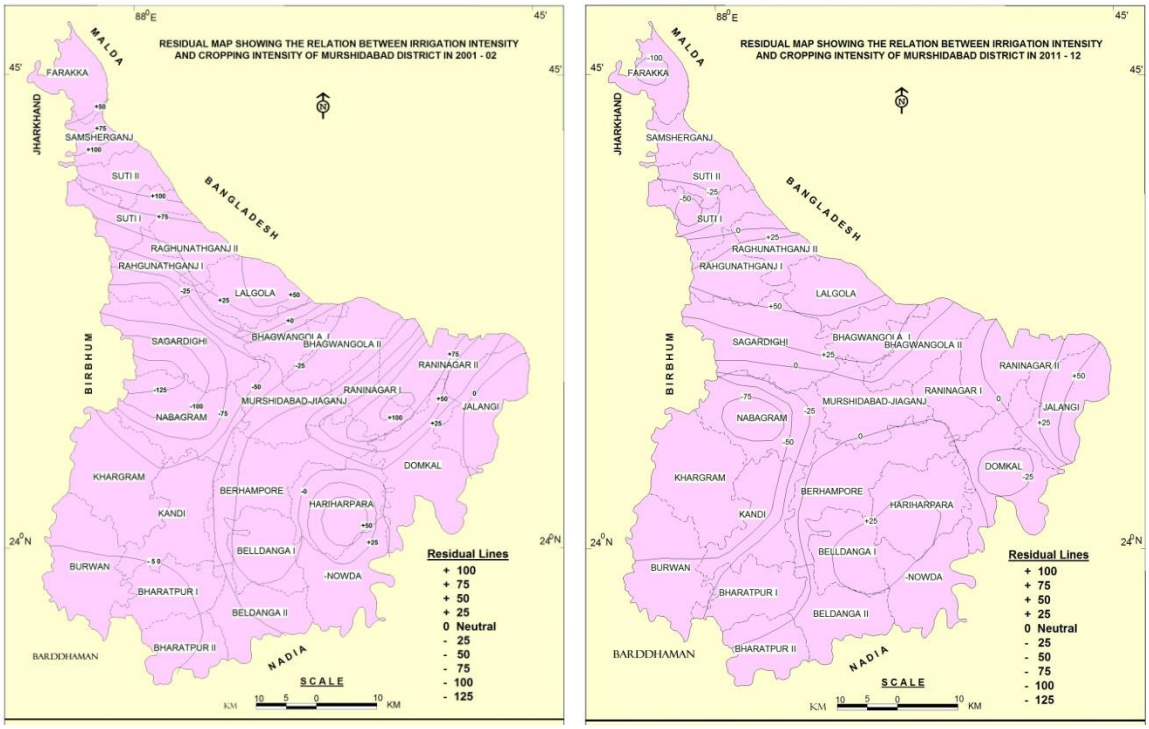
Volume:03, Issue:07 "July 2018"

Figure-6



CONCLUDING REMARKS

No attempt has been made to study the secondary benefits of irrigation. In this paper some questions have been raised only about the direct effects of irrigation, that is to say its contribution to agricultural output. But our analysis has clearly demonstrated that the impact of irrigation facilities needs to be evaluated more carefully and rigorously for zenith output from agriculture. With regard to our findings about the impact of irrigation on crop output, it seems that though the expansion of irrigated area did make an impressive contribution to agricultural growth. The full potential of irrigation in augmenting agricultural output was not properly achieved in the study area due to some physical and cultural factors. This is because the desired crop-mix was not achieved and the expansion of irrigated area was not accompanied by the use of such inputs as could result in a cumulative increase in productivity.

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