

**Preliminary (First) Report on the Research Project:  
'A Study on Transformation of Indian Agriculture in the  
Post Doha Scenario and its Macro Economic Impact'**

**APARAJITA MUKHERJEE**

**AND**

**SAUMYA CHAKRABARTI**

**DEPTT. OF ECONOMICS AND POLITICS  
VISVA-BHARATI (UNIVERSITY)  
SANTINIKETAN – 731235  
WEST BENGAL  
INDIA**

## **Abstract**

The aim of the project is to examine the process of transformation the agrarian economy of India is undergoing under the post Doha situation. As is claimed in current literature the opening up of the agrarian economy should lead to transformation of the economy from traditional grain based production system to one based on production of high value export oriented crops, particularly fruits and vegetables. It is also claimed that this transformation in production follows not only increasing opportunity for exporting these crops but also the changing pattern of domestic consumption of food which shows a shift from food grains to non food grains. On one hand we have undertaken statistical analysis of macro level data on cropping pattern and variables that may be expected to influence this pattern, pertaining to different provinces of India, on the other we have taken up analysis of detailed micro level data on cropping pattern and several other variables, pertaining to production behaviour at the farm level . Our aim would be to examine a) whether and under what conditions there has been greater diversification of cropping pattern, b) what are the factors at micro level which influence the farmers' decision regarding diversification and c) to what extent consumption pattern of the rural households shows importance of non-food grain items. While in this preliminary first report we have concentrated on these three issues ,on the basis of both some secondary level data, pertaining to few provinces of India and primary farm level data collected through, intensive field survey of farming households of three districts of a province in India, namely, West Bengal, in the rest of our research work we shall concentrate on such issues as efficiency and export oriented ness of the diversified cropping system under Indian conditions, the question of food security, the efficacy of contract farming system and the role of food processing industries as solution to the problems of credit and marketing in the production of high value crops.

## 1. Objective of the Study:

The broad aim of the research project is to examine the process of transformation the agrarian economy of a South Asian country, India, is undergoing in the post Doha situation. In more specific terms we would examine the feasibility of transformation of Indian agriculture from traditional crop based system towards more diversified system of crop production geared to the world market. In this context, the two important issues we want to address are, first, the potential positive impact of such transformation in terms of greater degree of competitiveness and secondly the long run impact of such transformation on the status of food security.

For the present report, however, starting with analysis of some macro level data we have confined ourselves to the analysis of conditions of production and productivity with regard to traditional crops vis-à-vis high value non-food grains items, under varying conditions with regard to infrastructure and irrigation, as experienced by individual farmers belonging to different size classes. We have also examined the consumption pattern of individual households. Our analysis has been based on primary data collected through field survey on different aspects of economics of traditional vs. high value crop production along with pattern of consumption and conditions of living of farming households. For the present analysis we have taken up three districts of West Bengal, carefully selected to represent different types and extent of irrigation and different conditions with regard to infrastructure. In the final phase of our research work, however, we shall not only include other issues namely, efficiency and export-oriented ness of diversified cropping system, question of food security, efficacy of contract farming and role of food processing in this context, but also other provinces namely Punjab, Haryana and Maharashtra.

## 2. The General Perspective:

From the early post war period of reconstruction up to the beginning of the twenty first century the world economy has seen major developments having far reaching influence on the pattern of trading relationships not only between the North and the South but also within each part. The most important of such developments are: First, the growth of Transnational Corporations based in US and other European nations like France, Germany, Britain and such economically powerful Asian nation as Japan and competition and rivalry among them had its impact on the

pattern of trade and development at the world scale. Handful of big TNCs were seen to emerge to control not only the major portion of world production and global trade in commodities and finance but also most vital part of research and development activities of the developed countries. Secondly, in the field of trade in agricultural commodity, emergence of European community as a net grain exporter region broke the dominant position held so far by the US and Canada in the field of grain trade. The EC and North America emerged as the two big players in the world grain trade. In both these regions whole production increase had been built on heavy subsidies. By 1980 it was seen that as the OECD countries appeared as big exporters of agricultural commodities capturing major share of export trade, there arose strong rivalry among the TNCs engaged in agriculture related goods based in USA on one hand and countries under European community on the other. The trade wars between these two blocks of agricultural exporters led to price cutting and accumulating stocks in the world market. The situation led to continuous process of increase in subsidies to be borne by these two blocks as retaliatory measures undertaken by the one against the other of the two major contending blocks of oligopolists. By 1990 world trade in agriculture related commodities acquired two major characteristics: First world grain trade was mainly controlled by five big TNCs with high degree of concentration of power in one or two biggest TNCs like Cargil with 25 per cent market share (based in USA) and Continental Grain with 20 per cent market share. Secondly, it was seen that more than one-third of agricultural production in North America and Europe were meant for exports and in the specific case of major cereal, wheat, developed countries occupied major share of world exports and developing countries occupied major share of world imports, giving rise to conditions under which it becomes obvious that developed countries' major concern would be how to change domestic policies of the less developed countries so that they are compelled to increase their imports of grain. The ultimate objective in this direction was to reduce production of grains at the world scale, which is nothing but the obvious reactions of the oligopolist grain traders faced with the problem of falling world demand due to achievement of self-sufficiency in grain, by several developing countries of the world.

It is in this general perspective that we propose to examine the nature of transformation the Indian agrarian economy is undergoing as impact of recent policy changes, along with its short term and long term impact. The Doha development declaration, that was meant to emphasize the implementation aspect, was intended to create environment such that developed countries adhere

to their commitment to provide greater market access and special and differential treatment to the least developed nations and lower the volume of domestic supports in various forms (the amber box, blue box and ante cyclical supports). While stricter implementation of reduction of domestic support clause by the developed countries could have improved the relative competitive position of the developing nations who have shown their willingness to implement market access clause as suggested by the Doha meeting, the developed nations are taking very rigid position. This situation has created uncertainties regarding success of the Doha declaration and worsens the competitive position of the developing countries in practice.

The post Doha agricultural situation in India can be discussed as follows: While reluctance of the developed countries to reduce domestic support to the desired extent makes it difficult for the developing countries to protect the agrarian economy based on production of traditional crops like wheat and rice from cheaper imports, they find it difficult to expand their exports in the developed countries. At the same time reduction of subsidies and direct government expenditure and removal of restriction on entry of private enterprises and TNCs in business in agricultural inputs have the effect of increasing cost of production through increase in price of inputs.

Further, the TRIPS which have been extended to cover genetically engineered biological materials, microorganism and microbiological process, envisaged major changes in domestic patent laws. This change has ensured penetration of TNCs incurring huge investment for the development of diverse varieties of seeds, of genetically modified and transgenic crops and bio-fertilizer, into the seed market of the developing countries and their control over these markets. The process has led to increased dependence of the farmers on purchase of high priced seeds. The deregulation of fertiliser industry and replacement of chemical by biological fertiliser has also contributed to the increased dependence on TNCs. All these have contributed to huge increase in cost of material inputs. The fall in public expenditure, particularly in irrigation, though is accompanied with rise in private investment, has led to reduction in the rate of gross capital formation in agriculture, resulting in negative effects on agricultural growth. Moreover, the increased dependence on private irrigation system has led to not only increased price of water for irrigation but also excessive depletion of ground water. The compound effect has been the reduced return per unit of investment from production of traditional grains which are water intensive in nature. A chemical-based technology, which leads to degradation of the fertility of soil through over use of chemical fertilizer, has also contributed to the falling yield rates through

out the country. All these are said to have made traditional crop based agriculture nonviable, particularly in the new globally integrated market situation, characterized by greater uncertainties and volatilities. Since evidently developed countries continue to show their reluctance to reduce domestic support and since domestic price of agricultural commodities in India has to remain at par with international price, it must be kept at low levels and becomes subject to fluctuations. The high cost of inputs and irrigation water, low yield rates and low price make it imperative for the farmers to depend on credit, and in the face of non-availability of adequate credit facilities from institutional sources, they are compelled to depend on informal sources of credit at high cost and extremely unfavourable terms and conditions. Strong existence and active role of interlinked credit, inputs and product markets are reported in states like Punjab, Maharashtra, Andhra Pradesh, Orissa, Bihar and West Bengal. Both domestic and transnational enterprises and their local agents dealing in patented hybrid seeds and fertilizers are often seen to play dominant role in the structure of the interlinked products, inputs and credit markets.

As a solution to the problems affecting our agrarian economy based on traditional food grains and as a way out from nonviable non competitive state of our agriculture, World Bank appointed team of experts have suggested a package of three major strategies, namely, i) diversifying our agriculture away from production of traditional food grains and traditional commercial crops ii) adopting new technology based on use of bio fertiliser iii) promoting Contract Farming as a solution to the problem of marketing and credit. Keeping these suggestions in view, much emphasis is being placed on diversification of our agricultural sector towards production of fruits and vegetables, meat, fish and dairy products in place of traditional items of food grains. The argument in favour of these suggestions that are put forward are that a) these items have high demand in the international market; b) in domestic market there has been perceptible change in the composition of demand for food with increasing share of these non food grain items in place of food grains; c) there has been gradual shift in favour of production of fruits vegetables and other items of food in place of traditional grain; d) production of these new items would lead to increased employment of labour and reduced use of water; e) in a globalised market situation such change would lead to greater integration of our agriculture with world market and transform our agricultural sector in a positive way; f) this would lead to growth of agro processing industries and reduce rural unemployment, increase income of the rural households and solve, to a large extent, the problems of marketing and credit for the farmers.

### 3. Review of Literature:

There has been large number of studies on the probable impact of provisions under WTO and IMF-World Bank sponsored economic reforms. While many of the early studies had concentrated on analysing different provisions and their possible impact (Usha Menon 1992, Biswajit Dhar 2000, B K Keayla 2000, Bhagirath Lal Das 1999) on Indian agriculture, a host of studies have come up to discuss inappropriateness of the measures taken up by the IMF, the World Bank and the WTO under the name of globalisation, from the perspective of development of the developing countries (Stiglitz 2001). Many of the studies have made attempts to quantify the impact of multilateral trade reforms of agricultural sectors of the developing countries (Mc Calla and Nash ed. 2007). WTO has made its own study on the matter, which has been reviewed and discussed (H B Huff, et al. 2007). All these studies provide useful insight into many of the issues we take up for analysis. Further there has been a host of studies on the impact of WTO measures on South Asia (S Kalengama 2001) and reports on South Asia and Cooperation 2004 (RIS 2004) which discuss the need and prospects of cooperation among South Asian nations in the context of developments with regard to agricultural trade reform under WTO. We have come across many regional studies on the impact of WTO measures on Indian agriculture (Economic and Political Weekly different issues). However, no comprehensive and systematic study to examine the nature of changes Indian agriculture is under going under the impact of new policy regime has been made so far. It is in this context that we find it necessary to take up such an attempt, taking into account all-important issues relevant to the problem.

There are many very important studies on some of the issues mentioned: There has been a host of regional studies on the issues relating to Indian agriculture as mentioned above, pertaining to states like Maharashtra, Punjab, Bihar, Andhra Pradesh, Orrisa and so on. These studies shed light on the magnitude and importance of the problems we take up for investigation, (EPW December 24, 2004). For example there have been a number of studies on capital formation and growth in Indian agriculture. It is observed that share of capital formation at the private and farm level has grown over time in the face of declining trend in public investment. It has also been observed that pattern of private sector investment has influenced composition of agricultural production by inducing a strong trend towards diversification away from food grain crops and a significant jump towards fruits, vegetables, floriculture, kitchen gardens' activities and to some extent to oilseeds (Ashok Gulati, Seema Batila, 2001). However, there is indication of falling

private investment in the field of cultivation of cereals as a lagged reaction to falling public investment in irrigation projects during 1980s and early 1990s.

It is claimed that there has been fall in demand for food grains and significant shift in the pattern of consumption away from food grains which induces private investors to shift their investment initiative towards non food grains (Gulati and Batila 2001, C.H.H.Rao 2000). However a careful examination of data show that the decline in food consumption has not been universal irrespective of level of income. Studies of 200 landless rural households in Tamil Nadu indicate abject poverty and extreme dependence on cereals as the main item of consumption (A.K. Rajuladevi 2001, NSSO 59th round). Study on NSSO 59th round data also observes changes in consumption pattern except for the lowest stratum. A more intensive investigation is required to bring out the fact about demands for food grains among small and marginal farmers. In so far as weightage of landless labourers, marginal and small farmers in total rural population is very high, the pattern of consumption of these groups of farmers would definitely influence the pattern of overall demand.

It has been indicated that Indian agriculture suffers from some serious institutional constraints (Vaidyanathan-2000, C.H.H.Rao, A. Gulati, 1994). Rao and Gulati have indicated some imperfections in the functioning of formal credit market which give rise to prominence of informal credit charging high rate of interest leading to rent seeking by the middleman. But no serious in depth study has been undertaken so far to examine the functioning of informal credit market in detail and its role in retarding the process of capital formation and growth in agriculture. Khasnabish (1994) has observed operation of interlinked credit product and inputs market in Nadia district of West Bengal and Kalpana Wilson (2002) has observed how small cultivators in Bihar resort to marketing the “distress surplus” and become involved in dependent relationship with their larger counterparts who are more powerful, for high-interest production and consumption loans. She also observed that this small number of larger and powerful farmers play dominant role as supplier of inputs including fertilizer, seeds and diesel. The present researcher herself has observed such relation to operate and influence negatively the process of growth in agriculture (A. Mukherjee – 1980-90, 1998-2000). More recent studies point to continuous marginalisation in the structure of land holding and increasing magnitude of indebtedness of the farmers to the informal sources of credit. There are studies on farmers’ indebtedness and distress and efficacy of contract farming in states like Punjab, Maharashtra, and

Andhra Pradesh, Karnataka [EPW Dec 25, 2004, June 25- July 1, 2005], while these writings analyse the factors leading to farmers' distress, they have also analysed the efficacy of the contract system as a solution to the problem of marketing of products and supply of credit. Some of these studies have pointed out market imperfection and indebtedness of the farmers as the cause of their distress. A host of studies on farmers' distress and suicides point to the alleged negative roles played by the new policy regime as the cause of decline of the agricultural sector. It has been pointed out that in the case of Maharashtra cotton farming, the dumping of global market by the U S, low import tariff, failure of monopoly cotton procurement scheme and declining public investment in irrigation are the main factors behind the disaster. [April 22, 2006]. For Andhra Pradesh, it has been pointed out that indebtedness, high costs of production and negative returns have been responsible for the disaster. A study on Kerala has demonstrated that the regions dominated by export-oriented crops are worst hit in recent years and link with global market has increased vulnerability of the farmers. Small farmers are reported to have worst affected as they are vulnerable to crop losses and price declines. All these writings indicate existence of interlinked credit, inputs and products markets and extreme dependence of the farmers on such interlinked markets.

All these studies concentrate on one or two aspect of the problem separately and confine to one or two villages in the states mentioned above. A comprehensive rigorous investigation into the behaviour of a heterogeneous group of farmers vis-à-vis the new trends affecting the economy is what is needed, to be able to suggest ways to raise agriculture to a competitive level. we propose to take up such an analysis in this project.

#### 4. Hypotheses:

It is against this background that we propose to examine the appropriateness of the suggestions made by World Bank experts in the context of post Doha Indian agriculture. We propose to take up for investigation the validity of all the arguments put forward in favour of this suggestion. In particular we take up the following hypotheses for testing:

a) Those areas which are endowed with assured water supply at cheap rates (mostly canal and deep tube-well facilities supplied by the govt.) continue to concentrate on production of cereals and traditional crops showing lower extent of crop diversification and greater extent of specialization.

- b) In those areas where farmers have to depend on private sources of water at high cost due to non-availability of publicly supplied irrigation system, they diversify away from water intensive cereals and other traditional crops towards various other high value crops showing greater degree of diversification.
- c) Transformation from wheat and rice to high value crops has occurred mainly to increase family income for meeting rising consumption needs of the family, by the very marginal and marginal farmers, where availability of water is uncertain and costly.
- d) Yield rates of traditional items like paddy and wheat can be maintained if favourable conditions in terms of irrigation and infrastructure are provided.
- e) Transformation in cropping pattern has occurred more in those cases where farm households are in a position to provide more family labour for cultivation.
- f) While the marginal and very marginal farmers consume vegetables and protein their consumption of cereals is still substantial.
- g) In spite of declining fertility of soil, yield rates and return on investment, production of rice and wheat maintains steady growth rates. In spite of cost of production being too high it is possible for Indian farmers to maintain a competitive position in the world market with regard to rice and wheat under the condition that developed countries comply with the principles laid down in the Doha declaration.
- h) In a small and marginal farms dominated agrarian economy, agro-processing based on contract farming system of production and procurement of agricultural raw materials, may not create sufficient incentive for the farmers to adopt crop diversification by eliminating risk and uncertainty.
- i) Under the present situation characterized by low domestic demand for processed food, it would be very difficult for agro-processing industries to grow and sustain their existence.
- j) Contract farming system fails to solve the problem of credit and marketing for the small farmers.
- k) Increased degree of crop diversification would have a long term negative impact on food security.

For the present report we shall concentrate on the first six hypotheses only, leaving the other five hypotheses for the remaining part of our research work.

## 5. Methodology:

In order to find the factors that may be important in explaining the difference in the crop diversification among different provinces we have first of all conducted regression analysis of panel data on crop diversification index of seven provinces of India, namely, West Bengal, Orissa, Andhra Pradesh, Gujarat, Tamil Nadu, Haryana and Punjab against different explanatory variables using CMIE (Centre for Monitoring Indian Economy) data. We have used Simpson's Diversification index (SDI) to measure degree of crop diversification:

$SDI = 1 - \frac{\sum(p_i / \sum p_i)^2}{n}$ , where  $p_i$  is the area under  $i^{th}$  crop and  $i = 1,2,3,\dots,n$ . is the number of crops.

Next, we take up the analysis on the basis of field data on farm behavior at the micro level. As we have already noted, in this first draft of the report we have taken up for testing only the first six hypotheses, leaving the other four hypotheses for testing for the second phase of our research work. Again, testing of hypotheses under a, b, c, d, e, and f which depend on performance analysis of paddy and wheat can be done by taking up two different provinces producing paddy and wheat as the principal crops. We take up West Bengal as a paddy producing state and Punjab/Haryana as a wheat producing state. However, in the present part of the report we take up only the question of performance of cereal production dominated by paddy vis-à-vis production of high value crops, in West Bengal, leaving the performance of wheat in Punjab/Haryana for the second phase of the research. We have selected three districts of West Bengal, namely, Hooghly, Burdwan and North 24 Parganas.

Burdwan, one of the most prosperous agricultural districts, well endowed with public irrigation facilities, with almost 90 per cent of its irrigated area being under government canal and with high soil fertility, concentrates mainly on the production of paddy. Hooghly, which is also a very prosperous district is also endowed with government canal irrigation facilities, though in a lesser extent (less than 30 per cent of irrigated area under canal) and deep tube well irrigation, depends also on shallow tube-well and various other combination of public and private sources of irrigation. The district is famous for potato production along with paddy. The district of North 24 Parganas is not only not endowed with any public irrigation and infrastructural facilities in most part, but also suffer from high salinity of the soil, particularly in the southern part of the district. The district is famous as traditional producer and supplier of fruits and vegetables to urban areas surrounding the provincial capital Kolkata, which also serves as an outlet to the overseas market.

In each of these districts we have selected two separate Blocks, one relatively more endowed with public irrigation and infrastructural facilities and the other, either less endowed with these facilities or having none of these facilities. Before going to undertake analysis of field data we start the analysis on the basis of secondary Block level information from the office of the Block Development Officer, Agriculture Development Officer and Block Land and Land Revenue Officer. We select one Gram Panchayat area (local self-government unit) in each block on the basis of maximum agricultural activities.

SELECTED FIELD OF PRIMARY INFORMATION			
Selected Districts	Selected Blocks	Selected Gram Panchayats	Selected Villages
Burdwan	Memari	Gope Gantar – 1	Sankarpur, Gantar, Denha
	Galsi – 1	Bhuri	Jujuti, Ketna
Hooghly	Pandua	Berela-Konchmali	Boragori
	Balagarh	Somra – 1	Natarah, Paigachhi, Abdulpur
North 24 Parganas	Bongaon	Chouberia – 1	Gopinathpur
	Hasnabad	Amlani	Haripur

We take all farming households in each Gram Panchayat as the population from which we construct a sample of 60 households following Stratified Random Sampling procedure, after stratifying the population in different size of operational land holdings. We thus get a big sample of  $60 \times 6 = 360$  households divided into six sub-samples, each from one gram panchayat in a block, representing varying conditions with regard to availability of irrigation and infrastructure on one hand and different size of operational holdings on the other. Data on following broad aspects of farming are collected on the basis of structured questionnaires: a) pattern of land ownership, number of family members, size of operational holdings, main and subsidiary occupation of the household; b) allocation of land under different crops; c) production, consumption, sale and other uses of each of the crops and time profile of marketing of different crops along with prices; d) allocation of family and hired labour in different agricultural operations along with wage rates of hired labour e) cost of production of each crop along with use of family labour, hired labour and different material inputs with wage rate and prices of each input; f) interlinkage of credit, input and produce markets; g) ownership and use of agricultural

implements; h) type and cost of irrigation; i) current and outstanding debt of the households; j) detailed consumption pattern of the households.

While we collect detailed information on all these aspects of farming for 360 households belonging to different size classes of operational holdings, in the first step, for this report, we take up data on 180 households (30 households from each of the sub-samples) for processing and detailed primary investigation. We, however, expect to present results on all the 360 households in the August 9<sup>th</sup> Conference.

## 6. Observations based on secondary data:

### A) Inter-province variations in crop diversification:

Time-series data on crop diversification index of seven provinces of India namely, West Bengal, Orissa, Andhra Pradesh, Gujarat, Tamil Nadu, Punjab and Haryana and of India as a whole for the period 1986 - 2002 enable us to draw some important observations:

**Table 6.1**  
**Simpson's Index of Crop-diversification\* for India and different Provinces:**

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
West Bengal	0.43	0.40	0.39	0.40	0.41	0.41	0.40	0.40	0.38	0.39	0.38	0.44	0.46	0.47	0.46	0.49	0.45
Gujarat	0.64	0.64	0.63	0.61	0.63	0.61	0.64	0.65	0.65	0.66	0.67	0.68	0.68	0.70	0.70	0.71	--
Tamil Nadu	0.52	0.52	0.55	0.57	0.55	0.57	0.63	0.56	0.58	0.60	0.61	0.60	0.59	0.59	0.58	0.57	0.61
Punjab	--	--	--	--	--	--	--	0.29	0.25	0.25	0.31	0.32	0.30	0.25	--	--	--
Orissa	0.41	0.41	0.43	--	0.43	--	0.40	0.39	0.39	0.40	0.41	0.42	0.42	0.42	0.39	0.37	--
Haryana	--	--	--	--	--	--	0.50	0.45	0.45	0.44	0.46	0.47	0.44	--	0.40	--	--
Andhra Pradesh	0.53	0.51	0.54	0.55	0.56	0.58	0.59	0.61	0.60	0.61	0.62	0.61	0.62	0.62	0.61	0.59	--
All India	0.42	0.42	0.44	0.44	0.45	0.47	0.49	0.48	0.49	0.49	0.51	0.51	0.50	0.50	0.51	0.51	0.51

Source: Calculated for food grains, fruit and nuts, fibres, oil seeds, plantations, spices, vegetables etc. from CMIE (2006). \* See methodology.

First, there has been a smooth rise over time of the index for India as a whole.

Secondly, we can divide the provinces/states in three groups. The first group consists of provinces which have shown continuous rise in the index over the period. The second group consists of those which shows continuous fall in the index. And the third group shows more or less stagnant situation in this regard. The first group includes Gujarat, Andhra Pradesh and Tamil

Nadu, all three show higher level of diversification ,compared to other provinces. On the other hand, states like Punjab, Haryana and Orissa having much lower diversification index show declining trends over time. West Bengal is the single state which shows moderate fluctuations in the index and a level which fall between the first two groups.

It can be seen that traditionally prosperous wheat producing region, Punjab and Haryana have low and falling crop diversification index along with Orissa, a traditionally rice producing zone. On the other hand Gujarat, Andhra Pradesh and Tamil Nadu show high and rising levels of diversification, with Gujarat showing as high a figure as 0.71 in 2002 against the figure of 0.25 of Punjab in 1999.

We run a regression analysis with panel data on crop diversification index as given in table 6.1 against panel data on proportion of irrigated area, fertilizer per hectare and rain fall as independent variables. Though average farm size and several other factors may be important in explaining inter-province and temporal variation in crop diversification index, lack of availability of consistent time series data constrains us to confine the analysis with two or three variables which are available.

### Random-effects of GLS regression

#### Result with

**Dependent variable crop diversification index - cdi**

**Regressors: rainfall – rain**

**proportion of irrigated land – irrprop**

**fertilizer per unit of land – fert**

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Group variable (i): state      Number of obs   =    88
                              Number of groups =     7

R-sq:  within = 0.3126        Obs per group:  min =     7
        between = 0.2261      avg =    12.6
        overall = 0.0607     max =    17

Random effects u_i ~ Gaussian  Wald chi2(3)    =   33.36
corr(u_i, X) = 0 (assumed)    Prob > chi2    =   0.0000

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      cdi |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----+-----
      rain | -.0000176   .0000146    -1.21  0.227   - .0000462   .000011
  irrprop |  .000717    .000795     0.90  0.367   - .0008411   .0022751
      fert | .0000656    .0000157     4.17  0.000   .0000347   .0000964
      _cons | .3938377    .0642694     6.13  0.000   .2678719   .5198034
-----+-----
  sigma_u | .14183501
  sigma_e | .02447023
      rho | .97109514   (fraction of variance due to u_i)

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The results of our panel data regression analysis show that variation in the use of fertilizer per hectare plays strong positive impact on variation in crop diversification among states and over time. The only factor, the use of fertilizer per hectare of cultivated land appears to explain this variation, which seems to be somewhat unrealistic. Failure to incorporate crucial variables like farm size makes it imperative to conduct detailed micro level analysis of the factors causing the variation in crop diversification. We have undertaken such a micro-level analysis at the level of farming households, to examine their behaviour regarding crop diversification along with various other aspects of farming. Before going to analyse the results of our investigation in detail we may start with our detail observations based on secondary district level data regarding different aspects of production and crop diversification.

## B) Variations among the selected districts:

As we have mentioned in the methodology, for detailed analysis we have taken up three districts of West Bengal and two blocks in each of the districts. The six blocks are selected to represent variations with regard to infrastructure and irrigation. The analysis of district level secondary data would serve as necessary background to the analysis of micro data at the farm-level.

IRRIGATION IN DIFFERENT DISTRICTS								
PROPORTION OF IRRIGATED AREA UNDER DIFFERENT SOURCES (%)								IRRIGATED AREA AS % OF GROSS CROPPED AREA
District	Year	Govt. Canal	Tank	Deep Tube- well	Shallow Tube- Well	River Lift Irrigation	Others	%
Burdwan	2001-2	89.39	NIL	6.55	NIL	4.04	NIL	35.20
	2005-6	89.21	NIL	7.05	NIL	3.73	NIL	39.19
Hooghly	2001-2	28.93	11.22	4.44	43.04	12.36	NIL	60.10
	2005-6	29.79	11.18	4.60	41.65	12.80	NIL	62.58
North 24 Parganas	2001-2	NIL	10.58	5.00	69.34	3.84	10.94	28.00
	2005-6	4.82	9.72	4.86	70.56	7.67	2.37	32.00

Source: Calculated from District Statistical Handbooks of Burdwan, Hooghly and North 24 Parganas; Bureau of Applied Economics and Statistics, Govt. of West Bengal, India.

As table 6.2 shows the district of Burdwan depends mainly on surface irrigation provided by the government. By contrast, the district of North 24 Parganas mainly depends on underground water from private sources. The district of Hooghly, on the other hand, having a low proportion of irrigated area under canal, depends on varied sources of irrigation combining both underground and surface water. It should be noted that throughout our analysis of crop diversification we have excluded flowers from our analysis so that 'gross cropped area' always excludes area under flower.

NET SOWN AREA, GROSS CROPPED AREA (in '000 Hectares), INTENSITY OF CROPPING AND CROP DIVERSIFICATION INDEX FOR THE DISTRICTS					
District	Year	Net Sown Area (in '000 Hectares)	Gross Cropped Area (in '000 Hectares)	Intensity of Cropping (%)	Simpson's Crop Diversification Index
Burdwan	2001-2	472.96	842.00	178.02	0.3678
	2005-6	454.94	811.46	178.37	0.3681
Hooghly	2001-2	225.91	520.60	230.45	0.5960
	2005-6	218.82	533.50	243.81	0.6280
North 24 Parganas	2001-2	277.23	564.13	203.49	0.6070
	2005-6	260.54	482.38	185.15	0.6220

Source: Calculated from District Statistical Handbooks of Burdwan, Hooghly and North 24 Parganas; Bureau of Applied Economics and Statistics, Govt. of West Bengal, India.

Table 6.3 shows that the district of Burdwan does not reveal any perceptible increase either in intensity of cropping or in diversification of cropping pattern. In fact, comparing with table 1 we can see that this traditionally prosperous paddy producing district of West Bengal with its less than 40 per cent gross cropped area under irrigation has failed to increase private investment in irrigation so that it has just maintained the cropping intensity and crop diversification.

By contrast, the district of Hooghly has been able to increase its proportion of gross cropped area under irrigation which was already high at more than 60 per cent in 2001-02 by combining shallow tube-well with publicly provided irrigation facilities. As a consequence the district has been able to increase its gross cropped area (in the face of fall in net sown area) and a very high intensity of cropping which has shown an increase of 5.8 per cent during the reference period. With this, the district also shows increase in crop diversification.

The district of North 24 Parganas, with its around 30 per cent gross cropped area under irrigation shows considerable fall in gross cropped area and intensity of cropping though it has achieved increase in the extent of crop diversification.

<b>TABLE: 6.4</b>							
<b>CROPPING PATTERN IN DIFFERENT DISTRICTS</b>							
<b>PROPORTION OF GROSS CROPPED AREA UNDER</b>							
District	Year	Cereal	Potato	Vegetables	Fruits	Oil Seeds	Fibre Crops
Burdwan	2001-2	78.99	4.82	5.45	0.7	6.88	2.23
	2005-6	79.05	5.35	7.02	0.9	5.18	1.91
Hooghly	2001-2	59.97	15.27	9.31	2.25	6.45	6.28
	2005-6	58.22	17.28	9.85	2.27	5.85	5.81
North 24 Parganas	2001-2	61.71	1.26	11.43	2.55	9.20	11.13
	2005-6	58.98	1.18	13.35	3.73	9.24	10.39

Source: Calculated from District Statistical Handbooks of Burdwan, Hooghly and North 24 Parganas; Bureau of Applied Economics and Statistics, Govt. of West Bengal, India.

Table 6.4 shows that the district of Burdwan remains a cereal producing area with almost equal proportions of land being under other crops except fibre crops and fruits. However, there has been increase in the proportion of land under cereal, potato and vegetables in the reference period. The district does not produce jute in any perceptible extent; however, it allocates some area under sugarcane.

The district of Hooghly allocates much less land compared to Burdwan under cereal and more land for potato, vegetables, fruits and fibre. Evidently the district is more diversified compared to Burdwan.

The district of North 24 Parganas allocates less land for potato but more land for vegetables, fruits, oil seeds and fibre compared to other two districts. It is also very much diversified. Lack of government irrigation facilities does not appear to stand in the way of crop diversification in terms of allocation of land. However, impact of irrigation becomes evident if we consider yield rates.

Table 6.4 shows that while the water intensive crops like cereal and potato suffer from lack of irrigation in North 24 Parganas, there have been wide spread fall in yield rates for all crops other than cereals in all districts except for fruits and potato in North 24 Parganas during the reference period.

<b>TABLE: 6.5</b>					
<b>YIELD RATES OF DIFFERENT CROPS IN DIFFERENT DISTRICTS (ton per hectare)</b>					
District	Year	Cereal	Potato	Vegetables	Fruits
Burdwan	2001-2	2.920	29.966	11.000	11.331
	2005-6	3.077	21.249	11.230	9.851
Hooghly	2001-2	2.722	29.633	12.260	13.110
	2005-6	2.738	25.500	11.140	11.940
North 24 Parganas	2001-2	2.556	19.550	12.568	13.790
	2005-6	2.578	22.150	11.892	16.520

Source: Calculated from District Statistical Handbooks of Burdwan, Hooghly and North 24 Parganas; Bureau of Applied Economics and Statistics, Govt. of West Bengal, India.

The analysis shows that: a) districts with larger extent of production of fruits and vegetables and larger extent of crop diversification are accompanied with underground water use to a relatively greater extent compared to less diversified areas; b) greater availability of canal irrigation is accompanied with not only higher level of production of cereals but also higher level of productivity; c) in recent years extent of crop diversification has increased both in Hooghly and North 24 Pargana in spite of the fact that while the former is more endowed with irrigation the latter suffers from lack of irrigation facilities.

However, we may get some indication regarding impact of diversification on food security from these district level gross information.

<b>TABLE: 6.6</b>					
<b>EXTENT OF IRRIGATION, CROP DIVERSIFICATION AND PER CAPITA PRODUCTION OF FOOD GRAINS</b>					
District	Year	Crop Diversification Index	Per Capita Production of Food Grains (Kg. per year)	Proportion of Irrigated Area under Canal	Extent of Surface Water Irrigation
Burdwan	2001-2	0.3678	282	89.3	93.10
	2005-6	0.3681	268	89.2	93.10
Hooghly	2001-2	0.6070	169	29.1	52.10
	2005-6	0.6220	156	29.1	53.10
North 24 Parganas	2001-2	0.5960	100	NIL	15.10
	2005-6	0.6280	75	4.82	18.71

Source: Calculated from District Statistical Handbooks of Burdwan, Hooghly and North 24 Parganas; Bureau of Applied Economics and Statistics, Govt. of West Bengal, India.

Table 6.6 shows that districts with higher levels of crop diversification are with extremely low levels of annual per capita production of food grains. Moreover, in reality crop diversification is not accompanied with relatively less use of underground water; this goes against the expectation that shift from cereal production to fruits and vegetables would lead less extraction of underground water. From this very aggregative district level data we get the indications that: a) farmers shift towards more production of vegetables and fruits in order to protect their income in the face of falling land productivity and low and falling per capita production of food grains; b) availability of low cost surface irrigation water does not induce farmers to diversify cropping pattern; less availability of such water leads to more use of underground water from private irrigation sources and more crop diversification. These indications will be put under rigorous examination on the basis of detailed data at the level of farming households collected through field survey.

## 7. Observations based on primary survey:

As we have already noted in the methodology, we have selected two blocks in each of the three selected districts of West Bengal, representing different characteristics with regard to irrigation and infrastructure . We have selected one gram panchayat from each block and constructed sample of 60 farming households on the basis of stratified random sampling method from each gram panchayat within a block, so that we construct a sample of 360 households, consisting of six sub-samples each representing a block. We collected information on different relevant aspects of farming along with consumption pattern and conditions of living for all the 360 farming households.

However, because of the time and budget constraint in this preliminary phase of the research work we have been able to process data on only a few aspects of production and consumption which include size-distribution of holding, cropping pattern, yield rates of different crops, use of family labour and consumption of cereals and all these only for 180 households taking 30 households from each of the sub-sample. We just planned to have a view of the relationship between crop diversification and few other variables, under varying conditions with regard to irrigation and infrastructure. We leave many important aspects like cost of production, marketing, indebtedness and detailed consumption behaviour, for analysis in the next phase.

## A) Ranking of the six selected blocks:

Selected villages falling under each selected block of the districts mentioned, show varied characteristics with regard to infrastructure and irrigation, the two major variables, that may affect crop diversification. Before going to analyse the results of our farm level investigation we find it essential to identify the blocks with codes in terms of level of infrastructure and irrigation. The survey villages in each block are placed at different distances from cold storage, market, high ways and railway station and are connected through different types of roads with these centres. Accordingly, we have used the following coding system:

<b>Code for Pattern of Irrigation</b>				
Pattern				Code
Public Irrigation System with Canal and Deep Tube-well along with all Other Types				1
No Canal, No Deep Tube-well, But availability of enough surface water due to proximity to river :				2
No Canal, No Deep Tube-well, only Shallow Tube-well, Tank etc. :				3
No Canal, No Deep Tube-well and Use of Underground Water is Not Always Possible in Sufficient Quantity due to High Salinity				$2 \times 3 = 6$ <sup>1</sup>
<b>Codification of Survey Villages for Irrigation Type</b>				
District	Block	Gram Panchayat	Village	Code for Type of Irrigation
Burdwan	Memari	Gope-gantar 1	Sankarpur	Canal, Deep Tube-well and Others (Shallow Tube-well, Tank and River Lift) : Code 1
„	Golsi	Bhuri	Jujuti, Ketna	No Canal, No Deep Tube-well, But availability of enough surface water due to proximity to river : Code 2
Hooghly	Pandua	Berela-Konchmali	Boragori	Canal, Deep Tube-well and Others (Shallow Tube-well, Tank and River Lift) : Code 1
„	Balagarh	Somra 1	Paigachhi, Abdulpur, Natagarh	No Canal, No Deep Tube-well, But availability of enough surface water due to proximity to river : Code 2
North 24 Parganas	Bongaon	Chouberia	Gopinathpur	No Canal, No Deep Tube-well, only Shallow Tube-well, Tank etc. : Code 3
„	Hasnabad	Amlani	Haripur	No Canal, No Deep Tube-well and High Salinity : Code 6

<sup>1</sup> In Hasnabad block of North 24 Parganas district dry season crops like Boro paddy can hardly be produced without incurring excessive expenditure on irrigation and level of productivity remains very low for other crops due to high salinity. This negative impact of absence of public irrigation system is highly intensified and hence we have multiplied the code 2 by 3 in order to catch this irrigational disadvantage.

Code for Distance and Road Type	
Distance Code	Code for type of Road
0 - < 5 KM : 1	
5 - < 10 KM : 2	Metal Road : 1
10 - < 15 KM : 3	Mud Road : 2
15 & Above : 4	No Road : 3

Codification of Survey Villages for Infrastructure								
Village	Distance from :							
	Cold Storage	Road Type connecting Cold Storage	Market	Road Type connecting Market	High Way	Road Type connecting High Way	Rail Station	Road Type connecting Rail Station
Sankarpur	4 KM	Metal	1 KM	Mud	10 KM	Metal	6 KM	Metal
Code <sup>2</sup>	1	1	1	2	3	1	2	1
Jujuti, Ketna	10 KM	Mud	8 KM	Mud	8 KM	Mud	14 KM	Mud
Code	3	2	2	2	2	2	3	2
Boragori	1 KM	Metal	1.5 KM	Metal	0.5KM	Mud	1.5 KM	Metal
Code	1	1	1	1	1	2	1	1
Paigachhi, Abdulpur, Natagarh	4.5 KM	Mud	3 KM	Mud	1 KM	Mud	3 KM	Mud
Code	1	2	1	2	1	2	1	2
Gopinathpur	7 KM	Mud	3 KM	Mud	7 KM	Mud	25 KM	Mud
Code	2	2	1	2	2	2	4	2
Haripur	25 KM	Mud	3 KM	Metal	0.5KM	Metal	1 KM	Mud
Code	4	2	1	1	1	1	1	2

Ranking of Blocks on the Basis of Infrastructure and Irrigation Codes of the Villages							
District	Block	Gram Panchayat	Village	Infrastructure Code	Irrigation Code	Total Code	Rank
Burdwan	Memari	Gope-gantar 1	Sankarpur	12	1	13	2
	Golsi	Bhuri	Jujuti, Ketna	18	2	20	6
Hooghly	Pandua	Berela-Konchmali	Boragori	9	1	10	1
	Balagarh	Somra 1	Paigachhi, Abdulpur, Natagarh	12	2	14	3
North 24 Parganas	Bongaon	Chouberia	Gopinathpur	17	3	20	4
	Hasnabad	Amlani	Haripur	13	6	19	5

<sup>2</sup> Refer the last table for codification.

## B) Irrigation, infrastructure, cropping pattern and yield:

The ranking of blocks shows that Memari and Pandua fall in the same irrigation type with availability of both canal and deep tube-well along with other sources. These two blocks exhibit similar characteristics with regard to crop diversification with higher proportion of land being allocated to Aus and Aman paddy compared to others. In fact, with its best infrastructural and irrigational advantages Pandua allocates much higher proportion of its land under cereal production showing high degree of specialization. Memari, though allocates less land to production of cereals, allocates more land to potato, another traditional water intensive crop. In fact, the two kinds of traditional crops, namely, cereals as a group and potato together occupy more than 80 per cent of gross cropped area of these canal irrigated blocks.

**TABLE 7.1**

<b>Ranking of Blocks and Simpson's Crop Diversification Index (SDI)</b>				
Infrastructure Rank	Block	Irrigation Code	SDI	SDI Rank
1	Pandua	1	0.417	6
2	Memari	1	0.531	5
3	Balagarh	2	0.763	1
4	Bongaon	3	0.737	2
5	Hasnabad	6	0.678	3
6	Golsi	2	0.546	4

Source: Field survey

Balagarh and Golsi falling under same irrigation category 2, because of access to surface water from river, also allocate high proportion of their land to cereals. But, while Balagarh has the highest figure of crop diversification index among the blocks, Golsi's crop diversification index figure is the lowest, because Golsi allocates more than 80 per cent of its land to cereals and potato, does not produce jute at all, allocates very small proportion of its land to fruits and vegetables. Balagarh on the other hand, allocates the residual land over and above the part allocated under cereals more or less evenly to potato, oil seed and jute and relatively higher proportion of its land to vegetables compared to Golsi. The better infrastructure in Balagarh enables it to diversify. Another reason may be that in Balagarh productivity of cereals is relatively less compared to the canal irrigated regions namely, Memari and Pandua and also to

Golsi. While the negative impact of most backward infrastructure of Golsi outweighs its advantage of availability of surface water and prevents it to diversify, the higher productivity of cereals positively induces it to specialize.

**TABLE 7.2**  
**DISTRITBUTION OF SAMPLE HOUSEHOLDS ACCORDING TO SIZE OF OPERATIONAL HOLDINGS**

FARM SIZE (IN HECTARE)	PROPORPOTION OF FARMING HOUSEHOLD					
	BURDWAN		HOOGHLY		NORTH 24 PARAGANAS	
	MEMARI (%)	GOLSI (%)	PANDUA (%)	BALAGARH (%)	BONGAON (%)	HASNABAD (%)
0<0.5	26.70	30.00	27.27	36.66	31.03	45.45
0.5<1	33.30	20.00	45.45	43.33	37.93	24.24
1<2	20.00	23.30	24.24	10.00	27.58	18.18
2<4	20.00	26.70	3.03	10.00	3.45	12.12
AVERAGE FARM SIZE	1.13	1.27	0.82	0.79	0.85	0.83

Source: Field survey

**TABLE 7.3**  
**PROPORTION OF AREA UNDER DIFFERENT CROPS: CEREALS**

FARM SIZE (IN HECTARE)	PROPORPOTION OF AREA UNDER CEREALS					
	BURDWAN		HOOGHLY		NORTH 24 PARAGANAS	
	MEMARI (%)	GOLSI (%)	PANDUA (%)	BALAGARH (%)	BONGAON (%)	HASNABAD (%)
0<0.5	50.39	63.15	64.75	56.25	38.94	41.07
0.5<1	44.86	60.21	68.56	48.51	48.14	48.99
1<2	63.43	59.42	62.14	73.63	47.59	61.28
2<4	48.88	52.65	74.93	73.64	58.06	62.71
AVERAGE	50.85	58.89	66.16	56.37	45.47	49.29

Source: Field survey

**TABLE 7.4**  
**PROPORTION OF AREA UNDER DIFFERENT CROPS: POTATO**

FARM SIZE (IN HECTARE)	PROPORPOTION OF AREA UNDER POTATO					
	BURDWAN		HOOGHLY		NORTH 24 PARAGANAS	
	MEMARI	GOLSI	PANDUA	BALAGARH	BONGAON	HASNABAD
0<0.5	39.19	17.18	19.03	10.23	4.04	2.17
0.5<1	24.63	27.67	21.29	11.71	10.32	1.44
1<2	28.35	24.60	25.08	8.56	9.90	1.72
2<4	33.49	28.08	17.29	3.56	6.45	0.75
AVERAGE	31.03	23.92	21.47	10.04	8.12	1.74

Source: Field survey

**TABLE 7.5**  
**PROPORTION OF AREA UNDER DIFFERENT CROPS: OILSEED**

FARM SIZE (IN HECTARE)	PROPORPOTION OF AREA UNDER OILSEED					
	BURDWAN		HOOGHLY		NORTH 24 PARAGANAS	
	MEMARI	GOLSI	PANDUA	BALAGARH	BONGAON	HASNABAD
0<0.5	7.47	12.28	14.84	9.85	9.79	5.12
0.5<1	29.23	7.11	8.93	8.82	14.74	27.18
1<2	6.73	14.38	10.85	5.14	11.81	16.72
2<4	15.22	12.29	4.32	2.77	19.36	7.20
AVERAGE	16.12	11.74	10.86	8.22	12.55	12.83

Source: Field survey

**TABLE 7.6**  
**PROPORTION OF AREA UNDER DIFFERENT CROPS: JUTE**

FARM SIZE (IN HECTARE)	PROPORPOTION OF AREA UNDER JUTE					
	BURDWAN		HOOGHLY		NORTH 24 PARAGANAS	
	MEMARI	GOLSI	PANDUA	BALAGARH	BONGAON	HASNABAD
0<0.5	0	0	0	12.87	8.07	10.48
0.5<1	0	0	0	14.64	2.60	11.35
1<2	0	0	0	8.56	8.33	9.83
2<4	0	0	0	8.71	16.14	12.01
AVERAGE	0	0	0	12.79	6.35	10.75

Source: Field survey

**TABLE 7.7**  
**PROPORTION OF AREA UNDER DIFFERENT CROPS: VEGETABLES**

FARM SIZE (IN HECTARE)	PROPORPOTION OF AREA UNDER VEGETABLES					
	BURDWAN		HOOGHLY		NORTH 24 PARAGANAS	
	MEMARI	GOLSI	PANDUA	BALAGARH	BONGAON	HASNABAD
0<0.5	2.95	0.07	0.99	2.42	20.36	11.121
0.5<1	1.28	0.05	1.21	1.97	12.96	20.70
1<2	1.48	0.06	1.60	0.68	24.58	4.10
2<4	0.45	0.07	2.80	0.37	0.00	10.26
AVERAGE	1.59	0.06	1.29	1.85	18.02	12.06

Source: Field survey

We observe a pattern of relationship between irrigation and infrastructure on the one hand and degree of diversification on the other. We see that availability of assured and cheap water leads to specialization in one or two crops with which farmers of the region are accustomed. On the other hand, when there is no such availability of cheap source of irrigation and farmers have to depend mainly on private sources at high cost, they diversify away from water intensive cereals or potato towards various other crops. In such a situation irrigation plays a crucial role. Thus in North 24 Parganas, Bongaon being infrastructurally more backward, is more diversified compared to Hasnabad because of the fact that Hasnabad in most part suffers from high salinity of the underground water and has to depend mainly on rain water. Hasnabad's marginal farmers cannot produce Boro paddy at all, which is a dry season crop and requires irrigation. It thus allocates double the proportion of land to rain-fed Aman paddy compared to Bongaon. These observations go in favour of acceptance of our first hypothesis.

If we examine the productivity of different crops, it can be seen that areas which are less diversified show higher productivity of cereals. Not only that the farmers allocate more land to cereals but also put in much more efforts to maintain productivity, compared to others who undertake diversification. However, with regard to productivity of vegetables the vegetable producing regions do not show greater efficiency compared to others. This may be due to the constraints imposed by lack of infrastructural and irrigational facilities. The areas concentrating on production of traditional crops are seen to exhibit greater productivity, compared to others.

**TABLE 7.8**  
**PRODUCTIVITY OF DIFFERENT CROPS: CEREALS**

FARM SIZE (HECTARE)	PRODUCTIVITY OF CEREALS					
	BURDWAN		HOOGHLY		NORTH 24 PARAGANAS	
	MEMARI	GOLSI	PANDUA	BALAGARH	BONGAON	HASNABAD
	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE
0<0.5	5027.77	4650.55	54465.845	3943.67	4186.667	4220.68
0.5<1	4732.83	5750.33	4372.86	3918.10	4627.048	3499.27
1<2	4345.45	5007.92	4668.453	3760.46	3443.593	3471.17
2<4	5441.06	5390.13	3833.654	4103.22	2762.829	3538.38
AVERAGE	4875.651	5151.11	4453.54	3930.224	3755.03	3826.81

Source: Field survey

**TABLE 7.9**  
**PRODUCTIVITY OF DIFFERENT CROPS: POTATO**

FARM SIZE (HECTARE)	PRODUCTIVITY OF POTATO					
	BURDWAN		HOOGHLY		NORTH 24 PARAGANAS	
	MEMARI	GOLSI	PANDUA	BALAGARH	BONGAON	HASNABAD
	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE
0<0.5	29702.38	28935.75	20107.13	24328.571	13714.28	15456.52
0.5<1	22824.63	22743.24	12537.46	23635.71	22121.84	9375
1<2	21292.37	31130.76	16071.42	24000	17712.32	5571.42
2<4	28172.01	32421.87	11250	18666.66	15000	13200
AVERAGE	25421.72	29139.05	15419.62	23429.28	18050.6	11911.4

Source: Field survey

**TABLE 7.10**  
**PRODUCTIVITY OF DIFFERENT CROPS: JUTE**

FARM SIZE (HECTARE)	PRODUCTIVITY OF JUTE					
	BURDWAN		HOOGHLY		NORTH 24 PARAGANAS	
	MEMARI	GOLSI	PANDUA	BALAGARH	BONGAON	HASNABAD
	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE
0<0.5	0	0	0	3056.81	2142.85	2314.93
0.5<1	0	0	0	2766.42	3610	2367.59
1<2	0	0	0	2640	2037.5	2415
2<4	0	0	0	2577.27	1800	2311.5
AVERAGE	0	0	0	2841.339	2658.47	2345.475

Source: Field survey

**TABLE 7.11  
PRODUCTIVITY OF DIFFERENT CROPS: VEGETABLES**

FARM SIZE (HECTARE)	PRODUCTIVITY OF VEGETABLES					
	BURDWAN		HOOGHLY		NORTH 24 PARAGANAS	
	MEMARI	GOLSI	PANDUA	BALAGARH	BONGAON	HASNABAD
	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE	AVERAGE PRODUCTIVITY PER HECTARE
0<0.5	15426.92	8279.22	32388.88	16207.67	15733.33333	15253.75494
0.5<1	9964.286	26145.83	15024.46	42325.27	20541.36691	2759.022556
1<2	6300	19963.23	27199.20	29497.40	10687.05036	12481.63265
2<4	781.25	10966.23	750	42332.86	0	3854.385965
AVERAGE	8851.524	15295.35	22279.1	31466.79	15622.46	10338.96

Source: Field survey

We have also examined whether productivity of aggregate agricultural output of different provinces of India is influenced by crop diversification. In order to examine this we have run panel data regression analysis on aggregate agricultural output per unit of cultivated land as the dependent variable and crop diversification index, proportion of irrigated area and fertilizer per hectare as independent variables. It is seen that fertilizer per hectare is the most significant factor in explaining inter-state variation in productivity. Proportion of irrigated area is another significant explanatory variable. Crop diversification index is also seen to play important influence on variation in productivity but at much lower level of statistical significance, compared to the last two variables. This appears to go against the view that yield from agriculture depends to a large extent on the degree of crop diversification.

**Random-effects of GLS regression**

**Result with dependent variable: Production per unit of land – PROD**

**Regressors: Crop diversification index - cdi**

**Proportion of irrigated land – irrprop**

**Fertilizer per unit of land – fert**

```

Group variable (i): state      Number of obs   =      92
                               Number of groups =       7

R-sq:  within = 0.4315        Obs per group:  min =       7
        between = 0.0498      avg =      13.1
        overall = 0.0028      max =      17

Random effects u_i ~ Gaussian   Wald chi2(3)    =     53.33
corr(u_i, X) = 0 (assumed)     Prob > chi2    =     0.0000

```

prod	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
cdi	5.035863	3.145997	1.60	0.109	-1.130177	11.2019
irrprop	.0221654	.0125773	1.76	0.078	-.0024857	.0468166
fert	.0025813	.0005489	4.70	0.000	.0015055	.0036571
_cons	-1.690825	1.646521	-1.03	0.304	-4.917946	1.536296
sigma_u	1.51696					
sigma_e	.89694075					
rho	.74095683	(fraction of variance due to u_i)				

### C) Farm size, family labour days and cropping intensity:

Next we examine the impacts of farm-size and use of family labour days on crop diversification. Our field data show that in Balagarh, Bongaon and Hasnabad marginal and very marginal farmers allocate greater proportion of their land compared to others to the production of potato oil seed and vegetables. Even in Memari and Balagarh small farmers are found to allocate greater proportion of their land compared to others to vegetables. Hence intensity of cropping in all blocks is higher for very marginal farmers compared to others. It can be seen that intensity of cropping is the highest for marginal and very marginal farmers in all of our survey villages and crop diversification index is the highest either for very marginal farmers or marginal farmers in all the blocks except Golsi.

**TABLE 7.12**  
**FARM SIZE, SDI, CROPPING INTENSITY AND FAMILY LABOUR DAYS**  
**BURDWAN**

FARM SIZE (HECTARE)	MEMARI			GOLSI		
	SDI	INTENSITY OF CROPPING	AVERAGE FAMILY LABOUR DAYS	SDI	INTENSITY OF CROPPING	AVERAGE FAMILY LABOUR DAYS
0<0.5	0.553	1.93	86.9	0.488	4.015	47
0.5<1	0.519	1.85	213.95	0.552	2.692	27
1<2	0.4918	1.50	413.75	0.567	3.548	38
2<4	0.5627	1.79	25.25	0.591	2.825	57
AVERAGE	0.531	1.7893	182.29	0.546	3.324	43.56

Source: Field survey

**TABLE 7.13**  
**FARM SIZE, SDI, CROPPING INTENSITY AND FAMILY LABOUR DAYS**  
**HOOGLY**

FARM SIZE (HECTARE)	PANDUA			BALAGARH		
	SDI	INTENSITY OF CROPPING	AVERAGE FAMILY LABOUR DAYS	SDI	INTENSITY OF CROPPING	AVERAGE FAMILY LABOUR DAYS
0<0.5	0.456	2.315789	175	0.711	2.0108	206.8182
0.5<1	0.379	2.215143	192.8	0.776	1.867742	305.4545
1<2	0.455	2.289308	283.125	0.682	2.014123	67.27273
2<4	0.341	2.039648	120	0.726	2.104625	36.36364
AVERAGE	0.417	2.25525	207.63	0.763	1.958523	218.5606

Source: Field survey

**TABLE 7.14**  
**FARM SIZE, SDI, CROPPING INTENSITY AND FAMILY LABOUR DAYS**  
**NORTH 24 PARAGANAS**

FARM SIZE (HECTARE)	BONGAON			HASNABAD		
	SDI	INTENSI TY OF CROPPIN G	AVERAG E FAMILY LABOUR DAYS	SDI	INTENSITY OF CROPPING	AVERAGE FAMILY LABOUR DAYS
0<0.5	0.595	2.2839	42	0.741	2.428	195
0.5<1	0.846	1.921	75	0.653	1.787	201
1<2	0.793	1.718	187	0.602	1.943	119
2<4	0.76	1.722	175	0.61	1.009	93
AVERAGE	0.737	1.9707	99.10	0.678	2.012	170.27

Source: Field survey

This seems to support our hypothesis that marginal farmers everywhere are diversifying cropping pattern to supplement their income; the cereals they produce meet their consumption needs directly whereas they meet their consumption needs of other purchased items out of non-cereal production. But the relatively bigger farmers find a constraint due to lack of availability of sufficient family labour days to undertake diversification on a larger scale. They diversify in relatively smaller proportion of their land compared to the marginal and very marginal farmers which is limited by the non-availability of family labour. This may also indicate absence of scope for large scale commercial production of non-cereal crops.

**TABLE 7.15**  
**PROPORTION OF PRODUCTION USED FOR OWN CONSUMPTION**  
**MEMARI**

Farm size (hectare)	Percentage of cereal production used for own consumption	Percentage of pulses production used for own consumption	Percentage of potato production used for own consumption	Percentage of vegetables production used for own consumption
0<0.5	38.85	0	8.124	19.82
0.5<1	36.41	0	8.276	3.0107
1<2	21.33	0	3.335	65.46
2<4	10.26	0	3.63	100
Average	28.73	0	6.2	39.33

Source: Field survey

**TABLE 7.16**  
**PROPORTION OF PRODUCTION USED FOR OWN CONSUMPTION**  
**GOLSI**

Farm size (hectare)	Percentage of cereal production used for own consumption	Percentage of pulses production used for own consumption	Percentage of potato production used for own consumption	Percentage of vegetables production used for own consumption
0<0.5	57.48	0	9.318	0
0.5<1	51.47	0	5.983	89.14695341
1<2	28.90	0	10.8656	100
2<4	8.47	0	2.6548	6.279932546
Average	36.58	0	7.2053	42.73

Source: Field survey

**TABLE 7.17**  
**PROPORTION OF PRODUCTION USED FOR OWN CONSUMPTION**  
**PANDUA**

Farm size (hectare)	Percentage of cereal production used for own consumption	Percentage of pulses production used for own consumption	Percentage of potato production used for own consumption	Percentage of vegetables production used for own consumption
0<0.5	36.45888	95.83333	21.17135	2.056075
0.5<1	16.26717	0	12.25605	4.687898
1<2	7.224026	0	5.596107	10.08696
2<4	14.44695	93.75	8.333333	6.666667
Average	18.59926	29.01	12.87	5.8744

Source: Field survey

**TABLE 7.18**  
**PROPORTION OF PRODUCTION USED FOR OWN CONSUMPTION**  
**BALAGARH**

Farm size (hectare)	Percentage of cereal production used for own consumption	Percentage of pulses production used for own consumption	Percentage of potato production used for own consumption	Percentage of vegetables production used for own consumption
0<0.5	80.15		33.76	1.0252
0.5<1	46.40	100	14.60	2.700
1<2	45.08		30	8.708
2<4	11.16	12.5	21.07	83.28
Average	54.86	83.00	23.76	10.88

Source: Field survey

**TABLE 7.19**  
**PROPORTION OF PRODUCTION USED FOR OWN CONSUMPTION**  
**BONGAON**

Farm size (hectare)	Percentage of cereal production used for own consumption	Percentage of pulses production used for own consumption	Percentage of potato production used for own consumption	Percentage of vegetables production used for own consumption
0<0.5	63.05732	33.33333	12.16216	3.21821
0.5<1	35.9229	100	19.08549	1.324266
1<2	43.38422	0	27.86408	0.3109
2<4	24.09639	0	17.85714	0
Average	45.89	48.17	19.242	1.41

Source: Field survey

**TABLE 7.20**  
**PROPORTION OF PRODUCTION USED FOR OWN CONSUMPTION**  
**HASNABAD**

Farm size (hectare)	Percentage of cereal production used for own consumption	Percentage of pulses production used for own consumption	Percentage of potato production used for own consumption	Percentage of vegetables production used for own consumption
0<0.5	86.62	60.25	66.45	26.6834
0.5<1	59.91	164.54	61.77	22.14666
1<2	45.24	0	61.153	18.26614
2<4	54.97	11.11	79.54	40.99255
Average	69.54	44.36	65.81	25.84

Source: Field survey

Tables 7.12, 7.13 and 7.14 show that family labour days which we think should have positive impact on crop diversification, shows an increasing tendency with farm-size up to certain size level, after which it falls. This is explained by the fact that very marginal sized farms can absorb smaller family labour days and relatively bigger farms require more family labour though beyond a certain size level use of family labour should be substituted by hired labour. One remarkable observation that comes out is that in most cases farmers within the category of 1

hectare to less than 2 hectares of land put in much more labour days compared to both marginal farmers and big farmers in Bongaon, Pandua and Memari.

#### D) Consumption pattern:

Coming to the question of consumption it is seen that consumption of cereal does not show any systematic pattern across blocks. It is not that average per capita per day consumption of cereals is lower in areas with higher diversification. Even in the areas where vegetables production gets more emphasis cereal consumption still occupy a very big proportion of total consumption and the areas which give least importance to vegetables production consume substantially higher quantity of vegetables. In general people consume cereal in very high quantities and per capita per day consumption of cereals is in most of the cases higher for small and middle farmers than marginal and very marginal farmers. On the other hand, the consumption of vegetables fish and chicken is not particularly low for marginal and very marginal farmers. In fact, it is sometimes higher than that of other groups. This may be due to the fact that marginal and very marginal farmers produce vegetables, part of which they consume directly. And with regard to fish we have seen that marginal and very marginal farmers undertake regular collection of fish apart from certain kinds of vegetables. The observation that emerges is that while the marginal and very marginal farmers consume vegetables and protein, their consumption of cereals is still substantial. In fact, for all classes of farmers consumption of cereals is still quite high. It may be that there has been improvement in level of consumption of the rural farming households but substitution of higher value items in place of cereals may not have taken place. This has implications for demand of cereals.

**TABLE 7.21**  
**CONSUMPTION OF CEREALS PER DAY PER CAPITA (in Kg.)**

	MEMARI	GOLSI	PANDUA	BALAGARH	BONGAON	HASNABAD
FARM SIZE (HECTARE)	AVERAGE CEREAL CONSUMPTION	AVERAGE CEREAL CONSUMPTION	AVERAGE CEREAL CONSUMPTION	AVERAGE CEREAL CONSUMPTION	AVERAGE CEREAL CONSUMPTION	AVERAGE CEREAL CONSUMPTION
0-<0.5	0.861833	0.554938	0.54030	0.5851	0.4744	0.67
0.5-<1	0.799433	0.588616	0.5699	0.53454	0.5552	0.56
1-<2	0.967693	0.717897	0.4886	0.6428	0.6347	0.58
2-<4	0.859328	0.563525	0.77	0.6337	0.5476	0.66
AVERAGE	0.872072	0.606244	0.548	0.57384	0.5755	0.625

Source: Field Survey

## E) Results of regression analysis:

In order to examine our hypotheses a, b, c and e we have run regression of crop diversification index against farm-size, extent of irrigation and family labour. Moreover, we use dummy variables to capture the impact of irrigation type and infrastructural variables, separately for different districts, using dummy variables for the blocks. We also run regression of diversification index against family labour, farm-size and cropping intensity / proportion of irrigated area, using area dummies for all the 180 households. We use the following form:  $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4D$  for individual district with  $X_1 =$  farm-size,  $X_2 =$  family labour days,  $X_3 =$  proportion of irrigated area,  $D = 1$  for a particular block,  $D = 0$  for another block. For the whole set of data for all six blocks we use the regression model:  $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4D_1 + \beta_5D_2 + \beta_6D_3 + \beta_7D_4 + \beta_8D_5$ , with  $X_1 =$  farm-size,  $X_2 =$  family labour days,  $X_3 =$  proportion of irrigated area,  $D_1 =$  dummy for Balagarh,  $D_2 =$  dummy for Bongaon,  $D_3 =$  dummy for Hasnabad,  $D_4 =$  dummy for Golsi,  $D_5 =$  dummy for Memari.

We present below the results of our regression analysis for the three districts:

### 1. HOOGHLY:

<i>Regression Statistics</i>	
Multiple R	0.88659
R Square	0.786042
Adjusted R Square	0.771286
Standard Error	0.097005
Observations	63

ANOVA	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	4	2.005068	0.501267	53.27028018	9.03696E-19
Residual	58	0.545773	0.00941		
Total	62	2.550842			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t-Stat</i>	<i>P-value</i>
Intercept	<b>0.747746</b>	0.028592	26.15223	8.59303E-34
FARM SIZE	<b>-0.18538</b>	0.06526	-2.84056	0.006202309
FAMILY LABOUR	<b>0.000191</b>	7.27E-05	2.632344	0.010848685
PROPORTION OF AREA UNDER IRRIGATION	<b>0.0741</b>	0.028691	2.58267	0.012349268
DUMMY(PANDUA)	<b>-0.36205</b>	0.025034	-14.4624	6.80023E-21

Dummy = 1 for Pandua and Dummy = 0 for Balagarh.

- a) The intercept is positive and significant and the dummy for Pandua is negative and significant.
- b) The coefficient of farm-size is negative and significant.
- c) The coefficient of family labour is positive and significant.
- d) The coefficient of extent of irrigation is positive and significant.

In Balagarh the value of Simpson's Diversification Index (SDI) is significantly greater than that in Pandua. The two regions representing two different irrigation and infrastructural types with Pandua representing impact of canal irrigation and the most developed infrastructure among the blocks and Balagarh representing impact of other types of irrigation with relatively inferior ranking with regard to infrastructure. This shows that in non-canal irrigated areas extent of crop diversification is significantly more than in canal irrigated region and the extent of crop diversification is strongly influenced by farm size, family labour and proportion of area under irrigation. The strong negative impact of farm size indicates smaller farmers take more initiative for diversification and strong positive impact of family labour indicates under this particular condition diversification depends to a large extent on number of family labour days the farming household can provide.

## 2. BURDWAN:

<i>Regression Statistics</i>	
Multiple R	0.379883634
R Square	0.144311575
Adjusted R Square	0.08207969
Standard Error	0.088900746
Observations	60

ANOVA	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	4	0.073309	0.018327	2.318933	0.068377
Residual	55	0.434684	0.007903		
Total	59	0.507993			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
INTERCEPT	<b>0.538082139</b>	0.051734	10.40095	1.34E-14
FARM SIZE	<b>0.002221246</b>	0.001595	1.392484	0.16938
FAMILY LABOUR DAYS	<b>6.82115E-05</b>	4.03E-05	1.690678	0.096559
INTENSITY OF CROPPING	<b>0.045437845</b>	0.020679	2.197344	0.032226
DUMMY (GOLSI)	-0.000255013	0.024172	-0.01055	0.991621

Dummy = 1 for Golsi and Dummy = 0 for Memari.

- a) The intercept is significant and the dummy for Golsi is negative but insignificant.
- b) The coefficient of farm-size is positive but insignificant.
- c) The coefficient of family labour is positive and significant.
- d) The coefficient of intensity of cropping is positive and significant.

It is seen that there is no significant difference in SDI between Memari which is endowed with canal water and Golsi which has access to surface water due to proximity to river. Contrary to the situation in Hooghly, in Burdwan farm size has a positive but insignificant impact on crop diversification. Family labour, however, continues to play a positive and moderately significant role on crop diversification. Since in Golsi the quantitative information on area under irrigation that has been available from field survey appears to be insufficient we use here intensity of cropping as a proxy variable.

### **3. NORTH 24 PARGANAS:**

<i>Regression Statistics</i>	
Multiple R	0.35687185
R Square	0.127357517
Adjusted R Square	0.065025912
Standard Error	0.089716586
Observations	62

ANOVA	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	4	0.065784222	0.016446055	2.043225353	0.100683
Residual	57	0.45074769	0.008049066		
Total	61	0.516531911			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
INTERCEPT	<b>0.684691446</b>	0.029678238	23.07048863	2.80821E-30
FARM SIZE	<b>-0.066658435</b>	0.042808122	-1.557144584	0.125070144
FAMILY LABOUR	0.000180637	0.000132756	1.36067126	0.179069038
PROPORTION OF AREA UNDER IRRIGATION	<b>0.043631371</b>	0.02777788	1.570723582	0.121880484
DUMMY (BONGAON)	0.023488878	0.025278314	0.929210635	0.356768143

Dummy = 1 for Bongaon and Dummy = 0 for Hasnabad.

- a) The intercept is strongly significant. Dummy for Bongaon is positive but not significant.

- b) The coefficient of farm size is negative but significant only at less than 88 per cent level.
- c) The coefficient of family labour is not significant.
- d) The coefficient of irrigated area is positive and significant at 88 per cent level.

This shows that in the infrastructurally backward North 24 Parganas the two blocks do not differ significantly with regard to SDI with Bongaon having slightly higher SDI than Hasnabad. Tendency for small farmers to undertake diversification to a larger extent is present though not very strong. Family labour has a very weak positive influence. This means none of the variables can really explain the variation in SDI in North 24 Parganas.

Next, we have conducted the experiment with regard to all 180 farming households of our sample using five dummies and the intercept to capture the impact of variations regarding infrastructure and type of irrigation with D<sub>1</sub> for Balagarh, D<sub>2</sub> for Bongaon, D<sub>3</sub> for Hasnabad, D<sub>4</sub> for Golsi and D<sub>5</sub> for Memari with intercept representing the benchmark value for Pandua with strongest infrastructural code and lowest average value of SDI. The results of the regression analysis show:

#### **4. ALL AREA**

<i>Regression Statistics</i>					
Multiple R	0.807180789				
R Square	0.651540826				
Adjusted R Square	0.635701773				
Standard Error	0.092774878				
Observations	185				
ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	8	2.832456058	0.354057007	41.13508626	1.75213E-36
Residual	176	1.514863318	0.008607178		
Total	184	4.347319377			
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	
INTERCEPT	<b>0.282380562</b>	0.032161087	8.780193445	1.40586E-15	
FAMILY LABOUR	<b>0.000110019</b>	3.4462E-05	3.192467119	0.001671126	
FARM SIZE	0.010723835	0.008923298	1.201779274	0.231063628	
CROPPING INTENSITY	<b>0.042698004</b>	0.01001303	4.264244176	3.26696E-05	
D <sub>1</sub>	<b>0.374244461</b>	0.024187015	15.47294962	1.1896E-34	
D <sub>2</sub>	<b>0.352670778</b>	0.024531298	14.37636031	1.68219E-31	
D <sub>3</sub>	<b>0.326060125</b>	0.023105213	14.11197226	9.75567E-31	
D <sub>4</sub>	<b>0.26734342</b>	0.024849496	10.75850466	4.57552E-21	
D <sub>5</sub>	<b>0.259943495</b>	0.02384105	10.9031897	1.77288E-21	

- a) Intercept is significant and all dummies are positive and strongly significant.
- b) The coefficient of farm size is positive and insignificant.
- c) The coefficient of family labour is positive and highly significant.
- d) The coefficient of intensity of cropping is very highly significant.

Pandua, the infrastructurally most advanced region and endowed with variety of sources of irrigation including canal and deep tube-well, has the lowest SDI and all other regions have significantly greater SDI compared to Pandua. The SDI is strongly and positively influenced by the capacity of the farming households to allocate more family labour days for cultivation.

From our analysis of panel data for states of India we have seen that use of fertilizer per hectare of land has a strong influence on inter-state and temporal variation in SDI. This has led us to conduct another experiment with regression analysis of all areas. The test result shows that fertilizer per unit of land plays insignificant role in explaining variation in SDI among farms.

#### **4. ALL AREA WITH INCLUSION OF FERTILIZER PER HECTARE**

##### SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.793121076
R Square	0.629041041
Adjusted R Square	0.609963152
Standard Error	0.095996341
Observations	185

ANOVA	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	9	2.734642	0.303849	32.97226	2.46294E-33
Residual	175	1.612677	0.009215		
Total	184	4.347319			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
INTERCEPT	<b>0.373658942</b>	0.021628	17.27685	1.13E-39
FAMILY LABOUR	<b>0.00011478</b>	3.58E-05	3.209044	0.001584
FARM SIZE	<b>-0.038242772</b>	0.017596	-2.17333	0.0311
IRRIGATED AREA	<b>0.024491626</b>	0.009979	2.454306	0.015094
per hectare fert use	6.03791E-07	1.6E-06	0.377327	0.706387
dummy(BALAGARH)	<b>0.352418691</b>	0.024385	14.45247	1.15E-31
dummy(BONGAON)	<b>0.345984782</b>	0.025341	13.65317	2.3E-29
dummy(H)	<b>0.354261546</b>	0.028066	12.62243	2.18E-26
dummy(G)	<b>0.272628588</b>	0.02586	10.54231	1.98E-20
dummy(M)	<b>0.261886604</b>	0.025566	10.24371	1.37E-19

This test result shows the coefficients of all variables except fertilizer per hectare are significant. Family labour plays a strong positive role. Farm size plays a strong negative role and irrigation a strong positive role for variation in crop diversification index. Type of irrigation and infrastructure play important role in raising crop diversification index among blocks in respect to the lowest index of Pandua.

Thus the analysis seems to provide support in favour of acceptance of the most of the first six hypotheses which we have taken for testing.

## References:

- 1) *Banik Arindam (1994); Farm size, Factor Productivity and returns to scale under different types of water management, EPW, Dec. 31, 1994.*
- 2) *Chand Ramesh (1999); 'Liberalization of Agricultural Trade and Net Social Welfare', EPW, Dec 25-31.*
- 3) *Das B. L. (2007), 'The World Trade Organisation- A Guide to the Framework for International Trade', Book Well, New Delhi, India.*
- 4) *Dhar Biswajit (2007); 'Protection of Plant Varieties and Farmers' Rights Bill 2000: Some Comments, Centre for Study of Global Trade System and Development, New Delhi, Dec.*
- 5) *Deshpande R. S., Nagesh Prabhu (2005); 'Farmers Distress: Proof beyond question', EPW, Oct 29.*
- 6) *Dyan V S (2004); 'Agricultural Distress, Strategy to Protect Vulnerable Section', EPW DEC 25.*
- 7) *Gandhi P Vasant, Zhang-Yue Zhou, John Mullen (2004); 'India's Wheat Economy: Will Demand be a Constraint or Supply', EPW, Oct 23.*
- 8) *Ghosh N (2004); 'Promoting Bio-fertiliser', EPW, Dec 25.*
- 9) *Gulati Ashok, BatilaSeema (2001); 'Capital Formation in IndianAgriculture', EPW, May 29.*
- 10) *Iyer V. R. K. (2000); 'GATT, TRIPS, Patent Law', Centre for Study of Global Trade System and Development, New Delhi, Dec.*
- 11) *Joshi P K, Gulati Ashok, Birthal S P, Tewri L (2004); 'Agricultural Diversification in South Asia: Patterns Determinants and Policy Implication', EPW, June 12.*
- 12) *Kalegama S., et al. (2001); 'Selected Articles on South Asia & GATT/WTO', Institute of Policy Studies of Srilanka and Coalition for Action on South Asian, Dec.*
- 13) *Keayla B. K. (2000); 'Protection of Plant Varieties and Farmers' Rights Bill 2000, Centre for Study of Global Trade System and Development', New Delhi, Dec.*

- 14) Khasnabis Ratan (1994); *'Temerial Condition in West Bengal: Continuity and change'*, EPW, Dec 31.
- 15) Kumar Nagesh (2001); *'WTO's Emerging Investment Regime: Way Forward for Doha Ministerial Meeting'*, EPW, Aug 18-24.
- 16) Kumar Procluman, Rosen Markw; *'Productivity&sources of growth for rice in India'*, IB
- 17) Landes R, GulatiA (2004); *'Farm Sector Performance and Reform Agenda'*, EPW, Aug. 7.
- 18) McCalla F., Nash J. (2007); *'Reforming Agricultural Trade for Developing Countries'*, The World Bank, Washington, DC, Vol-1 & 2.
- 19) Mahanti B. B., Sangeeta (2004); *'Farmers' Suicide in Maharashtra'*, Dec. 25.
- 20) Menon Usha (1992); *'Dunkel Proposal and Indian Agriculture'* in *"Dunkel's Draft Text: Indian Agriculture"*, July.
- 21) Mishra S (2006); *'Farmers' Suicide in Maharashtra'*, EPW, April.
- 22) Mishra S; *'Suicide Mortality Rates across States of India'*, EPW *ibid*.
- 23) Mohanakumar S, Sharma A K; *'Analysis of farmer Suicides in Kerala'*, *Ibid*.
- 24) Mukherjee Aparajita; *New Technology and Uneven Rural Development: A Report on Research Project funded by ICSSR (unpublished), 1989-90.*
- 25) Mukherjee Aparajita; *Pattern of Utilisation of Surplus, Capital Formation and Growth: A Report on Research Project funded by Planning Unit Fund, Visva- Bharati, 1998-2000 (Under process of publication).*
- 26) Mukherjee A., Bhattacharya K. (2003); *'Conditioning and Empowerment of Women- A Multidimensional Approach'*, Gyan Publishing House, New Delhi.
- 27) Radhakrishna R (2002); *'Agricultural Growth Employment and Poverty: Apolicy perspective'*, EPW, January 19-25.
- 28) Rao C H H (1994); *'Indian Agriculture: emerging perspective & policy issues'*, EPW, Dec 31.
- 29) Rao C H H (2000); *'Declining Demand for Foodgrain in Rural India: Cause and implication'*, EPW January. 8-14.
- 30) Rao C H H (2001); *'WTO and Viability of Indian Agriculture'*, EPW, Sept 8.
- 31) Rao V M Hamemapa (1999); *'Marginalisation Process in Agriculture; Indicators outlook and policy Implications'*, EPW, Dec. 25.
- 32) Rao P M, Gubalappa P V (2005); *'Agricultural Growth Farmers' Dstress; Tentative perspective from Karnataka'*, EPW, Dec 25.
- 33) Ray Sunil (1994); *'Farm Non-farm Interaction in a Labor Surplus Economy'*, EPW.
- 34) RIS (2004); *'South Asia Development and Cooperation Report 2004'*.

- 35) S S Jodhka (2006); *'Beyond Crises': Rethinking Contemporary Punjab Agriculture*, EPW, April 22.
- 36) Sekhar (2004); *'Agricultural Price Volatility in International & Indian Markets*', EPW, Oct 23.
- 37) Sharma Devinder (2004); *'WTO and Agriculture: Green Box Subsidies Must Go*', EPW, May 15.
- 38) Sing A, Taneja S (2004); *'Trend Break in Indian GDP Growth Rate: some comment*', EPW, Dec 25.
- 39) Sing J, Sandhu R S (2004); *'Factors in declining crop diversification: A case study of Punjab*', EPW, Dec 25.
- 40) Sing S (2004); *'Crisis & Diversification in Punjab Agriculture; Role of state & agri business*', EPW, Dec 25.
- 41) Stiglitz J. (2002); *'Globalisation and its Discontents*', Penguin Books, New Delhi.
- 42) Suri K.C. (2006); *'Political Economy of Agrarian Distress*', EPW April 22.
- 43) Suri K.C., Rao P.N.; *'Dimensions of Agrarian Distress in Andhra Pradesh*', IBID.
- 44) Sridhar V.; *'Why do Farmers Commit. Suicide? The case of Andhra Pradesh*', *ibid.*
- 45) Vakulabharanam V. (2004); *'Agricultural growth and Irrigation in Telangana. A review of evidence*,' EPW, March 27.
- 46) Vaidyanathan A. (2000); *'India's Agricultural Development Policy*' EPW, May 13.
- 47) The World Bank (Agricultural and Regional Development Unit – South Asia Region) and OUP (India) Publication (2005); *'India – Re – Energizing the Agricultural Sector to Sustain Growth & Reduce Poverty*'.