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Publication of Artha Beekshan, the quarterly referred journal of Bangiya Arthaniti Parishad, that is, the Bengal Economic Association, is one of the most important academic activities of the Association. The present volume, Volume 32, No.3 of the Journal, contains the papers contributed by scholars . We are thankful to the authors and members who have helped in one way or other in the preparation of this volume.

I would like to extend my whole-hearted thanks to the Editorial team, the Publisher, and all who have helped in the publication process, and especially the office bearers of Bangiya Arthaniti Parishad for their kind endeavours to make this issue of Artha Beekshan viable and Kolkata Mudran for bringing out the present issue.

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WEAKENED-WEAK AXIOM OF REVEALED PREFERENCE AND CONSISTENCY UNDER BOUNDED RATIONALITY IN DECISION MAKING

Somdeb Lahiri[1]

Abstract

The purpose of this note is to put on record a justification for the Weakened WARP Axiom using a "binary money-pump argument".

Key Words : choice function, weakened WARP, binary money pump, demand theory

JEL Classification:D01, D11, D91.

Jaha chai taha bhul kore chai, jaha pai taha chai na- Rabindranath Thakur

The purpose of this note is to put on record a justification for the Weakened WARP Axiom due to Ehlers and Sprumont (2008), using a "binary money-pump argument".

Let X be a non-empty set (not necessarily finite) of all alternatives and let $\Psi(X)$ be the set of all non-empty subsets of X. A non-empty subset of X is said to be a **menu**.

A **domain** is a non-empty subset $\mathfrak{D}$ of $\Psi(X)$.

A **choice function** on a domain $\mathfrak{D}$ is a function $C:\mathfrak{D} \rightarrow \Psi(X)$, such that for all $A \in \mathfrak{D}$, $C(A) \subset A$.

For $A \in \Psi(X)$, let $\mathcal{W}(A)$ be the set of weak-orders (i.e., reflexive, complete and transitive binary relations) on A.

Given a choice function C on domain, **the menu-dependent preference revealed by** C is a function $R^C:\mathfrak{D} \rightarrow \bigcup_{A \in \mathfrak{D}} \mathcal{W}(A)$ such that for all $A \in \mathfrak{D}$: (i) $R^C(A) \in \mathcal{W}(A)$, and (ii) for all $x,y \in A$: $[xR^C(A)y]$ if and only if [<u>either</u> $x \in C(A)$ <u>or</u> $x,y \in A \backslash C(A)$].

For $A \in \mathfrak{D}$ and $x,y \in A$, $xR^C(A)y$ is interpreted as "**given the menu** A, x **is revealed to be at least as good as** y". If $xR^C(A)y$ but it is <u>not the case</u> that $yR^C(A)$, i.e., $x \in C(A)$ and $y \in A \backslash C(A)$, then we can interpret the resulting relation between x and y as "**given the menu** A, x **is revealed to be strictly preferred (strictly better than or superior) to** y".

A choice function C on a domain $\mathfrak{D}$ is said to satisfy **Weak Axiom of Revealed Preference (WARP)** if for all $A,B \in \mathfrak{D}$ and $x,y \in A$: [$x \in C(A)$, $y \in A$ and $y \in C(B)$] <u>implies</u> [$x \notin B \backslash C(B)$].

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The following property due to Ehlers and Sprumont (2008) is a weaker version of WARP.

A choice function C on a domain $\mathfrak{D}$ is said to satisfy **Weakened-Weak Axiom of Revealed Preference (W-WARP)** if for all $A,B\in\mathfrak{D}$ and $x,y\in A$: [$x\in C(A)$, $y\in A\setminus C(A)$ and $y\in C(B)$] implies [$x\notin B\setminus C(B)$].

The difference between the two properties can be seen in the following example which along with several others has been discussed in Ehlers and Sprumont (2008).

Example: Let $X = \{x,y,z\}$ and suppose that the choice function C on $\Psi(X)$ satisfies $C(\{x,y\}) = \{x\}$, $C(\{y, z\}) = \{y\}$, $C(\{z,x\}) = \{z\}$ and $C(\{x,y,z\}) = \{x, y, z\}$.

It is easy to see that C satisfies W-WARP but violates WARP.

When C is "singleton valued" then WARP is equivalent to W-WARP.

The following interpretation of W-WARP in the context of "demand theory" is discussed in Lahiri (2023).

Suppose C on a domain $\mathfrak{D}$ is the choice function of a decision maker (DM) who values money (as an instrument with which he/she can derive satisfaction from the consumption of goods and services). If C violates W-WARP, then there exists $A,B\in\mathfrak{D}$ and $x,y\in A$: [$x\in C(A)$, $y\in A\setminus C(A)$, $y\in C(B)$ and yet $x\in B\setminus C(B)$].

Then according to the menu-dependent preference revealed by C, the DM strictly prefers x to y at A and strictly prefers y to x at B.

Consider the following thought experiment, where the DM starts off with x at A. Now, if he is given the option of choosing y from B in lieu of x which is also in B, then he will be willing to pay a strictly positive amount of money, say α, to get y in exchange of x since at B, the DM strictly prefers y to x. If after he has received y at B against a payment of α, he is given the option of choosing x from A in lieu of y which is also in A, then he will be willing to pay a strictly positive amount of money, say β, to get x in exchange of y since at A, the DM strictly prefers x to y.

In this way, by alternating between x from A and y from B, the entire wealth of the DM can be "pumped out" leaving the DM totally bankrupt.

Borrowing a terminology from Taylor and Zwicker (1992) given a menu A and two distinct alternatives x and y in A let us define a **swap of** y **in return for** x **at** A to be parting with y in return for x in lieu of a payment of a "positive" amount of money. In particular, exchanges for free are not swaps.

Let us call a finite sequence alternating between a voluntary swap of y in return for x at A and a voluntary swap of x in return for y at B, where A and B are two menus containing x and y, a **binary money pump**.

Thus, if not going bankrupt in a thought experiment based on a "**binary money pump argument**"is a minimal requirement of consistency- under bounded rationality- in decision making, then the choice function of the DM should satisfy W-WARP.

As a by-product of the above, we get a possible justification for a demand theory of the weak axiom of revealed preference as in Kihlstrom, Mas-Colell and Sonnenschein (1976).

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Agricultural and Rural Development in India- Need for Alternative Approach

Sankar Majumder[1]

Abstract

The paper explores the alternative vision for agricultural and rural development in India. It starts with the basic assumption that the 'development of agricultural sector and rural development' is required solely for development of the people of the country and not for the development of the agricultural or rural sector per se. Borrowing and highlighting Goulet's distinguishing concepts of three basic components or core values of development: life-sustenance, self-esteem and freedom, the author argues that agricultural development has not solved the problem of development of country's population. That is why, it is now necessary to search for alternative ways for development of the Indian population ensuring life-sustenance, self-esteem and freedom.

Key words: AML, Freedom, NFSA, Food security, Self-esteem, Sustenance

Jel Code: O1,O13,Q1,Q18

I. Introduction

This paper aims at exploring the alternativevision for agricultural and rural development in India. It starts with the basic assumption that the 'development of agricultural sector and rural development' is required solely for development of the people of the country and not for the development of the agricultural or rural sector per se. The meaning of 'development here follows Goulet's (1971) distinguishing concepts of three basic components or core values of development: life-sustenance. self-esteem and freedom. The path of agricultural development since mid-1960s definitely led to massive increase in agricultural production. But look at the people of the country and specifically the people residing in the agricultural/rural sector. Inequality, unemployment, poverty increased precisely in the midst of high remarkable achievements in agricultural sector. Hunger could not be helped through attaining high world ranks in various agricultural produces.

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Section-1 introduces the theme of the paper; Section-2 points out,very briefly, theInitial path that was followed for agricultural development in Independent India; Section-3 discusses the adoption of a new path of agricultural development; Section-4presents the views of the Current 'Think Tank' of the Government Initiatives in Agricultural Sector;-Section-5showstherecent measures taken by the Government; Section-6 evaluates the present scenario; and Section-7 discusses the lesson learnt and explores the alternative.

II.Initial Path of Agricultural Development in Independent India.

Attaining self-sufficiency in agriculture was the major objective from the very first and second five-year plans. One third of plan funds was allocated to agriculture. Large irrigation projects were started and several fertiliser manufacturing units were set up in the public sector. Agriculture grew by 3.22 % in the first plan (1951-52 to 1955-56) and 3.59 % in the second plan (1956-57 to 1960-61). During these years India was following institutional approach for agricultural and rural development. Several institutional measures (land reforms, cooperative, panchayati raj, etc) were taken to raise production along with social justice. In this institutional approach the process of agricultural development was expected as the outcome of the measures taken for social justice. It seems that social justice was given greater weight.

III. Adoption of a NewPath

But due to Indo-China war in 1962, Indo- Pak war in 1964, consecutive failure of monsoon at the middle of 1960s, and the improper implementation of the institutional measures, situations deteriorated in the whole country. India was almost forced to switch over to technological approach (HYV Technology) in the second half of 1960s and the country became largely self-sufficient in major cereals (rice and wheat) to meet the demand for the same.

Since then gradually India started adopting modern technologies in different crops as well as in other sub-sectors of agriculture (horticulture, livestock, fisheries, etc). With the development of new and newer technologies in the sphere of agriculture in the developed countries and at the international level, Indian agriculture was also adopting those technologies to the extent permitted by law, physical availabilities and the socio-economic conditions of the farming communities.

Gradually there are uses of bio-technological, molecular and nano-technology approaches in agriculture. In subsequent years these technologies did not remain confined to the production sphere only but the technological and institutional innovations got extended throughout the marketing, transportation, logistics, and digital access and payments. There are several ways of opting solutions by using new digital logistic tools with software and hardware engagements. Applications of digital technologies

and Agricultural Machine Learning (AML) in agricultural production systems have started in crop management, yield prediction, disease detection, weed detection crop quality and species recognition, livestock management, water management, soil management.

IV.Current 'Think Tank' of the Government Initiatives in Agricultural Sector

In deciding the course of actions, decision makers of the country sought the help of the national and international experts. Findings and recommendations of these experts shaped the policies of the government.

A Working Group under the Chairmanship of Professor Parmod Kumar of Institute of Social and Economic Change, Bengaluru, was set up by the Niti Aayog in July 2016, to work out demand and supply projections of crops, livestock and fisheries up to 2032-33.

Findings of the working Group: The working Group assumed that in this period, the Indian economy will grow by 6 to 8% per annum. The Working Group calculated averages of various estimates and projected demand of food grains at 337.01 million tonnes in 2032-33. Its estimate of domestic production (supply) in that year is expected to be 386.25 million tonnes. Wheat and rice are projected to be in surplus while the production of pulses is estimated to be lower than the demand. In the case of milk, eggs, meat, fish, vegetables, fruits and sugar, India is projected to meet its demand through enhanced production.Working Group made projections which coincides the vision document being prepared by NITI Aayog.

Major suggestions of the Working Group: (i) "The future growth in agriculture will primarily be knowledge and technology driven. This demands more investment in agricultural R&D, innovations and institutions to bring about significant change in technologies for resource conservations and productivity enhancement."(ii)"Business and enterprise friendly policies, laws, and regulations as well as physical and institutional infrastructures, which encourage commercial activities and entrepreneurship in farming, input supply, produce handling, processing and marketing as well as in manufacturing will be key factors to the success of agricultural mechanisation in the different states of India"(iii)"This requires substantive reforms in the land policy particularly at the State level, to achieve the economies of scale in agriculture. Promotion of contract farming, legislation on land leasing and encouragement of land sharing among both farmers and landowners is requisite. The model land leasing act suggested by NITI Aayog needs to be adopted by the States to enact their leasing laws." (iv) "Increasing productivity calls for investments in technology, extension, research and logistics to raise output through efficient usage of natural resources and also minimising wastage. Technology needs to be brought in to the centre stage."

Consider the Presidential address by Prof Ramesh Chand, an influential member of NITI Aayog, at the 102 Annual Conference of Indian Economic Association (IEA) in 2019. Here are some excerpts from his long keynote address: 'What has been achieved in agriculture is not compared with what is achieved in space, IT, telecom, services, automobiles, medical science, transport etc." He told that in agriculture the country requires "upgradation of agricultural technology, application of modern skills in farm practices, new innovation in farming, and lowering wastages in use of fertilizer, water and other inputs." "The main underlying reasons for under development of agriculture are poor extension, missing link with supply chain of quality seed and quality plant propagation material, low availability of institutional credit in many states, low level of investments in agriculture and low level of technology."

Then he opined "Efficiency is driven by strong and vibrant R&D by public or private sector. The gap between domestic and global agricultural innovations is rising and many fascinating changes experienced in global agriculture are missing in the country. There is a need to facilitate easy access to our farmers to global technology, high quality seed and germplasm and other knowledge products."

"Upgrading farming from low tech to high-tech (green house cultivation, poly houses, tissue culture, precision farming) will reduce average cost, raise farmer's income and address some scale disabilities."

"Food surplus (domestic production less domestic absorption) has been continuously increasing for the last 35 years. This require a complete shift in food policy from shortage management to surplus management. This also indicate that much of the under nutrition in India is not due to availability of food but it is due to low food intake by Indian consumers." He avoided the issue by simply saying that "There is need to address the reasons underlying this." And suggested that "In any case, India has to look for overseas market to dispose rising food surplus."

Experts of NITI Aayog in association with the experts from FAO organised a national dialogue"Pathways for Enhancing Farmers' Income, Nutritional Security and Sustainable Food Systems,"in 2021 to complement efforts of the NITI Aayog and Ministry of Agriculture and Farmers' Welfare (MoA&FW) in designing a post-Green Revolution future for the country. They all jointly opined that there is a clear need now for a transformative vision for the next decade. And, more long-term directional reorientation of food, agriculture, and farm policies"

Following two paras show the extent of technology-intensive ideas of the present Think Tank.

The goal is to attain self-sufficiency in agriculture and make the farmer productive as well as an entrepreneur.When farmers and farming move forward in the form of industry, employment and self-employment opportunities are going to be created in the village and near it, on a large scale. Be it drone technology, artificial intelligence technology, modern agricultural equipment, young researchers will have to work relentlessly to make it more and more useful in the country's agriculture. *Time demands that our agriculture sector becomes modern and there should be value addition, there should be food processing, food packaging. And it needs better infrastructure. Aim is to* transform the farmers into vibrant producers. Technological and institutional innovations are needed throughout the production marketing, policy research and enterprise domains.

To achieve self-reliance and self-sustainability in agriculture, new innovations in research and technological advances for increased productivity are required. Breakthroughs are needed in areas of transportation, logistics, and digital access and payments to enable widespread prosperity. Thus, focus must be on production, distribution, and management of food i.e., the complete agricultural value chain**.** The agricultural society need to synthesize an operational description for digital farming. There are several ways of opting solutions by using new digital logistic tools with software and hardware engagements. Agricultural Deep Learning (ADL) has also recently entered the domain of agriculture with applications of ADL in agriculture is image recognition, to overcome many obstacles as observed in agriculture. Applications of digital technologies and Agricultural Machine Learning (AML) in agricultural production systems can be categorized as crop management, yield prediction, disease detection, weed detection crop quality and species recognition, livestock management, water management, soil management.

V. Recent Measures taken by the Government

Reflections of all these suggestions are visible in the policies and measures taken by the government in the recent past.In May, 2020, the Union Finance Minister announced the measures to strengthen Infrastructure, Logistics, Capacity Building, Governance and Administrative Reforms for Agriculture, Fisheries and Food Processing Sectors as part of the **third tranche of Atmanirbhar Bharat Abhiyan.**In particular, Finance Minister announced that "Central law to be enacted to offer more choices to farmers to sell produce in a barrier free inter-state system.Cereals, edible oils, oilseeds, pulses, onions and potato to be out of Essential Commodities Act. Legal framework to be created for remunerative agriculture produce price and quality assurance. (i) Rs 1 lakh crore finance facilities to be provided to boost farm-gate infrastructure for farmers. (ii) Rs 10.000 crores finance facility to be put in place to develop Micro Food Enterprises for promoting local agricultural produce. (iii) Rs 20,000 crores fund to be launched for Pradhan Mantri Matsya Sampad Yojana. (iv)Rs 15,000 crores fund to be created for Animal Husbandry Infrastructure De-

velopment. (v)Rs 4,000 crores fund to be launched for promotion of Herbal cultivation. (vi) Rs 500 crores fund each to be set aside for Bee-keeping and Supply Chain initiatives for all fruits and vegetables. (vii)National Animal Disease Control Programme to be launched for 100% vaccination of animal for 'Foot and Mouth' disease."

Indian farmers could not sell their produce anywhere in the country and according to their will. He had to sell his produce at a notified area. Now all those restrictions have been eliminated. Now India's farmer will be able to breathe free by selling his produce in any part of the country or the world according to his own terms.

Two major Ordinances have been passed recently to empower the farmers, namely, the Farming Produce Trade and Commerce (Promotion and Facilitation) Ordinance, 2020 and the Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Ordinance, 2020, both promulgated on 5.6.2020.

In line with the continued commitment and resolve of the Government towards improving the agriculture and the financial status of farmers funds have been released under two major initiatives: (i)Pradhan Mantri Kisan Samman Nidhi Yojna (PM-KISAN) and (ii) In addition to the direct cash support under PM-KISAN, to create an ecosystem for farmer welfare and support them to build community farming assets and drive greater investment in the agriculture value chain, a new Central Sector Scheme of financing facility of Rs. 1 lakh crore under "Agriculture Infrastructure Fund" has been approved by the Government.

The objective is to drive investment across the agriculture value chain. The scheme will benefit farmers by improving marketing infrastructure and for building community farming assets that will allow them to store their produce till they can get a better price, reduce wastage and access affordable post-harvest infrastructure.

VI. Evaluation of the present scenario

Present scenario may be evaluated in two counts. Firstly, evaluation in terms of the achievements in agricultural sector, and secondly, evaluation in terms of meeting the requirements of Indian population.

All the policies of and programmes for adoption of modern agricultural technologies made India number second country in terms of total production of paddy, wheat, sugarcane, cotton lint, potato, fresh vegetables, and cow milk. India has become number one country in production of Buffalo milk and Banana (FAO,2008). These are no doubt big achievements.

Despite all these remarkable achievements in our agricultural sector,yields remained low by international standards and growth in yields has only been marginally higher than the world average.

One may reasonably ask: to what extent the development in agricultural sector has solved the food requirements of our population? Answer to this question may help in designing the vision and future course of actions in agricultural sector.

Look at the status of per capita consumption of agricultural products in India rather than their total production. One way is to compare the situation with the per capita consumption in other countries. For simple understanding, consider the Table-1 depicting the per capita consumption of some selected food items. Except for rice, per capita consumption of all other food items in India are below the world average and definitely far below the USA.

Table1: consumption of foods in India (2012), USA and the World (2021).

Food Items \ countries	India	USA	World
Rice	83.76	11.3	78.4 kg
Wheat	50.4	80.6	67 kg
Milk	51.6	217.7	79.3
Vegetables	28.32	66.6	107.9
Potato	20.5	54.8	32.9
Fruits	NA	21.7	26.7
Banana	6.5	12.2	11.9
Chicken	2.16	55	15.6
Eggs	1.4	16.1	9.7
Fish	3.12	22.2	20.2
Cattle, Bovine	0.70	36.1	24.7

Worldwide Food Consumption Per Capita, posted on Dec 2, 2021 by Goodseedventures

Consider the situation from another angle. To what extent the per capita consumption of food items differs from the recommended minimum requirements. Table-2 presents the scenario. Except for wholegrains, in all other cases Indians are terribly short of the recommended food intake even when India ranks first or second position in the world ranking in terms of total production of some items

Table-2 Daily Recommended and actual intake (in gms) of selected food items in India

Food items	Recommended	Rural	Urban
Whole grains	232	366	293
Lamb, Beef, Pork	14	3	5
Chicken	29	6	8
Eggs	13	4	7
Fish	28	9	8
Milk	250	145	183
Vegetables	300	160	174
Fruits	200	50	100

Gloomier picture comes out when one considers the variations in per capita consumption of food items among the different categories of households. Data on expenditure group wise quantity of per capita consumption of food and non-food items are rarely given by NSSO Survey Reports. Alternatively, 'Monthly Per Capita Consumer Expenditure (in Rupees) on Selected Food Items by fractile class of Monthly Per Capita Expenditure in Rural and Urban India' is considered here for getting some idea of prevalence of huge inequality in the per capita consumption of food items(Table-3). The differences in consumption by the bottom 5% and top 5% of the households are alarming. In case of consumption of milk, it is nearly 20 times and in 'egg, fish and meat' it is 10 times. Conversion of these data in quantity terms reveals more dismal picture. Consider the case of milk. India holds top position in total milk production in the world. Assuming the price of milk at Rs 30 per litre in 2012, per capita consumption of milk of the households belonging to top 5%, middle 40-50%, and bottom 5% were only 359gms, 100gms and 18gms respectively in rural areas. These amounts are slightly more in the urban areas. Per capita daily consumption of milk is insignificant in most of the India population though we hold the top position in total milk production.

Table-3: Monthly Per Capita Consumer Expenditure (in Rupees) on Selected Food Items by fractile class of Monthly Per Capita Expenditure in Rural and Urban India (Source: NSSO, 68th Round Survey,2011-12).

Food Items	Bottom 5%		Top 5%		Middle 40-50%	
	Rural	Urban	Rural	Urban	Rural	Urban
Cereals	101.22	117.72	200.30	233.80	149.59	169.11
pulses and pulse products	22.78	28.20	62.97	75.52	37.62	50.28
milk and milk products	15.34	38.66	313.60	424.73	87.82	155.31
egg, fish & meat	12.27	21.74	110.83	126.77	38.69	61.43
vegetables	37.72	43.28	93.47	125.30	58.75	76.95
fruits	03.50	07.21	85.59	88.56	17.63	40.08

In continuation of the above observations, consider the situation in respect of 'Food Security' and 'Hunger' in India.The Global Hunger Report 2022 released by Concern Worldwide and Welt Hunger Hilfe, Non-Government Organisations from Ireland and Germany respectively, has ranked India at 107 among 121 countries. India has slipped to the 107th position in the Global Hunger Index (GHI) 2022 of 121 countries, from its 2021 position of 101st and is behind its neighbours Pakistan, Bangladesh, and Nepal. Seventeen countries, including China, Turkey, and Kuwait, shared the top rank with GHI score of less than five. The GHI score is calculated on four indicators -- undernourishment; child wasting (the share of children under the age of five who are wasted i.e who have low weight for their height, reflecting acute undernutrition); child stunting (children under the age of five who have low height for their age, reflecting chronic undernutrition) and child mortality (the mortality rate of children under the age of five).

Food security, as defined by the United Nations' Committee on World Food Security, means that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life. A review by the Centre has found that 10.58 million additional people in the country can be enrolled as recipients of subsidised food handouts under the National Food Security Act (NFSA) 2013 without breaching the overall limit prescribed by the law, which currently stands at about 800 million. The landmark NFSA 2013, which made subsidised food grain a legal entitlement, prescribes coverage of up to 75% of rural population and 50% of the urban population. Based on this, the total coverage stands at

67% of the country's population as mandated by the Act. The National Food Security Act (NFSA), 2013, through the Public Distribution System (PDS), provides a crucial safety net for roughly 800 million people.

VII. Lesson learnt and in search of alternatives

The path of agricultural development since mid-1960s definitely led to massive increase in agricultural production. But look at the people of the country and specifically the people residing in the agricultural/rural sector. Inequality, unemployment, poverty increased precisely in the midst of high remarkable achievements in agricultural sector. Hunger could not be helped through attaining high world ranks in various agricultural produces. Majority of the Indian population are living their life because of passing the National Food Security Act (NFSA) 2013 which made subsidised food grain a legal entitlement. Fortunately, or unfortunately it prescribes coverage of up to 75% of rural population and 50% of the urban population. Based on this, the total coverage stands at 67% of the country's population.

Consider the meaning of 'development' following Goulet's (1971) distinguishing concepts of three basic components or core values of development: life-sustenance. self-esteem and freedom. What percentage of India's population /agricultural population/rural population are enjoying these values of development? Can these rural families/agricultural families who are completely dependent on government's food subsidy for their daily life-sustenance be transformed into agricultural entrepreneurs? Can they transform them into vibrant producers? Can they become partner in the complete agricultural value chain with the applications of digital technologies and Agricultural Machine Learning (AML)?Are Indian farm familiesself-sustainable? Do they have self-esteem? Do they have freedom?So called agricultural development has not solved the problem of development of country's population. It is now necessary to search for alternative ways for development of the Indian population ensuring life-sustenance, self-esteem and freedom.

This section considers the alternatives given by Tagore and Gandhi. Both of them experimented with alternative ways of development on their own. This paper only points out their understanding of the basic cause behind their miserable conditions and the approach to solve the problem. Consider the following few excerpts from Tagore's writings on rural reconstruction (Reprinted in 'Sristi' in English, Institute of Rural Reconstruction, Sriniketan).

"I was filled with eagerness to understand the villager's daily routine and the varied pageant of their lives. ------ Gradually the sorrow and poverty of the villages became clear to me and I began to grow restless to do something about it. ---- From that time forward, I continually endeavoured to find out how the villagers' minds could be aroused, so that they could themselves accept the responsibility for their own lives."

"If we offer them help from outside, **it would be harmful to them**. How could they themselves be stirred to life? -that question gave me much food for thought. **It was difficult to help them because they <u>despised themselves</u>**. They would say," we are dogs-only whipping and beating will keep us right."

"I saw that the people had lost confidence".

"**From ancient times the people of our country have been accustomed to rely upon others. Some wealthy men nurtured and protected the whole village**—burden of its health and education rested on them. ------. In this way all responsibility for the wellbeing of the village was borne by its wealthy households. I have praised this custom, but it is none the less true that **it has enfeebled self-reliance."**

"-----. **This oppression and this patronage have combined to destroy the villagers' self-reliance and self-respect**."

"It is very difficult indeed to help those who have been trained for generations to this sort of weakness, those who have become completely unaccustomed to any kind of self-reliance."

"----------. In our country, now-a-days the young students of the towns have taken up village service. The villagers laugh at them. How can they help them? They don't know their language and have no acquaintance with their minds."

"----------. During my frequent sojourns to and from Shilaida I came face to face with the poverty and squalor of the villagers' life. Their misery and helplessness became as plain to me as their ignorance and narrow selfish outlook. **They seemed to belong to a demoralised race whose self-respect has been abused and initiative taken away**. For every move in improving their social, financial and hygienic condition the villagers entirely depended upon the landlords."

"Remember that the very first condition of social service is that love should provide the motive impulse. I may assure you that the villagers have nothing but contempt in those half-baked philanthropists. Where services smack of lofty condescension. But I should also add that love alone can achieve little unless it is fortified by strenuous preparation based upon a close study of the many problems of village life. Nothing can be more harmful than ignorant service."

"----------. Attempting to help villagers from outside would be, I knew, an unnatural procedure. Even in desserts hidden springs can be found; coming from within they can never go dry. Such springs we must seek in the villages. **People have to find faith in their own strength. That is, for me, an essential principle."**

These excerpts from Tagore's writing clearly points out that for development of the rural people reconstruction of their lost self-respect and faith in self are most important things. For a pretty long year for every move in improving their condition, the villagers remained entirely depended upon the wealthy households and that has enfeebled the self-reliance of our earlier generations. And now for development of each and every aspect of life of the individualsas well as that of the area, the present generation is becoming more and more dependent on the government and panchayat. In earlier period people were dependent on the landlords and wealthy households for their life-sustenance but they had their own social-religious-cultural-sports activities. But day by day government and panchayat are taking the responsibilities of even these social-religious-cultural-sports activities of the people.Alternative is to generate strength- self-respect and self-reliance in the people and they will develop themselves ('People cannot be developed; they can develop themselves"- Julias Nyere)

Gandhi in his experiment and writing also pointed out that the people needed courage and self-respect to disentangle themselves from slavish mentality developed over centuries of bondage. At the individual level, swaraj is vitally connected with the capacity for dispassionate self-assessment, ceaseless self-purification and growing self-reliance. Although the word Swaraj means self-rule, Gandhi gave it the content of an internal revolution that encompasses all spheres of life. Gandhiji was completely devoted to the cause of village reconstruction, to uplift the standard and quality of life through the active participation of the people themselves. Gandhiji wanted the human intrusion into the functioning of the biosphere to be minimized. He is perhaps the only great thinker of the last century who could foresee the social and ecological consequences of the model of development and offer an alternative. He demonstrated how a very high level of culture and civilisation could be evolved without destroying the environment, and without exploiting nature and fellow humans. Gandhiji's philosophy offers a practical way to a peaceful social and economic revolution to improve the quality of life that this mother earth can sustain.What he preached was not only for the Indian masses but for the entire people of the world. His message was not for a particular time but for the future of mankind.

So far India has not given sincere thought on this alternative given by Tagore and Gandhi. Inside their alternative 'reconstruction' of village was their grand design of the new civilisation based on sustainable development in the real sense of the term. Considering the limited success of the ongoing policies, academicians and researchers need to discuss and debate on this alternative and prepare 'Policy Briefs' for the policy makers.

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Towards Green Growth in India and Other SAARC Countries

Somaiya Begum[1] and Debolina Saha[2]

Abstract

This paper examines the association of CO2 emissions per capita and GDP per capita for the eight SAARC nations, during 2010-2019, with an annual sample data for the respective countries. Per capita GDP reflects a country's economic growth, and CO2 emissions being a global variable reflect dreadful conditions of air quality. Therefore, this study is an attempt towards establishing a significant relationship between economic growth and environmental degradation for the SAARC nations. Trade Blocs being International Associations or Integrations are the platforms of Member States to work for a better position collectively. The Member States help each other in materialising their goals in the arenas of trade and finance, political and security issues, cultural and social paradigms, etc. SAARC as an important Asian trade bloc is not an exception in this regard. The study employs a regression method under panel data structure. Utilizing a Fixed-Effects model, the study comes to the conclusions that economic growth considerably contributed to air pollution in the SAARC countries collectively during 2010-2019. SAARC as a trade bloc did not pay attention on long-term goals like environmentally sustainable growth, despite of several discussions on green growth in international platforms. However, India and Bhutan are exception in this regard. A drive towards clean environment has been seen from the year 2014, in both the countries. The study also discusses India's commitment towards pollution-free environment by 2070. Hence, reconsideration of economic activities is of urgent need for most of the other SAARC countries to ensure environmental-friendly economic growth.

Keywords: **Green Growth, Trade Blocs, Air Pollution, Economic Growth, Environmental Degradation.**

JEL classification: C1, F1, Q53, Q56.

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I. Introduction

With the signing of SAARC Charter on 8 December 1985, the South Asian Association for Regional Cooperation (SAARC) was founded in Dhaka. However, the Association Secretariat was set up on 17 January 1987, in Kathmandu. If placed in ascending order of their sizes in terms of respective land areas (sq. km), the panel of SAARC nations is comprised of eight Member States namely Maldives, Bhutan, Sri Lanka, Bangladesh, Nepal, Afghanistan, Pakistan and India (World Bank Indicators). Being one of the distinct global trade blocs, some of the primary mottos of this association are to improve quality of life of the people in this region along with economic growth acceleration; to strengthen cooperation among the countries on matters of universal attentions; and to cooperate with international and regional organizations with similar aims and purposes.

Talking of common interests, environmentally sustainable growth is the lookout of the hour. But, with the increased economic activities all over the world, regional and global temperatures are soaring high with each passing year. South Asia is a prominent zone of regular climatic catastrophes, starting from earthquakes to draughts; from water scarcity to floods and rising sea levels. Notwithstanding the unbearable summers in the recent years, severe heat waves and irregular monsoon pattern exert tremendous stress on the South Asian nations. The mean, minimum and maximum daily temperatures in South Asia are increasing and winters are getting warmer faster than summers. The snow cover has started reducing over most of the Hindu Kush Himalaya (HKH) since the early 21st century, and glaciers have been thinning and losing their masses since 1970s (IPCC Report, 2021).[3] Carbon dioxide (CO2) is one of the most vital greenhouse gases (GHG); key in this global warming. CO2 concentrations are rising mostly because of the fossil fuels that people are burning for energy. The IPCC Report (2021) with high confidence states that in 2017, human-induced warming reached approximately 1°C (likely between 0.8°C and 1.2°C) above pre-industrial levels, increasing at 0.2°C per decade (likely between 0.1°C and 0.3°C). With medium confidence the report states that past emissions alone are unlikely to raise global-mean temperature to 1.5°C above pre-industrial levels. Also, with high confidence this report assesses projected global-mean warming of 1.5°C, between 2030 and 2052, if it continues to increase at the current rate. As a group, SAARC is comprised of developing nations located in a tropical zone with wide ranging extreme climatic conditions. Since five out of the eight SAARC countries are situated in coastal areas, so the rising sea levels due to global warming might be an alarming and detrimental factor for human survival.

The population density of South Asia is about 394.65 people per sq. km of land area, while that of the entire world is only at 60.17. South Asia is home to well over 24.11 per-

3. https://report.ipcc.ch/ar6/wg1/IPCC_AR6_WGI_FullReport.pdf

cent of the total world population, while it covers only about 3.67 percent of the world's land area. Hence, it is quite predictable that such a high population growth would demand more consumer durables, and thereby, it would result in unsustainable use and even depletion of natural resources in near future (World Development Indicators).

In view of the mentioned facts, the present study attempts to establish the relationship between economic growth and environmental degradation in terms of air pollution, considering secondary data of the Member States for the trade bloc – SAARC. Long back, Simon Kuznets also tried to establish such relationship which is popularly known as Environmental Kuznets Curve (EKC) hypothesis. The EKC curve is an inverted U-shaped curve which proposes that developing nations though face economic growth-clean environment trade-off in their initial phases of development; developed nations do not face so. Later on, EKC hypothesis was challenged by many researchers. But, the origin of environmentally sustainable growth or green growth is inserted in this theory. Section 2, of this study represents review of literature and the specific objectives of the study, which is followed by the section of methodology. Empirical findings and related discussions are made in section 4, and conclusions of the study are in section 5.

II. Review of Literature and Objectives of the Study

Numerous literatures are there which show the association of economic growth and environmental degradation. In a national level study, to analyze the possible effects of Spanish CO2 emissions; not only from economic growth but also from changes in pollutant energy consumption, Balaguer and Cantavella (2015) considered real oil price as an indicator of pollutant energy consumption. The dynamic relationships among CO2 emissions, economic growth and oil prices were built through an Autoregressive Distributed Lag Model (ARDL) model which revealed that changes in real oil prices were relevant to explain the evolution of CO2 emissions. Similarly, in the study by Sinha and Shahbaz (2017), the main focus was on analyzing the possible impacts of renewable energy generation in India on CO2 emissions for the period 1971-2015. The study found renewable energy to have significant negative impacts on CO2 emissions. The income generation process was found gradually shifting their source from fossil fuel based energy consumption to clean energy consumption, and therefore, the long-run income elasticity of CO2 emissions was turned out to be lower compared to short-run income elasticity of CO2 emissions. The study also found the evidence of inverted U-shaped EKC for India, through a time series analysis.

Hanif et al. (2019), under a panel framework during 1990-2013, and using an ARDL model, found that consumption of fossil fuels expanded economic growth of the 15 developing economies and their contribution to CO2 generation was at a regional level. More-

over, the study claimed carbon emissions at the domestic level got a boost from foreign direct investment (FDI). Renewable energy was supposed to be the cleaner alternative to rampant usage of fossil fuels. Before hand, Al-Mulali and Ozturk (2015) examined the effect of energy prices and other variables on pollution level, and investigated the existence of EKC hypothesis for the 27 advanced economies. The primary objective of the study was to examine the long-run and short-run relationships between CO2 emission, and GDP, electricity consumption from renewable and non-renewable sources, urbanization, trade openness, and energy prices. The second objective was to investigate the causal dynamic relationship between these variables. Panel non-stationary techniques were used to assess some of the relevant economies for the period 1990-2012. The study results demonstrated that CO2 emission, and GDP, renewable energy consumption (RE), non-renewable energy consumption (NR), trade openness (TD), urbanization (UR), and energy prices (PC) were cointegrated. Moreover, the results revealed that CO2 emission increased with GDP, NR, and UR increase; while reduced with RE, TD and PC increase. The inverted U-shaped relationship was confirmed between GDP and CO2 emission, implying the existence of the EKC hypothesis.

The other notable work in similar lines but this time for Southeast Asia (SEA) was done by Tjoek and Wu (2018). The study investigated the relationship between economic development and environmental degradation for the emissions of CO2 and SO2 in SEA, incorporating a pooled data consisting of 10 countries during 2003–2012. The study calculated the income elasticities of CO2 and SO2 emissions for each country to observe the sensitivity of environmental degradation for CO2 and SO2 emissions as an effect of economic development. The results displayed an inverted U-shape EKC for CO2 emissions. However, SO2 decreased at an increasing rate since 2003, though it was expected that SO2 would increase as the SEA economies further develop. In general, CO2 had relatively low-income elasticity, whereas income elasticities of SO2 of each country were all negative, suggesting that SO2 was an inferior good. The study thus led to the notion that the amount of SO2 emissions and the influence of economic development would provide a larger swing in emissions or reduction in atmospheric pollutants in comparison with CO2. Fong et al. (2020), in the first ever spatial econometric assessment of the EKC for SEA, confirmed the existence of an EKC hypothesis by deriving inverted U-shaped curves for the studied pollutants. The study focused on the emissions of three types of air pollutants –NO2, SO2 and fine particulate matter (PM2.5). The research utilized the data from 1993 to 2012, and applied a standard and a spatial EKC models that regress per capita emissions on several socio-economic indicators for nine SEA countries at varying levels of economic development. For the standard EKCs, four models were compared (a) pooled OLS; (b) individual Fixed-Effects (FE); (c) year FE; (d) two-way FE. The

FE estimator was used in the model estimations to account for individual heterogeneity. However, though the EKC hypothesis was supported, most of the countries were still on the upward sloping portion of the inverted U-shaped curve.

On this front, impact of consumption of renewable energy on CO2 emissions was investigated by Koengkan (2018), in five MERCOSUR's countries from 1980 to 2014. Using ARDL in the form of Unrestricted Error Correction Model (UECM), the study showed that all MERCOSUR countries were highly dependent on fossil fuels and that the consumption of renewable energy was able to reduce the CO2emissions in the short-run and long-run. Also, the study revealed that economic growth of these countries increased the CO2 emissions. The impact of renewable energy consumption though reducing the environmental degradation in the MERCOSUR countries, but was of small amount. In an another study conducted over the sample of MITKA (Mexico, Indonesia, the Republic of Korea, Turkey, Australia) countries from 1982 to 2011, Bakirtas and Cetin (2017) using a Panel Vector Auto Regressive (PVAR) model, examined the validity of EKC and Pollution Haven Hypotheses (PHH). In their research, some orthogonalized impulse-response functions were derived from PVAR estimations. The empirical findings revealed that the EKC hypothesis was rejected by the MIKTA sample. However, PVAR estimations showed the Granger causality for income level, FDI inward, and energy consumption with CO2 emissions. Results reflected that the response of CO2 emissions for a shock in FDI was positive. Income level was the main factor that explained the variation of CO2 emissions; 21 percent of entire variance. Further, energy consumption over the same period explained up to 13 percent of the variation of CO2 emissions. The findings asserted the detrimental effects of energy consumption and CO2 emissions on environmental quality for the MIKTA countries. The PHH was confirmed by the MIKTA sample.

Again, to establish the linkage between the emissions related to the consumption of products and services and their impact on sustainable development goals (SDGs), especially in five countries in the SAARC region, a Consumption-based CO2 emission (CBE) accounting method was used by Rahman et al. (2022). The study investigated the long-term effects of the CBE and SDG variables, between 1972 and 2015, using a Fully Modified Ordinary Least Square (FMOLS) model, and then tested for the causality. By establishing a long-term relationship between the CBEs and SDGs in the SAARC region, the study revealed that only the combustible renewable and waste (CRW) variable was significant for most of these countries. Moreover, the results illustrated that total imported emissions were more in India and Bangladesh in comparison with others. The household consumption contributed more than 62.39 percent of CO2 emissions overall in the SAARC region. India had the highest household emissions; up to 37.27 percent, and Nepal contributed the lowest; up to 0.61 percent. Latif et al. (2021), made a homogenous analysis to examine the association of the variables like carbon emissions (CE) and

dynamic causal interaction of CE with FDI, economic growth (EG), and other economic factors for the individual countries and SAARC as a group during 1990-2016. They used panel cointegration test, Dynamic Ordinary Least Squares (DOLS) and Vector Error Correction Model (VECM) in their study. The study confirmed the presence of unidirectional causal association of EG with CE. It also confirmed the causality of urban population and energy consumption with CE. Also, domestic capital and inflation rate confirmed the causal association with EG. Finally, domestic capital revealed causality with FDI. In a similar line, an annual time series analysis was done for the four SAARC nations by Azam and Khan (2015). The study was to empirically evaluate the impacts of urbanization along with other variables such as arable land, energy use and total population on environmental degradation measured by CO2 emissions, over the period 1982–2013. The method of Least Squares was employed and the impact of urbanization growth on environment was found blended. This relationship was significantly negative for Bangladesh and India, whereas it was significantly positive in case of Sri Lanka and insignificantly positive for Pakistan. Uddin and Wadud (2014), in their study to examine the causal relationship between carbon emissions and economic growth in seven SAARC countries, used a time series data for the period from 1972 to 2012, and applied VECM to exhibit cointegration between environmental pollution and economic growth. It was found that the estimated coefficients of emissions had positive and significant impacts on GDP in the long-run.

Though various research works have been done in establishing the relationship between economic growth and environmental degradation, the present study attempts to explore the association of CO2 emissions per capita and GDP per capita, for the eight countries – Bangladesh, Bhutan, India, Afghanistan, Maldives, Nepal, Pakistan and Sri Lanka under the trade bloc SAARC, by employing a regression method in a panel framework. A very few works have been done on SAARC countries as mentioned and no such work has been done yet which shows the relative position of India in SAARC over the aspect of economic growth and environmental degradation for the last decade, up till COVID 19 pandemic outbreak. Moreover, this study discusses India's commitments and initiatives, being a member of Conference of Parties (COP) which is the apex decision-making body of the United Nations Climate Change Framework Convention (UNFCCC), in making a clean and green world. Hence, this study is blended with empirics and policy review, which might help India to formulate better policies to achieve green growth truly in near future.

III. Methodology

This section discusses data sources and empirical method used in the study. Also, this section highlights different trade agreements of India and describes the SAARC nations in brief.

III. 1 Data

The study mainly uses the data of World Bank to examine the association of per capita CO2 emissions and per capita GDP for different SAARC countries. The outcome variable in the model is CO2 emissions per capita, measured in metric tons and the predictor variable is GDP per capita, measured in constant 2015 price; US$. The annual data from 2010 to 2019 are collected for all the SAARC countries from the World Bank database (World Development Indicators), based upon the latest availability of data. The other secondary data which have been collected from different reliable websites to support the present study results are also cited.

III. 2 India in Different Trade Agreements

India is one of the fastest growing nations; which actively engages in several regional and bilateral trade negotiations. Trade associations has aided India in diversifying and expanding its trade while safeguarding the availability of raw materials and capital goods required to spur its domestic manufacturing. Before the empirical build-up of the study, a brief discussion has been made on India in different trade agreements and about the goals of SAARC countries. India now shares preferential market access and economic cooperation through trade agreements with multitude of countries.

Some of the leading Free Trade Agreements (FTAs) are Comprehensive Economic Partnership Agreement (CEPA) between India and UAE; Economic Cooperation and Trade Agreement (ECTA) between India and Australia; Comprehensive Economic Cooperation Partnership Agreement (CECPA) between India and Mauritius; India ASEAN Trade in Goods Agreement (India ASEAN TIG), where the Member Nations are Brunei, Burma, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam, and India; South Asia Free Trade Agreement (SAFTA), where the Member States are India, Pakistan, Nepal, Sri Lanka, Bangladesh, Bhutan, and the Maldives; Indo Sri Lanka Free Trade Agreement (ISLFTA) between India and Sri Lanka; India Singapore Comprehensive Economic Cooperation Agreement (ISCECA) between Singapore and India; Japan India Comprehensive Economic Partnership Agreements (JICEPA) between Japan and India; India Korea Comprehensive Economic Partnership Agreements (IKCEPA) between South Korea and India.

The common Preferential Trade Agreements (PTAs) are Global System of Trade Preferences (GSTP), where the Member Nations are Algeria, Argentina, Bangladesh, Benin, Bolivia, Brazil, Burma Cameroon, Chile, Colombia, Cuba, Republic of Korea, Ecuador, Egypt, Ghana, Guinea, Guyana, India, Indonesia, Iran, Iraq, Libya, Malaysia, Mexico, Morocco, Mozambique, Nicaragua, Nigeria, Pakistan, Peru, Philippines, Republic of Korea, Singapore, Sri Lanka, Sudan, Thailand, Trinidad and Tobago, Tunisia, Tanzania, Ven-

ezuela, Vietnam and Zimbabwe; Asia Pacific Trade Agreement (APTA), where the member nations are Bangladesh, China, India, Lao PDR, Republic of Korea and Sri Lanka.

III.3 About the SAARC Countries

SAARC is an intergovernmental organization comprised of eight South Asian nations. Maldives is the only upper middle-income nation out of the eight nations, while all other countries come to the lower middle-income category (World Bank income statistic, 2019). In the year 2006, it launched the South Asian Free Trade Area (SAFTA) with the interest in ensuring regional political integration and promotion of economic development. Even SAARC Member States have issued several directives along with the establishment of institutions like SAARC Disaster Management Centre (SDMC) and SAARC Energy Centre (SEC)[4] to strengthen the regional ties in line with sustainable development since 1987.

In our study, under the framework of panel data analysis, the eight SAARC countries have been considered as eight Groups and are listed in Table 1, with the average ratios of their CO2 emissions per capita and GDP per capita.

Table 1: Profile of the SAARC Member Countries during 2010-2019

Group	Country	Ratio of CO2 Emissions and GDP in Per Capita Terms
1	Bangadesh	0.000358313
2	Bhutan	0.000604416
3	India	0.001037555
4	Afghanistan	0.000327327
5	Maldives	0.000338534
6	Nepal	0.000356306
7	Pakistan	0.000650584
8	Sri Lanka	0.000226508

Source: Prepared by authors

4. Collected from the website of SAARC (in reference)

III.4 Empirical Methods Used

After classification of eight Groups (eight Member States in SAARC) under the panel framework, a linear regression model was used to test the statistical significance of per capita GDP on per capita CO2 emissions. The panel is balanced in our study; each cross-sectional unit has the same number of time series observations. The effects in panel may be fixed or random. In the Constant Coefficient (CC) Model, all coefficients (intercept and slope) remain unchanged across cross-sectional units and over time. Hence, it applies Ordinary Least Square to a pooled data set to obtain the estimates of unknown parameters in the model. In contrast to CC model, the Fixed-Effects (FE) model assumes that the individual groups have different intercepts and Random-Effects (RE) model assumes that and individual groups have different disturbances in the regression equation. It is quite unrealistic to assume that the countries are homogeneous for all cross-sectional units. Hence, to put up the characteristic of heterogeneity, FE and RE models were applied, and Hausman test was performed to select the appropriate model[5]. The Hausman test basically tests whether the unique errors (Ui) are correlated with the regressors, the null hypothesis is they are not. Hence in Hausman test, the null hypothesis is that the preferred model is RE versus the alternative the FE. The Hausman test result (Prob>chi2 = 0.0000) clearly indicated the significance of using FE model in our study.

Model Description

The estimated FE model in panel framework is as follows:

Where,

$$\boldsymbol{CO2\ emissions\ per\ capita_{it} = \alpha_i + \beta\ GDP\ per\ capita_{it} + U_{it}}$$

CO2 emissions per capita$_{it}$ is the outcome variable

i indicates the SAARC countries, i = 1, 2, ..., 8

t indicates year, t = 2010, 2011, ..., 2019

GDP emissions per capita$_{it}$ is the predictor variable with β as the coefficient

α_i (i = 1,.....,7) is the unknown intercept for each country

U_{it} is the random error term

Since the number of cross-sectional units is 8 and number of years is 10, so all together the study has 80 observations on each variable. U_{it} is independently, identically and

5. Hausman test result is in appendix A1

normally distributed. *GDP per capita* is assumed to be non-stochastic and uncorrelated with U_{it}.

Subsequently, a few tests have been performed for the model validity and finally, a graphical representation has been made to show India's position among the SAARC nations in ensuring green growth.

IV. Findings of the Study and Related Discussions

This section at first exhibits the relationship between economic growth and air pollution for the SAARC countries, empirically. In doing so, the study employs a linear regression model under a panel data structure. The study considers heteroskedasticity-robust standard errors under FE model (to control heteroskedasticity), and performs Pesaran CD test (to deal with contemporaneous correlation). Then a comparative analysis of the SAARC countries has been done and India's commitments are highlighted towards ensuring green growth.

IV.1 Relationship between Economic Growth and Environmental Degradation

The estimation results of the FE model (with controlling heteroskedasticity) is presented in Table 2 which shows the association of GDP and CO2 emissions in per capita terms.

Table 2: Estimation Results of the FE Model

Fixed-effects (within) regression — Number of obs = 80; Number of groups = 8

R-sq: within = 0.7284; between = 0.7868; overall = 0.7752

Obs per group: min = 10; avg = 10.0; max = 10

F(1,7) = 18.98; Prob > F = 0.0033

corr(u_i, Xb) = -0.8680

CO2 emissions per capita	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDP per capita	0.0005828	0.0001338	4.36	0.003	0.0002665	0.0008992
_cons	-0.4370717	0.3629159	-1.20	0.268	-1.295231	0.4210882

sigma_u	0.95785004	
sigma_e	0.12127944	
rho	0.98422127	(fraction of variance due to u_i)

Source: Estimated by authors

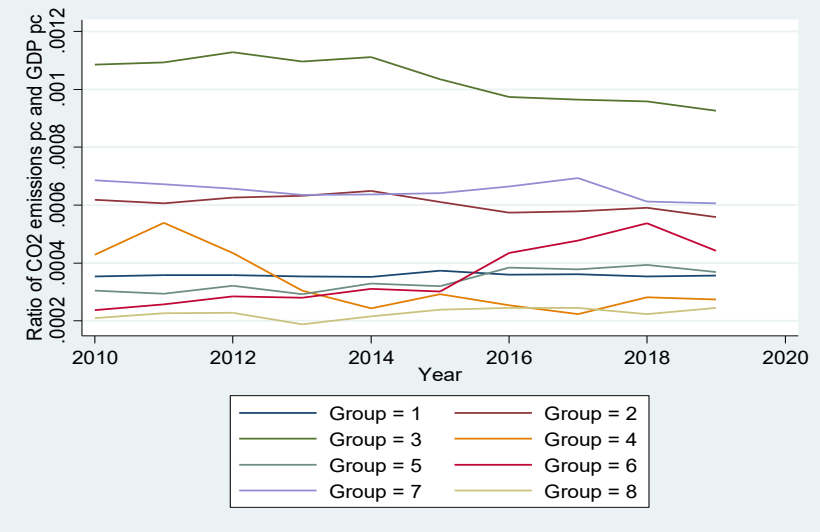
In Table 2, the R-sq values within (0.7284), between (0.7868) and overall (0.7752) show the amount of variations of CO2 emissions per capita explained by GDP per capita. F-test shows whether all the coefficients in the model are different than zero. Prob > F = 0.0033 is less than 0.05, which clearly indicates that the model is acceptable. Further, the estimation result shows that there is a positive association between CO2 emissions per capita and GDP per capita, and the probability of t-value shows that the GDP per capita has a significant (for a 99 percent confidence) influence on CO2 emissions per capita. The rho value (0.98422127, which shows interclass correlation) indicates that 98 percent of the variance is due to the differences across countries.

Subsequently, Pesaran CD test is done to examine whether the residuals are correlated across regions since the cross-sectional dependence may lead to bias in test results. The null hypothesis in the Pesaran CD test is that residuals are not correlated. Our study denies the presence of contemporaneous correlation.[6]

IV. 2. Comparative Analysis of the SAARC Countries towards Pollution-Free Environment

In connection with ensuring green growth, the trends of the ratios of CO2 emissions and GDP (in per capita terms) for the eight SAARC countries (denoted as Group in Table 1) are represented in Figure 1.

Figure 1: Trends of the Ratios of CO2 Emissions Per Capita and GDP Per Capita



Source: Prepared by authors

6. See appendix A2

Figure 1 reveals that India leads the Groups, though 2014 onwards a gradual decline of this trend has been perceived for India, indicating a sterntake towards ensuring clean environment. United Nations Environment Programme (UNEP) in its Emission Gap Report (2014) had recognized India as one of the countries on course to achieving its voluntary goal of reducing emissions intensity of its GDP by 20–25 percent, over 2005 levels, by 2020 (INDC, 2016).[7] Pakistan and Bhutan are in the middle position in Figure 1, but 2014 onwards Bhutan's stand in achieving pollution-free environment is very prominent. Bhutan uses its widespread river resources to produce a huge amount of renewable hydro energy, boosting the nation to carbon negative status. Among the other SAARC countries, though air pollution was high for Afghanistan in the initial years, a more or less declining trend has been perceived 2011 onwards. The falling CO2 emissions (metric tons per capita) in Afghanistan is not owing to the declining GDP growth figures, 12.8 in 2012 while 3.9 in 2019 (World development Indicators).[8] In Afghanistan, energy is relint especiaally on hydro power and energy is also imported from neighbouring countries. On the contrary, Nepal shows a continuously increasing trend with a major hike from 2015 and up till 2018, indicating its awful performance towards ensuring a clean environment. This was mainly due to increasing import of petrolium from India for the transportation sector. Nepal had registered a positive trend in CO2 emissions (metric tons per capita) since 2006 (World Development Indicators), which was quite a contradictory movement for Nepal, since in its first Nationally Determined Contribution (NDC), the country had pledged to reduce fossil fuel dependency by 50 percent by 2050 (Nepal NDC, 2016).[9] Bangladesh, Maldives and Sri Lanka are in the bottom lines in Figure 1, with Sri Lanka occupying the best position in attaining green growth among the SAARC countries. Apart from Colombo and its surrounding neighbourhoods, Sri Lanka is eco-rich. In Maldives, though in the initial years CO2 emission was less relative to its economic activities, the year 2015 onwards a shift from this aspire has been observed. A rampant usage of vehicles such as car, trucks and motocycles is upsetting the air quality of the island country. Also the idyllic country astonishingly generates 860 metric tonns of waste - majorly plastic on a daily basis; which when burnt in the open generates toxic smoke and increases carbonconcentration.[10]

IV.3 Highlights on India's Commitments

India's commitment on green growth has always remained satisfactory in international forums, especially in the past few years. In 1988, Intergovernmental Panel on Climate Change (IPCC) was set up by the United Nations Environment Programme (UNEP) and

7. https://unfccc.int/sites/default/files/NDC/2022-06/INDIA%20INDC%20TO%20UNFCCC.pdf
8. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=AF
9. https://unfccc.int/sites/default/files/NDC/2022-06/Nepal%20First%20NDC.pdf
10. https://www.unep.org/news-and-stories/story/maldives-gets-out-ahead-air-pollution

the World Meteorological Organization (WMO). The United Nations Framework Convention on Climate Change (UNFCCC) came to the origin in 1992, to mitigate global climate change. There upon the Conference of Parties (COP) acts as the apex decision-making body of the UNFCCC. The first conference (COP 1) was held in 1995 in Berlin and the latest being in 2022, the COP 27 at Egypt. The primary and ultimate objective of all the agreements under the UNFCCC is to stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous human interference with the climate system, essentially within a time frame which would allow ecosystems to adapt naturally, and thereby enabling sustainable development.

Kyoto Protocol was the first legally binding climate treaty adopted in 1997 (COP 3), but came into force in 2005. It required developed countries to trim down emissions by an average of 5 percent below 1990 levels, and set up a system to monitor progress of the nations. Though India was exempted from this legally binding commitment, India raised voice against the differentiation of developed and developing nations connected to the burden of responsibility for climate action. Since then a lot has been aimed and discussed in the past two decades. However, the stand of India as a crucial and influential member of the assembly has achieved dominance only recently. The COP 21, commonly known as the Paris Agreement, was a breakthrough in the course of cleaner environment drive, which held in Paris in 2015. The Paris Agreement was ratified by India on 2nd October 2016.

In India, where 80 percent of the energy needs of the country are met by three fuels - coal, oil and solid biomass; coal remains the largest single fuel in the energy mix (EnviStats India, 2022).[11] The first NDC submitted by India in 2015 comprised of eight goals; three of these has quantitative targets up to 2030 namely, cumulative electric power installed capacity from non-fossil sources to reach by 40 percent; reduction of emissions intensity of GDP by 33 to 35 percent compared to 2005 levels and creation of additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover. At COP 26 (in 2021),[12] India updated its Intended NDC as a major step towards achieving long-term goal of reaching net-zero by 2070. The world five nectar elements 'five elixirs' was announced by Union Cabinet chaired by the Prime Minister, Shri Narendra Modi. As per the updated NDC, to achieve net-zero by 2070, India now stands committed to reduce carbon emissions intensity of its GDP by 45 percent by 2030, from 2005 level; achieve to 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030. Additionally, India committed to increase its non-fossil capacity to 500 gigawatt (GW) by 2030 along with the aim to reduce at least one billion tonnes of

11. http://164.100.161.63/sites/default/files/reports_and_publication/statistical_publication/EnviStats/Envistats22v2/Chap2_Energy_accounts.pdf
12. https://pib.gov.in/PressReleasePage.aspx?PRID=1795071

total projected emissions between the present date and 2030. In terms of climate finance, the Prime Minister strongly urged the developed countries to enable low-cost technology transfer raise to 1 trillion US$.[13] NDC also stressed on attaining sustainable lifestyles and climate justice to protect the poor and vulnerable group from adverse impacts of climate change. The updated NDC reads "To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation, including through a mass movement for 'LIFE'– 'Lifestyle for Environment' as a key to combating climate change". Simultaneously, India has aimed to build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D (India INDC, 2022).[14] Thus, the updated NDC reaffirms India's commitment towards green growth.

As a part of Climate Finance Policies, India has now aimed at setting up of INR 3,500 million (USD 55.6 million) of National Adaptation Fund, along with reduction in subsidies on fossil fuels including diesel, kerosene and domestic LPG. Coal cess is quadrupled from INR 50 to INR 200 per tonne to help finance clean energy projects and Ganga rejuvenation. India also proposed the introduction of Tax Free Infrastructure Bonds for funding to renewable energy projects (India INDC, 2016). As per Press Information Bureau (PIB, 2022),[15] the net-zero target by 2030 by Indian Railways alone would lead to a reduction of emissions by 60 million tonnes annually. Similarly, India's massive LED bulb campaign is reducing emissions by 40 million tonnes annually. Also, India has planned for installation of 450 GW renewable energy capacities for the country. India has thought upon the uses of renewable energy, green hydrogen, emobility and ethanol blended fuels as an alternative energy source as well.

V. Conclusions

The objective of the study was to examine the relationship between economic growth and environmental degradation across the SAARC countries, and also to assess India's stand in this front. Therefore, the study considered a FE model under the panel framework to show the connection between GDP per capita and CO2 emissions per capita. The estimation results reveal that GDP per capita has a significant influence on CO2 emissions per capita. Hence, economic growth considerably contributed to air pollution for the SAARC countries collectively during 2010-2019. SAARC as a trade bloc put impor-

13. https://weather.com/en-IN/india/climate-change/news/2021-11-02-five-big-commitments-made-by-pm-modi-at-cop26

14. https://unfccc.int/sites/default/files/NDC/2022-08/India%20Updated%20First%20Nationally%20Determined%20Contrib.pdf

15. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1847812#:~:text=India%20at%20the%2026th%20session%20of%20the%20Conference,five%20nectar%20elements%20%28Panchamrit%29%20of%20India%E2%80%99s%20climate%20action

tance on their short-term goals ignoring the fact of environmentally sustainable growth. However, India and Bhutan are exception in this regard. In both these countries, a drive towards clean environment has been seen from the year 2014. India's commitments on green growth in international forums and actions for achieving the target have always remained satisfactory. Although the study results seem to have great policy implications for the SAARC nations, the expansion of time horizon or incorporation of other trade blocs might enhance better understanding of the world environment.

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Appendices

A1: Estimates of Hausman Test

	---- Coefficients ----			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fe	re	Difference	S.E.
GDP per capita	.0005828	.0004974	.0000855	.0000185

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg
Test: Ho: difference in coefficients not systematic
chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 21.34
Prob>chi2 = 0.0000

Source: Estimated by authors

A2: Results of Pesaran's Test

Pesaran's test of cross sectional independence = -0.191, Pr = 0.8482
Average absolute value of the off-diagonal elements = 0.460

Source: Estimated by authors

Changing Levels of Living in Rural India: An Inter-State Analysis

Dr. Pamela Paul[1] & Dr. Prankrishna Pal[2]

Abstract:

In this study we make an attempt to examine the standard of living in terms of accessibility of basic necessary facilities such as dwelling types, uses of bathroom and latrine, availability and mode of drinking water and affordability in terms of lighting and cooking energy n rural peoples in India and its constituent states during the period of 1993/94 – 2018. NSSO data of different rounds for 22 major states are used for this analysis for the rural area. The study reveals that at the all-India level, the share of pucca house has increased by 47.3% in rural area. Not only that the share of households using the bathroom and latrine has been rising in the rural India and its constituent states during the period under study. Also, the share of households using 'no bathroom' and 'no latrine' has declined in rural area during the period under study. In case of drinking water facility, almost 54% households in rural areas have used pipe water at all India level in 2018. Similarly, the percentage of LPG and electricity users has also risen from in rural area. Under the SDGs India government has implemented various programmes to promote inclusive and sustainable development with full employment level.

Key Word: Sustainable Development,Difference in states, Level of Livings

JEL Classification: C1, C3, D1, O18

I. Introduction

In any economy like India the level of living of a household is judged by the of consumption expenditure, the changing consumption pattern and the quality of consumption goods and other basic amenities like sanitation, dwelling types, drinking water etc. For any economy rural development implies both the economic improvement of peoples as well as greater social transformation of the society. In order to provide the rural people with better prospects for economic development, increased participation of people in the rural development programmes, decentralization of planning, better enforcement of land reforms and greater access to credit are needed. Alarge section of the population has been

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facing a transition from deficiency to the adequate amount of food and clothing with the economic reform in 1990s, especially in rural area.Therefore, in this paper we are to examine the living standard of the rural household in terms of the accessibility of some basic necessary facilities including availability and sustainable management of water and sanitation for all, adequate amount of drinking water supply and access to affordable, reliable and sustainable modern energy for all (6^{th} and 7^{th} goals under 17 goals of SDGs) respectively under the lights of implementation of Sustainable Development Goals (SDGs) (NITI Ayog Report 2017).

The SDGs has come into effect on 1 January, 2016 as a part of the Millennium Development Goals (MDGs) adopted by 193 Member States at the 70th Session of the United Nation General Assembly Summit in September 2015 as a part of their agenda for Sustainable Development (Ref. Voluntary National Review Report on Implementation of Sustainable Development Goals, 2017).

Under the SDGs India government has implemented various programmed to ensure the availability of sufficient water and sanitation facility, affordable and reliable access of electricity to all, safe, affordable, accessible and sustainable transport systems for all, improving road, expanding public transport etc.(source: NITI Aayog, August 2018).

Literatures on spending diversification on commodities are very few both national and international levels. **Chaudhuri and Gupta (2009)** presented a profile of living standard, poverty and inequality for all the districts of 20 major states of India. Using NSS data for the period of 2004-05 they tried to examined the degree of variation within and across the states. The result shown that there was a strong rural-urban difference at the district level but the pattern had not much predictable. But the range of disparity was significantly higher at the sub-states level within states rather than between the states. However**, Bhat (2015)** studied the present status of India and analyzed the various programmed taken by the government towards the sustainability. He used to study different programmed and policy implemented by the government in different sectors in India. The study revealed that India achieved a positive growth rate of 8.2% among the six South-East Asian countries in 2009. Similarly, **Amir and Ghufran (2015)** tried to show the impact of changing lifestyle on consumption pattern in relation to the demographic variables and socio-economic characteristics. The challenge of sustainable consumption had studied by **Kumar et. al (2011)** and concludedthat for the sustainability government, business, civil society and consumers all were responsible equally. Based on the data of UK households, **Blundelland Preston (1996),** tried to find out the reason behind difference between the income-base and consumption-base measures of living standard mainly in terms of inequality and poverty over the period of 1970-92 years. In the paper by **P.K. Pal and Paul (2019-20)** an attempt had made to find out the changing monthly per capita consumption expenditure pattern and the degree of diversification of the spending pattern

both in the rural and urban India and its states during 1983 – 2011/12. The study revealed that initially the degree of diversification is quite higher in non-food basket compared to food one but over the time consumers have highly diversified food expenditure in all the states as well as in India.

II. Objectives of the Study

As a developing country, it must be a challenge in India to instigate the Sustainable Development Goals. In this regard, we are to attempt

- To analyse the change in living standard of the rural household in India and its constituent states during the period of 1993/94 – 2018 in terms of the basic needs such as drinking water, electrification, sanitation, mode of cooking and dwelling types of the households etc.
- To analyse the association of these needs with the monthly per capita income (MPCE) of the households during the period of 1993/94 - 2018.

III.Data &Methodology

For this study we have used the NSSO data (50th round (July 1993-June 1994), 56th round (July 2001- June 2002), 68th round (July 2011- June 2012), 69th round (July – December 2012) and 76th round (July- December 2018)) on MPCE and living standard of the households on the above mentioned services with the rural India as well as state-wise. Here 2011/12 is considered as the base year and using Consumer price index (CPI), i.e., CPI of agricultural labour (CPI-AL) for the rural area MPCE current price data have been converted to the real term.

Now to study the association between the monthly per capita consumption expenditure (MPCE) and these six essential basic services, a model may be used. The functional form of the model can be written as:

$$\mathbf{MPCE = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + U,}$$

where, X_1 = Katcha House, X_2 = Tap Water, X_3 = No Bathroom, X_4 = No Latrine, X_5= LPG and X_6 = Electricity. β_0 is the intercept term, β_i, i= 1, 2,…,6, are the co-efficient or parameters attached to these explanatory variables and U is the stochastic or error term in the model to capture the impact of other variables that are not included in the model.

To analyse the impact of several explanatory variables on MPCE, multivariate regression model is the most suitable one. But in estimation the problem of multicollinearity (higher correlation between two or more explanatory variables) will arise and there is no suitable remedial option. All the explanatory variables are related. So, we use the Principal Component Analysis (PCA).

The input for PCA is a data matrix X (a random vector), in which the columns represent different explanatory variables and the rows correspond to values measured on the variables. The maximal number of components in PCA is equal to the number of variables. Therefore, maximum of six components can be extracted using the data of the study. The principal components are the linear combinations of the original variables, i.e., a weighted sum of the input variables:

$$PC1 = w_{1,1} X_1 + w_{1,2} X_2 + w_{1,3} X_3 + w_{1,4} X_4 + w_{1,5} X_5 + w_{1,6} X_6 .$$

$$PC2 = w_{2,1} X_1 + w_{2,2} X_2 + w_{2,3} X_3 + w_{2,4} X_4 + w_{2,5} X_5 + w_{2,6} X_6 .$$

$$\text{Similarly, } PC6 = w_{6,1} X_1 + w_{6,2} X_2 + w_{6,3} X_3 + w_{6,4} X_4 + w_{6,5} X_5 + w_{6,6} X_6 .$$

Where $w_{i,j}$ is a weighting coefficients of i^{th} row and j^{th} column. The first principal component (PC1) points in the direction of the largest variance in the data set. PC2 is orthogonal to PC1 and shows the direction of the second greatest variance, and so forth, until the maximal number of components is reached (Ref. Ming-ming and Jing-lian, 2015). So, the main step of PCA is the computation of these weights.

IV. Estimates & Results

Before analysis the standard of living of the rural households here we are first considering the MPCE of rural households (at the base year price 2011-12) of India and its constituent states as well as some of the daily-life necessary facilities namely dwelling types, mode of drinking water supply, sanitation habits in terms of using bathroom and latrine, availability of electricity supply and source of cooking energy used by the household in India and its constituent states during the period of 1993/94 – 2018 in the rural area.

MPCE of Indian States

As the Indians try to climb the growth ladder the consumer's behaviours are varying over the years across the states by a whole range of factors including the availability and accessibility of the product, test and preferences, purchasing power and more by urbanisation and globalisation. This scenario would be clearer from the Table 1 which shows the monthly per capita expenditure of the households in rural India and its constituent statesduring 1993/94-2011/12. From the table its very clear that over time the MPCE of rural households are increasing in Indian and its constituent states.

Structure of Dwelling Types of the Household in Rural-India

In this study the structure of the dwelling types has classified into three distinct categories based on the type of materials used in construction of the house of a household such as pucca house (made of burnt bricks, stone, cement, concrete, cement - plastered reeds etc.), katcha house (built up with mud, bamboo, grass, leaves, reeds, unburnt bricks etc.) and semi-pucca house (made of either the roof or the walls, but not both) (Ref. NSSO

rounds). Table 2 has shown the structural change of the house in rural India and its constituent states during the period of 1993/94 - 2018.

All India Level:

Our estimates (Table 2) reveals that in rural India the proportion of the households living in the pucca house has increased continuously from 29.3% in 1993-94 to 38.5% in 2001-02, to 55.4% in 2008-09, to 65.8% in 2011-12 and 76.7% in 2018. This shows that the share of households using of pucca house has increased by almost 47.6% during the period of 1993/94 – 2018. In case of semi-pucca house the share has decreased from 38% in 1993-94 to 31.5% in 2008-09 and to 17.4% in 2018 and the share of katcha structure has declined from 32.7% in 1993-94 to 17% in 2008-09, to 9.6% in 2011-12 and 5.9% in 2018.

State Level Analysis:

A wide fluctuation of structure of the dwelling units have also observed in the constituent states in rural India as the share of semi-pucca and katcha house have continuously declinedduring 1993/94 - 2018 though the percentage of the declining share has varied among the states. In 1993-94, the maximum pucca house has shown in Haryana (72.5%) followed by Punjab, Kerala, Rajasthan, Himachal Pradesh, Gujarat, Tamil Nadu and so on. In case of semi-pucca the highest share has observed in Madhya Pradesh (76.4%) followed by Karnataka, Maharashtra, Sikkim, Himachal Pradesh, Bihar etc. Whereas in case of katcha house the maximum share has shown in Tripura (81.9%). In 2000-01, the maximum share of pucca housing structure has shown in Punjab (77.3%) followed by Kerala, Haryana, Andhra Pradesh, Himachal Pradesh etc. and the highest share of semi-pucca house has observed in Chhattisgarh (64.1%). The proportion of katcha house has again maximum in Tripura (87.8%) and it is almost 6% higher compared to the share in 1993-94. In 2008-09, the highest share of pucca house has shown in Haryana (92.9%) and the maximum share of semi-pucca and katcha house have shown in Tripura (74.6%) and in Arunachal Pradesh (53.8%) respectively. From 2011-12 onwards, though the maximum share of semi-pucca and katcha housing structure have shown in Tripura (79.7% in 2011-12 and 68.4% in 2018) and in Arunachal Pradesh (54.4% in 2011-12 and 35.3% in 2018) respectively but in case of pucca house the highest share has shown in Punjab (96.2% in 2011-12 and 97.9% in 2018).

Accessibility of Sanitation Facilities in the House in Rural-India

With the continuation of the previous section (structure of the dwellings) here we are focused on the sanitation facilityof the household which is not only important in our daily lives, but also crucial for our sustainable, inclusive healthy development of individuals and society. Here the availability of the bathroom and latrine facilities have differ-

entiating in terms of households 'exclusively use', households' commonly use' (sharing same latrine with one or more households in the building) and 'public/commonly use' (sharing latrine in the locality) and households have 'no access' to bathroom or latrine (Ref. NSSO rounds).

A) Bathroom Facilities:

All India Level Analysis:

Table 3 shows the estimates of the accessibility of the bathroom facilities by the households in the rural India and its constituent states during the period of 1993/94 - 2018. At the all-India level, the proportion of 'exclusively using bathroom' by the household has gradually increased from 5.4% in 1993-94 to 12.5% in 2008-09, to 15.5% in 2011-12 and to 50.3% in 2018. As a result, the share of 'not using bathroom' has declined by 87% in 1993-94 to 64.4% in 2008-09 and to 43.6% in 2018. Therefore, over these 25 years the share of the households has progressively shifted from 'not using bathroom' to 'using bathroom' in the rural area. Simultaneously, the share of commonly using bathroom has firstly increased from 7.5% in 1993-94 to 23.1% in 2008-09 and then declined to 6.1% in 2018 as the share partly occupied by the public bathroom facilities in 2018.

State Level Analysis:

In the state level, in 1993-94, the highest share of 'exclusive using bathroom' has shown in Karnataka (29.4%) followed by Himachal Pradesh, Kerala, Gujarat and so on whereas the proportion of 'households commonly using bathroom' has highest in Kerala (29.7%) followed by Assam, Sikkim etc. The highest share of 'not using bathroom' has marked in Orissa (98.5%) followed by Bihar, Arunachal Pradesh, Madhya Pradesh, Uttar Pradesh, West Bengal, Jharkhand and lower in Tripura which has the share of 'no bathroom' above 90% in rural area. In 2008-09, the share of 'exclusive using bathroom' has increased and the highest share has shown in Jammu & Kashmir (45.4%) followed by Karnataka, Kerala, Himachal Pradesh, Haryana and so on. At the same time the share of 'commonly using bathroom' has also been increasing and the highest share has shown in Assam (64.5%). But the share of 'no bathroom' facilities has still very significant and the highest share has shown in Tripura (93.5%) followed by Orissa, Bihar, Chhattisgarh, Uttar Pradesh and Jharkhand. From 2011-12 and onwards the highest share of households 'exclusive using bathroom' has marked in Kerala (46.8% in 2011-12 and 95.6% in 2018). Though the highest share of 'commonly using bathroom' has shown in Haryana (59.8%) in 2011-12 then in Arunachal Pradesh (18.6%) in 2018 but some other states namely, Punjab, Assam, Andhra Pradesh, Himachal Pradesh, Kerala etc also have a significant share in this segment. However, from 2011-12 and onwards the share of 'no bathroom' using households has declined but still it is quite significant and the highest share has shown in

Jharkhand (89.4%) in 2011-12. But over time this share has declined sharply and it is just 12.2 % in 2018 in Jharkhand.

B) Latrine Facilities:

All India Level:

Table 4 has shown the estimates of the availability of the latrine facilities of the household in the rural area at the all-India level as well as at the state level during the period under study. At all India level the proportion of households using latrine has increased from 14.1% in 1993-94 to 71.2% in 2018 and obviously the share of households 'not using latrine' has continuously been decreasing from 85.8% in 1993-94 to 28.7% in 2018. That means, over the 25 years the share of households not using the latrine facilities has declined by almost 57% which means this 57% households are now using the latrine in their day life in rural area.

State Level Analysis:

On the other hand, at the state level although the scenario has almost same but there are still some differences between the states. In 1993-94, the highest share of households 'using latrine' has shown in Tripura (93.3%) followed by Assam, Kerala, Arunachal Pradesh, Sikkim and so on. But at the same time, the share of households not using the latrine has quite high and it is highest in Madhya Pradesh (97.3%) followed by Orissa, Jammu & Kashmir, Haryana, Tamil Nadu, Uttar Pradesh, Maharashtra, Rajasthan etc. From 2008-09 and onwards, the highest share of 'exclusive using latrine' has shown in Kerala (89.7% in 2008-09 and 92.7% in 2011-12) followed by Sikkim, Assam, Tripura and so on. The share of households 'commonly using latrine' has continuously increased and the highest share shown in Arunachal Pradesh (19.5%) in 2008-09 and in West Bengal (15.7%) in 2011-12 followed by Sikkim, Punjab, Himachal Pradesh, Haryana, Arunachal Pradesh, Tripura etc. In case of 'public use latrine', the share has initially increased and the highest share has shown in Jammu & Kashmir (6.2%) in 2008-09 but then it has declined and it is very insignificant in all the states except in Tripura (2.8%) in 2011-12. The share of 'no latrine' households have still very significant and the highest share had marked in Orissa (88.2% in 2008-09 and 81.4% 2011-12) followed by Bihar, Madhya Pradesh, Jharkhand, Rajasthan, Chhattisgarh, Uttar Pradesh, Rajasthan etc. In 2018, the highest shareof 'exclusive using latrine' has shown in Maharashtra (97.2%), however, the highest share 'commonly use bathroom' has shown in West Bengal (25.4%). The share of publicly used latrine has very insignificant in all the states except Maharashtra and Tamil Nadu. But still the share of households in 'no latrine' has also significant and the highest share has shown in Orissa (50.7%) followed by Uttar Pradesh, Jharkhand, Bihar, Tamil Nadu and Rajasthan in 2018.

Sources of Drinking Water in the House Rural-India

Likewise, the dwelling type and sanitation (discussed in the previous sections) safe drinking water is also a basic necessity for human survival. In this study the major source of drinking water used by the households has categorised into bottled water (drinking water packaged in bottles or pouches), tap or piped water (into dwelling, to the plot and pubic tap), wells (protected and unprotected) and hand pumps or tube-well and other sources (included tank or pond, spring water, rain water, others types of surface water etc).

All India Level:

At the all-India level (Table 5), majority of the rural households have used the tap or piped water, tube well or hand pump and well as their sources of drinking water during the period under study. In case of using 'tap water' the share of households has increased from 18.6% in 1993-94 to 27.5% in 2001-02, to 31.2% in 2011-12 and to 32.9% in 2018 whereas for tube well & well the proportion has declined from 76.2% in 1993-94 to 69.2% in 2001-02 and to 61.1% in 2018. At the same time though the share of 'bottled water' are very insignificant (1.6% in 2011-12 and 4% in 2018).

State Level Analysis:

At the states level (Table 5), this picture has varied because of geographical differences. In case of 'tap or piped water' using households, the maximum share has shown in Himachal Pradesh (75.6%) in 1993-94 but in 2001-02 this share has increased for all the states and the highest share has shown in Arunachal Pradesh (78.7%) followed by Arunachal Pradesh, Gujarat, Maharashtra, Haryana, Tamil Nadu and so on. From 2011-12 and onwards the highest share has shown in Tamil Nadu (increased from 83.6% in 2011-12 to 893.3% in 2018) followed by Sikkim, Arunachal Pradesh, Gujarat, Maharashtra, Jammu & Kashmir, Himachal Pradesh, Karnataka and so on. On the other hand, in case of 'tube well& well' in 1993-94 the highest share has shown in Bihar (97.4% in 1993-94, 99% in 2001-02and 97.2% in 2018) followed West Bengal, Bihar, Punjab, Uttar Pradesh, Orissa, Madhya Pradesh, Assam and Chhattisgarh. Though the 'tank' and 'spring' might be (included in others) considered a sources of drinking water but the share of users has been declining over time. The states like, Assam, Sikkim, Orissa, Gujarat and Rajasthan have mainly used the 'tank water'. On the other hand, Jammu & Kashmir and Sikkim have shown for the share of 'spring water' users during the period under study in rural area (Ref. NSSO data).

Primary Sources of the Energy for Cooking and Lighting

Likewise, the above discussion now, in this section we have analysed the primary sources of energy used by the households for their regular cooking and lighting. In India

with the huge population and variation, households have used multiple type of energy sources for cooking and lighting which may include kerosene, LPG, soft coke or coal, electricity, fuel wood dung cakes, gobar gas etc. So, in next two sub-section we have analysed the changing pattern of the source of energy used by the household for cooking and lighting in the rural area in India and its constituent states during the period of 1993/94 - 2018.

A) Energy for Cooking

With the increasing income, the rural households have shifted from traditional biomass-based fuels or stove to liquid petroleum gas (LPG) over time. Base on the ground, we have classified the primary sources of fuel into 'firewood andchips', 'LPG' and 'others' (kerosene, dungcake, coke,coal, gobargas, charcoal, electricity) and 'no cookingarrangement'.

All India Level Analysis:

During the period of 1993/94 – 2018, At the all-India level (Table 6), the share of households using ''fire woods and chips' has declined from 78.2% in 1993-94 to 75.4% in 2001-02, to 67.3% in 2011-12 and to 44.5% in 2018. These decreasing shares have occupied by the LPG. During these 25 years the share of LPG user has risen significantly from 1.9% in 1993-94 to 7.2% in 2001-02, to 15% in 2011-12 and to 48.3% in 2018 in the rural area. At the same time the share of households with 'no cooking arrangement' has also declined and in 2018 it is almost insignificant.

State Level Analysis:

At the state level in 1993-94, majority of the states have above 80% share of households using 'fire wood' and 'chips' as their primary source of fuel for cooking and the highest share has shown in Tripura (98.7%) in 1993-94, in Assam (96.4%) in 2001-02 and in Chhattisgarh (93.2%) in 2011-12. During the period of 1993/94 – 2011/12 the states namely Arunachal Pradesh, Tripura, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Orissa, Himachal Pradesh, Rajasthan, Jammu & Kashmir and Sikkim have above 80% share of households who used the 'fire wood and chips.' After 2011-12 the share has gradually declined and in 2018 the maximum share has shown in Orissa (71.4%). Over time the declining share of 'firewood and chips and others energy for cooking have deliberately occupied by 'LPG'. The share of using 'LPG' households is quite low in 1993-94 and the highest share has shown in Punjab (5.1%) followed by Jammu& Kashmir, Gujarat, Kerala, Maharashtra, Tamil Nadu and Haryana. But gradually the share of 'LPG' has increased. The highest share has shown both in Punjab and Kerala (19.9%) in 2001-02, in Tamil Nadu (37.2%) in 2011-12 and in Sikkim (97.8%) in 2018. Interestingly, lower than 25% share of 'LPG' users has shown in three states namely Jharkhand, Orissa

and West Bengal. Lastly, though the share of 'no cooking arrangement' has irrelevant during 1993/94 – 2001/02 but almost 4% households in Maharashtra in 2011-12 and 3.6% households in Orissa in 2018 have marked in this category in the rural area.

B) Energy for Lighting:

In 1990s though electricity has predominantly an urban energy source and majority of the rural households depended on the kerosene for their domestic lighting. But over time most of the households have depended on electrical energy to meet their daily energy demands. So, based on this idea here we are to analyse (Table 7) this changing pattern of lighting source in the rural India and its constituent states during the period of 1993/94 – 2011/12. Here, the major source of energy used by the households for lighting has classified into four categories namely 'kerosene', 'electricity', others (included other oil, gas and candle) and 'no lighting arrangement'.

All India Level:

At the all-India level (Table 7), the share of households using 'kerosene' has gradually declined from 62% in 1993-94 to 48% in 2001-02, to 33.5% in 2008-09 and to 26.8% in 2011-12 and quite obviously this fallen share of 'kerosene' has substituted by the 'electricity'. Therefore, the share of 'electricity' using households has risen from 37% in 1993-94 to 51% in 2001-02, to 65.8% in 2008-09 and to 72.7% in 2011-12. However, the share of households with 'no lighting arrangement' has neglectable in the rural India during the period under study.

State Level Analysis:

In case of state level, we observe that throughout the study period, the highest share of 'kerosene' users has shown in Bihar though the share has apparently declined from 92.8% in 1993-94 to 92.3% in 2001-02, to 80.5% in 2008-09 but still it captured almost 73.9% in 2011-12 in the rural area. The states namely Uttar Pradesh, Assam, Orissa, West Bengal and Jharkhand have a significant share of households using 'kerosene' as one of the primary sources of lighting in their daily routine. On the other hand, during the period of 1993/94 – 2011/12, the highest share of households using 'electricity' has shown in Himachal Pradesh (91.4% in 1993-94, 95.2% in 2001-02, 97.9% in 2008-09 and 98.6% in 2011-12) followed by Punjab, Haryana, Jammu& Kashmir, Gujarat, Andhra Pradesh, Kerala, Karnataka, Tamil Nadu etc. for which the share of 'electricity' users has been rising from almost 50% to 95% during the period under study. In case of 'no lighting arrangement' the share has only significant in Arunachal Pradesh (26.3%) in 1993-94 and then the rural households might be used some alternatives (like firewood) as the share of 'others' has occupied 10% during the period of 2008/09 – 2011/12.

1. Overall State -wise Analysis:

From the above discussion we observe that during the period of 1993/94 - 2018standard of living of the households has been increasing during the period under study. At the all-India level, the share of pucca house has increased by 47.3% and simultaneously the share of semi-pucca and katcha house declined by20.5% and by 26.6% respectively. The maximum improvement in the dwelling units has marked in Punjab, Haryana, Kerala, Himachal Pradesh and so on. Although the lowest share of pucca house has observed in Tripura (29%) in 2018 but the transformation from the share of 81.9% katcha house in 1993-94 to 68.4% semi-pucca in 2018 has been outstanding at all. Similarly, the states like, Arunachal Pradesh, Sikkim, Orissa, Gujarat, Himachal Pradesh, Assam and Rajasthan have marked for maximum used of the 'tab or piped water'. On the other hand, Kerala in 'well' water, Jammu & Kashmir and Sikkim in 'spring water', and Bihar in 'hand pump or tube well' have a significant share in the rural area during the period under study.

In case of sanitation, over the 25 years the share of households not using the bathroom and latrine facilities has declined by almost 57% in rural area which means these households are now using the bathroom and latrine in their daily life.During this period some of the states namely Kerala, Sikkim, Tripura, Karnataka, Gujarat, Arunachal Pradesh, Jammu & Kashmir etc. have improved their sanitation facilities but the states namely Bihar, Orissa, Jharkhand, Chhattisgarh, Tripura, Tamil Nadu, Uttar Pradesh etc. have not yet very progressive in the rural area. So, as we know that the purpose of good sanitation has provided not only a healthy living environment for all but also protected various natural resources such as surface water, groundwater and soil. We must be more aware about our defaecate or urinate for our own safety, security and dignity.

On the other hand, we observe that over time in the rural area although the share of 'LPG' users has continuously increased but firewood, dung cake, coal, kerosene etc. also has an important share in terms of cooking medium in rural India and its constituent states during the period of 1993/94- 2018. Not only that with the rapid development, India has shifted more towards clean and efficient energy sources in the rural area.

Basically, it has noted that most of the states namely, Himachal Pradesh, Jammu & Kashmir, Punjab, Haryana, Kerala, Karnataka, Andhra Pradesh, Gujarat, Maharashtra Tamil Nadu etc. which have the MPCE higher than the all-India level is also noted in the progressive region in all aspect of development in the rural area. But some of the states namely Bihar, Tripura, Arunachal Pradesh, Assam, Chhattisgarh, Jharkhand etc. have improving their situation but still counted as a backward state especially in the rural area during the period under study.

V. Estimates of PCA Analysis

In the previous sections we have already discussed about the situation of the households in terms of the basic necessities in details in rural India and its constituent states during the period of 1993/94- 2018. Let us now examine the association between these necessary facilities. Here we have used the PCA technique to determine the association between the six explanatory variables namely 'Katcha House', 'Tap Water', 'No Bathroom', 'No Latrine', 'LPG' and 'Electricity'. Tables 7 and 8have shown the PCA results.

Table 8 has shown the descriptive statistics in terms of mean and standard deviation (SD) values. In the rural area the SD has significantly higher for all the variables excepting in 'LPG' (1.785 in 1993-94, 6.163 in 2000-01 and 13.729 in 2011-12). Also, the SD values of 'Katch House' has significantly declined from 23.866 in 1993-94 to11.955 in 2011-12 in rural area. The high levels of SD can be explained taking into account the high correlations between the original variables.The higher correlation between the variables have been creating the problem of 'information redundancy'. During the period of 1993/94 – 2011/12, the higher correlation has shown between 'Katcha House' and 'No Bathroom', 'Katcha House' and 'No Latrine', 'No Latrine' and 'No Bathroom', 'LPG' and 'Tap Water' (negatively related) and 'LPG' and 'Electricity' in rural area.

In case of the eigenvalue correlation matrix, we are concern about those eigenvalues which have the values greater than 1 (only the Principal Components (PCs) with higher variance than the standardized original variables should be extracted). In case of rural area only two components (components 1 and 2) of the correlation matrix have the eigenvalue greater than 1 during the period of 1993/94- 2011/12. In rural area first two components have explained almost 74.9% in 1993-94, 76.3% in 2000-01 and 75.4% in 2011-12 of the variation.

Based on the proportion of the variation explained by the eigenvalues the component matrix table (Table 9) has estimated where the correlation between the principal components (have eigenvalue greater than 1) and the original variables have marked during the period of 1993/94 – 2011/12. In1993-94 'Electricity', 'LPG' and 'Tap Water' are strongly correlated with PC1(principal component 1). For PC2 the strongly positive correlation has marked in 'Katcha House' and 'No Bathroom'. But the negative relation has also shown in 'Electricity', 'LPG' and 'Tap Water'. In 2000-01 the PC1 has positively correlated with 'Katcha House', 'No Latrine' and 'No Bathroom' but strongly negative correlation has shown in 'Electricity', 'LPG' and 'Tap Water'. Also, higher negative correlation has shown in PC2 with 'No Latrine' and 'No Bathroom' in this period. In 2011-12 PC1 still negatively related to 'Electricity', 'LPG' and 'Tap Water'.

Basically, in this study we use to consider the PCA for investigating the relationship between the explanatory variables. As PCs identify the correlated variables, thereby it is

easy to estimate the meaningful pattern of the actual data. Here we observe that 'Katcha House', 'No Latrine' and 'No Bathroom' are positively correlated with each other for the rural households which means that these variables are vary together. In rural area a household with katcha house structure may not have separate bathroom or latrine concept with it. Basically, in rural area, households with lower mpce cannot afford the basic necessities of the living. On the other hand, 'Electricity', 'LPG' and 'Tap Water' are negatively related variables. The negativity might be explained in a way that households are not very easily getting these facilities in rural area during the period of 1993/94 – 2011/12.

VI. Conclusions

In this paper we have broadly discussed about the changing living standard of the households in the rural India and its constituent states for the 25 years. The study discloses that India has a progressive trend in terms of the accessibility of the basic necessities namely proper dwelling, safe drinking water, better sanitation and improved mode of energy for cooking and lighting. The states like Kerala, Punjab, Himachal Pradesh, Sikkim, Gujarat, Karnataka, Arunachal Pradesh, Jammu & Kashmir etc. have gradually achieved an improved living standard in the rural area. Whereas the state namely Bihar, Chhattisgarh, Jharkhand, Uttar Pradesh, Rajasthan, Tripura etc. have not a significant share in these basic needs. Though, to achieve the better standard of living with the SDGs agenda, government of India already have implemented various programme namely, National Rural Drinking Water Programme, Nirmal Bharat Abhiyan, Pradhan Mantri Krishi Sinchayee Yojana, National River Conservation Programme (NRCP), Namami Gange - Integrated Ganga Conservation Mission (to ensure the availability of sufficient water and sanitation facility) Deen Dayal Upadhyaya Gram Jyoti Yojana, National Solar Mission (providing continuous power supply to rural India), India Energy Policy Power (2015) – (electrification of the villages including the Solar Power) etc. But still a higher standard of governance should be required at all the levels, especially in the development of the rural area. The two levels of the governments, the centre as well as states have to be joined hands to bring about these changes in India and its constituent states to move towards the achievement of the basic needs of sustainability by 2030.

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Table 1: Monthly Per Capita Consumption Expenditure (in rupees) in Rural Indian States During 1993/94– 2011/12

Year / States	1993-94	2000-01	2004-05	2011-12
Andhra Pradesh	526.37	244.67	325.84	1533.2
Arunachal Pradesh	577.69	284.19	429.31	1583.9
Assam	470.58	228.26	302.26	1043.03
Bihar	398.01	197.84	232.11	1004.98
Chhattisgarh	--	236.15	236.55	881.04
Gujarat	552.99	295.12	331.70	1460.62
Haryana	701.95	340.58	480.17	1882.02
Himachal Pradesh	639.28	349.81	444.12	1858.53
Jammu and Kashmir	662.40	339.32	441.37	1582.55
Jharkhand	--	225.98	236.66	897.89
Karnataka	491.18	265.08	282.94	1399.66
Kerala	711.79	419.97	563.79	2509.92
Madya Pradesh	459.46	194.68	244.32	1044.78
Maharashtra	497.20	253.00	315.93	1433.66
Orissa	400.75	195.92	221.97	880.24
Punjab	789.46	384.99	471.19	2076.43
Rajasthan	587.81	268.68	328.78	1432.56
Sikkim	544.64	--	383.14	1388.21
Tamil Nadu	535.30	262.43	335.09	1504.81
Tripura	627.07	316.72	271.35	1109.98
Uttar Pradesh	499.20	309.42	360.12	1046.81
West Bengal	508.32	394.88	312.79	1143.18
All India	513.06	197.10	310.95	1278.94

Table 2: Percentage Distribution of Households by Type of structure of the dwellings in Rural Indian States During 1993/94 - 2018

	1993-94			2000-01			2011-12			2018		
State	Pucca	Semi-pucca	Katcha	Pucca	Semi-pucca	Katcha	Pucca	Semi-pucca	Katcha	Pucca	Semi-pucca	Katcha
Andhra Pradesh	32.5	25.6	41.9	56.2	21.4	22.4	79.6	13.6	6.8	88.6	6.9	4.5
Arunachal Pradesh	9.8	12.8	77.4	12.6	11.7	75.7	20.1	25.5	54.4	27.2	37.5	35.3
Assam	5.5	27	67.5	9.3	27.6	63.1	26.6	58	15.4	53.1	44.1	2.8
Bihar	17.6	41.5	40.9	27.2	28.2	44.6	58.8	21.3	19.9	76.7	14.2	9.1
Chhattisgarh	--	--	--	4.5	64.1	31.4	29.3	58.7	12	58	39.6	2.4
Gujarat	36.6	44.4	19	45.1	36.4	18.5	80.1	18.2	1.7	86.2	11.2	2.6
Haryana	72.5	14.5	13	68.6	22.2	9.2	93.2	5.1	1.7	92.5	7.2	0.3
Himachal Pradesh	43.9	48.5	7.6	45.9	42.8	11.3	84.8	15	0.2	86.9	12.9	0.2
Jammu and Kashmir	30.4	37.8	31.8	32.9	50.2	16.9	63.2	18	18.8	85.5	8.8	5.7
Jharkhand	--	--	--	11.6	36.3	52.1	32.2	60.6	7.2	52.8	38.6	8.6
Karnataka	28.7	53.8	17.5	50.2	37.8	12	65.4	31.7	2.9	79.2	17.6	3.2
Kerala	51.5	29.8	18.7	69.7	20.7	9.6	85.4	12.9	1.7	85	14.6	0.4
Madhya Pradesh	13.3	76.4	10.3	20.4	51.4	28.2	59.9	37.5	2.6	60.6	33.5	5.9
Maharashtra	34.1	50.9	15	39.8	44.3	15.9	77.1	21.2	1.7	82.1	14.4	3.5
Orissa	10.2	19.1	70.7	18.2	16.5	65.3	44.1	27.1	28.8	59.5	23.8	16.7
Punjab	67.8	19.8	12.4	77.3	20	2.7	96.2	2.2	1.6	97.9	1.3	0.8
Rajasthan	46.3	24.8	28.9	57	17	26	76.2	15.2	8.6	88.9	7.4	3.7
Sikkim	23.7	52.2	24.1	0	0	0	60.6	34	5.4	91.4	8.3	0.3
Tamil Nadu	36.4	24.5	39.1	39.6	27.4	33	69.1	18.9	12	88.3	7.6	4.1
Tripura	1.8	16.3	81.9	3.9	8.3	87.8	14.8	79.7	5.5	29	68.4	2.6
Uttar Pradesh	32.2	37	30.8	41.3	34	24.7	73	15.9	11.1	82.7	9.3	8
West Bengal	15.6	38	46.4	16.6	33	50.4	47.6	40	12.4	64.1	27.7	8.2
All India	29.3	38	32.7	38.5	31.5	30	65.8	24.6	9.6	76.7	17.4	5.9

Source: Various rounds of NSSO, Govt. Of India (MOSPI).

Table 3: Percentage Distribution of Households by Type of Bathroom in the house in Rural Indian States During 1993/94 - 2018

Year	1993-94			2008-09			2012			2018			
States	Bathroom exclusive use of HHDs	Bathroom common use of the HHDs in a building	No Bath-room	Bath-room exclusive use of HHDs	Bath-room common use of HHDs in a building	No Bath--room	Bath-room exclusive use of HHDs	Bath-room common use of HHDs in a building	No Bath--room	Bath-room exclusive use of HHDs	Bath-room common use of HHDs in a building	Public use Bath-room*	No Bath-room
Andhra Pradesh	2.3	8.2	89.5	8.4	32.7	58.9	10.3	44.3	45.4	70.4	12.1	0	17.4
Arunachal Pradesh	2	3.1	94.8	17.1	40.6	42.3	13	34.5	52.5	64.5	18.6	0.1	16.8
Assam	1.7	24.3	73.9	1.8	64.5	33.7	3.6	50.7	45.6	61.1	2.7	0	36.2
Bihar	1.4	2.9	95.7	4.8	13.5	81.7	7.6	10.5	81.9	33.3	7.4	0.1	59.2
Chhattisgarh	--	--	--	1.8	10.3	88	2.7	12.4	84.9	29.6	6	0.5	63.9
Gujarat	12.7	8.7	78.5	18.9	21.5	59.6	24.6	21.5	53.9	65.6	4.7	0	29.7
Haryana	6.3	6.5	87.1	21.7	43.7	34.7	25.9	59.8	14.4	88.8	7.4	0	3.8
Himachal Pradesh	14.7	5.5	79.7	33.3	24.2	42.5	32.3	36	31.7	85.1	10.1	0	4.7
Jammu & Kashmir	2	6.2	91.7	45.4	21.2	33.4	33.9	25.6	40.5	78.8	6.9	0	14.2
Jharkhand	--	--	--	1.7	20.4	77.9	2.5	8	89.4	15.9	2.9	0	81.2
Karnataka	29.4	11.5	59.1	43.8	12.5	43.7	33.3	18.6	48.1	77.9	3.3	0.1	18.8
Kerala	12.3	29.7	58.1	36.9	45.3	17.8	46.8	43.5	9.7	95.6	1.8	0	2.6
Madhya Pradesh	1.9	3.3	94.8	6.8	23.5	69.7	10.5	13.9	75.6	46.3	4.9	0	48.7
Maharashtra	6.1	6.5	87.4	18.3	26.3	55.4	22.7	23.1	54.2	75.7	4.2	0	20.1
Orissa	0.5	1	98.5	1.6	5.4	93	3	8.8	88.2	14.2	6.6	0.1	79.1
Punjab	9	29	62	11.9	48.9	39.2	21.9	55.5	22.6	86.8	9.5	0	3.7
Rajasthan	5.1	5.9	88.9	11.5	17.3	71.2	16.6	24.8	58.6	58.3	6.8	0.1	34.8
Sikkim	3.9	19.2	76.9	19.4	59.8	20.8	22	71.7	6.3	95.3	4.7	0	0
Tamil Nadu	3.8	10	86.2	14.4	24.4	61.2	17.7	24.6	57.7	67.5	3.4	0.6	28.5
Tripura	1.3	6.4	92.2	0.7	5.8	93.5	1.4	8.8	89.7	11.3	3.7	0	85
Uttar Pradesh	3.4	3.5	93.1	9	11.6	79.4	13.3	7	79.6	28.5	4.8	0.1	66.6
West Bengal	2.5	4.9	92.7	4.4	26.5	69.1	8.7	18.3	73	25	9.6	0	65.4
All India	5.4	7.5	87	12.5	23.1	64.4	15.5	22.2	62.3	50.3	6.1	0.1	43.6

Source: Various rounds of NSSO, Govt. Of India (MOSPI). Note: HHDs mean household

Table 4: Percentage Distribution of Households by Type of use of Latrine in the house in Rural Indian States During 1993/94 – 2018

Year	1993-94		2008-09				2011-12				2018			
States	HHDs use Latrine	No Latrine	Latrine exclusive use of HHDS	Latrine common use of HHDs	Public use Latrine	No Latrine	Latrine exclusive use of HHDS	Latrine common use of HHDs	Public use Latrine	No Latrine	Latrine exclusive use of HHDs	Latrine common use of HHDs	Public use Latrine	No Latrine
Andhra Pradesh	13.1	87	26.6	8.3	0.9	64.3	34.5	10.3	0.4	54.8	66	10.9	0.1	22.9
Arunachal Pradesh	61.6	38.4	62.7	19.5	1.7	16.2	49.2	11.1	1.2	38.5	91	6	0	3
Assam	70.3	29.6	80.7	5	0.7	13.5	79.4	5.3	0.1	15.3	95	2.2	0	2.8
Bihar	7.4	92.6	17.3	2.1	0.7	79.8	18.8	6.5	0.5	74.2	55.8	7.6	0	36.6
Chhattisgarh	0	0	14.3	1.6	1.7	82.3	18.8	4.5	0	76.7	83.2	7.5	0	9.3
Gujarat	17	83.1	26.7	5	0.9	67.3	36.6	4.3	0	59	71.4	3.2	0.6	24.8
Haryana	6.4	93.5	43.8	10.7	0.2	45.3	63.9	9.7	0.7	25.7	87.6	8	0	4.3
Himachal Pradesh	13	86.9	38.7	14.3	0.5	46.5	59.5	12.3	0.3	27.9	88.7	7.5	0	3.8
Jammu & Kashmir	3.9	96.1	53.5	5.4	6.2	34.9	49.4	5.7	0.3	44.6	76.6	7.1	0	16.4
Jharkhand	--	--	12.6	2.5	0.7	84.1	7.5	1.4	0.1	91	55.1	3.1	0	41.9
Karnataka	11.2	88.8	21.2	3.1	0.5	75.2	24.4	3.5	0.9	71.2	67.9	1.1	0.2	30.7
Kerala	67	33.1	89.7	4.4	0.6	5.3	92.7	3.3	0	3.9	97.2	1.7	0	1.2
Madhya Pradesh	2.7	97.3	11.8	2.1	0.8	85.3	15.3	5.5	0.1	79	65.3	5.2	0.1	29.5
Maharashtra	7.6	92.4	27.1	7.1	5.1	60.7	33.2	11	0.5	55.2	72.7	3.3	1.6	22.3
Orissa	2.5	97.4	9.4	1.9	0.5	88.2	12.4	5.8	0.3	81.4	40.2	8.8	0	51
Punjab	20.8	79.2	51.9	10.8	1.1	36.2	65.5	11.5	0.1	22.8	85.4	7.9	0	6.7
Rajasthan	9.7	90.3	14.3	3.4	0.2	82.1	21.5	5.2	0	73.3	60.2	5.3	0	34.5
Sikkim	61.2	38.9	85.1	12.4	0	2.5	85.7	12.5	1	0.8	96.8	3.2	0	0
Tamil Nadu	8.3	91.7	22.9	2.1	1.5	73.5	27.3	3.8	2.5	66.5	59	2.3	1.2	37.5
Tripura	93.3	6.6	69.3	27	0.3	3.4	72.7	12.2	0.6	14.5	84.3	12.7	0.5	2.4
Uttar Pradesh	9	91.1	16.5	3.6	0.7	79.2	19.5	4.7	0	75.7	46.1	5.6	0	48.3
West Bengal	16.8	83.1	40.6	16	1.7	41.7	40	15.7	1	43.2	56	25.4	0.2	18.5
All India	14.1	85.8	27.9	5.7	1.2	65.2	31.9	7.1	0.8	60.2	63.2	7.3	0.2	29.2

Source: Various rounds of NSSO, Govt. Of India (MOSPI). Note: HHDs mean Households

Table 5: Percentage Distribution of Households by Principal Sources of Drinking Water in Rural Indian States During 1993/94 – 2018

Year	1993-94			2001-02			2011-12				2018			
State	Tab Water	Tube Well & Well	Others	Tab Water	Tube Well & Well	Others	Bottled Water	Tab Water	Tube Well & Well	Others	Bottled Water	Tab Water	Tube Well & Well	Others
Andhra Pradesh	17.4	76.4	6.2	54.3	42.8	2.8	13.4	57.2	27	2.5	30.5	47.6	20.1	1.9
Arunachal Pradesh	66.3	7.5	26.1	78.7	5.9	15.4	0	81.4	13.7	4.8	0	66.7	32	1.3
Assam	8.4	78.2	13.5	6.9	81.3	11.9	0.1	6.5	89.1	4.3	0	8.1	87.1	4.8
Bihar	0.7	97.4	2	0.9	99	0.1	0	0.2	99.7	0	0.8	1.7	97.5	0
Chhattisgarh	--	--	--	1.8	96.2	1.9	0	13.3	86.4	0.3	0	23.6	74.6	1.7
Gujarat	52.6	40	7.3	58.2	39.5	2.3	2.8	60.3	33.2	3.7	4.1	69.4	25.7	0.8
Haryana	43.5	53.7	2.7	38.8	59.9	1.3	0.1	67.1	30.5	2.3	3.2	60.2	36.6	0
Himachal Pradesh	75.6	8.5	16	74.1	15.2	10.6	0	71.3	14.3	14.4	0	84.2	12.4	3.5
Jammu and Kashmir	29.3	34	36.6	55.7	21.7	22.6	1.2	53.3	19.6	25.8	0	74.8	11.5	13.6
Jharkhand	--	--	--	3.6	91.4	5	0	1.1	93.2	5.7	0.2	1.7	97.4	0.7
Karnataka	31.3	62.2	6.6	59.5	38.7	1.8	0.7	75.1	20.6	3.5	16.1	66.8	16.3	0.8
Kerala	12.8	85.3	1.9	10.8	85.3	3.9	0.3	15.7	81.8	2.2	0.1	15.3	83.4	1.3
Madhya Pradesh	5.6	90.5	3.9	6.9	91.5	1.7	0	15	83.6	1.2	0	19	80.6	0.6
Maharashtra	48.7	49	2.2	48.5	48.1	3.5	1.1	55.6	40.9	2.4	2.3	68.7	27.7	1.3
Orissa	0.6	89.2	10.3	4.6	88.5	7	0.2	13.6	84.7	1.5	0	15.4	82.6	1.9
Punjab	13.1	85.7	1.2	22	77.8	0.3	0	41.9	57.6	0.6	0.1	49.9	49.9	0.2
Rajasthan	22.1	72	5.9	25.1	63.2	11.8	0.1	41.7	45.5	12.7	0.5	42.1	46.1	11.4
Sikkim	77	0	22.7	53.6	0.1	46.3	0	80.2	0	19.8	0	81.8	2.3	15.9
Tamil Nadu	38.7	54.1	7.2	76.9	19.7	3.5	2.2	83.6	10	4.3	1.9	89.3	6.3	2.5
Tripura	23.4	68.7	7.8	21.9	77	1.2	0	34.9	63.4	1.7	0.1	32.7	65.5	1.8
Uttar Pradesh	6.6	91.6	1.8	2.2	97.8	0	0	2.5	97.5	0	0.7	3.8	95.3	0.2
West Bengal	4	93.5	2.5	12.5	86.5	1	0.5	13.3	85.7	0.3	1.2	21.2	77	0.5
All India	18.6	76.2	5.2	27.5	69.2	3.4	1.6	31.2	64.1	3.1	4	32.9	61.1	2.1

Source: Various rounds of NSSO, Govt. Of India (MOSPI). Note: Others included rain water, other surface water and other source of water.

Table 6: Percentage Distribution of Households by Primary Source of Energy used forCooking in Rural Indian States During 1993/94 - 2018

Year	1993-94				2001-02				2011-12				2018			
State	Fire-wood & Chips	LPG	Others*	No Cooking Arrngt	Fire-wood & Chips	LPG	Others*	No Cooking Arrngt	Fire-wood & Chips	LPG	Others*	No Cooking Arrngt	Fire-wood & Chips	LPG	Others*	No Cooking Arrngt
Andhra Pradesh	93.7	2.3	3.4	0.6	83.7	11.8	2.5	2	67.5	28.9	0.9	2.7	18.4	79	0.2	2.7
Arunachal Pradesh	97	1.1	1.8	0	91.4	6.9	1.8	0	65.4	31.4	1.4	1.8	44.1	55.3	0.6	1.8
Assam	97.2	1.1	1.7	0	96.4	3	0.5	0.1	81	17.2	0.9	0.9	45.6	53.5	0.9	0.9
Bihar	63.4	0.3	36	0.3	66.7	1	32.2	0	56.4	5.9	37.6	0.1	39.8	44.2	16	0.1
Chhattisgarh	--	--	--	--	90.4	1.7	7.2	0.6	93.2	1.5	4.7	0.6	68.5	29.4	0.6	0.6
Gujarat	78.7	4.9	15.8	0.5	69.6	10.9	18.1	1.4	79.7	13.9	5.1	1.3	47.6	50.1	1	1.3
Haryana	68.3	3.6	28	0.1	46	12.4	41.1	0.5	41.7	26.7	31.4	0.3	32.1	54.2	13.7	0.3
Himachal Pradesh	88.4	4.8	6.5	0.3	80.1	15.3	4.6	0	72.7	25.2	1.4	0.8	52.2	47.5	0.2	0.8
Jammu and Kashmir	80.6	5.2	13.9	0.3	65.6	13.5	21	0	67.8	26.5	5.4	0.4	36.3	61.2	2.4	0.4
Jharkhand	--	--	--	--	79.4	1.5	18.8	0.4	77.7	3	17.7	1.6	62.1	21.5	16.2	1.6
Karnataka	93.9	1.7	3.3	1	88	6.5	2.8	2.6	80.5	14.7	2.7	2.1	27.3	72.2	0.3	2.1
Kerala	92.1	4.1	2.5	1.4	76.6	19.9	3	0.6	66.3	30.8	0.9	2	47.9	50.7	0.7	2
Madhya Pradesh	91.1	0.5	8.1	0.3	92.8	2.7	3.9	0.7	80.8	6.2	12.1	0.9	62.4	33.1	4.2	0.9
Maharashtra	76.7	3.5	18.9	0.9	71.4	12.6	14	1.9	62.1	23.1	10.9	3.9	32.5	65.8	1.2	3.9
Orissa	88.9	0.3	8.8	2.1	86.2	0.7	12.3	0.7	87	3.9	8.5	0.6	71.4	23.8	1.1	0.6
Punjab	50.7	5.1	43.6	0.6	38.7	20.1	40.9	0.4	30.5	30.5	37.2	1.9	16.1	77.4	6.5	1.9
Rajasthan	90	2	7.9	0.2	93.7	3.3	2.8	0.2	89.3	8.9	1.7	0.1	65.5	33.7	0.4	0.1
Sikkim	90	1.8	6.4	1.9	0	0	0	0	40.4	56	1.1	2.6	2	97.8	0.2	2.6
Tamil Nadu	91.3	3.1	4.3	1.3	83.1	10.2	5	1.6	58.3	37.2	2.7	1.8	15.3	83.8	0.6	1.8
Tripura	98.7	0.7	0.4	0.2	95.5	4.4	0.1	0	92.5	6.3	0.7	0.5	69.8	29.9	0.3	0.5
Uttar Pradesh	62.7	1.2	35.7	0.4	60.2	4.4	35.3	0	56.1	6.7	36.5	0.7	43	37.8	19.2	0.7
West Bengal	61.3	0.3	37.2	1.1	74.5	4.8	19.6	1	62.9	6.6	29.8	0.7	71	24.5	3.8	0.7
All India	78.2	1.9	19	0.9	75.5	7.3	16.3	0.9	67.3	15	16.5	1.3	44.5	48.3	6.6	1.3

Source: Various rounds of NSSO, Govt. Of India (MOSPI). Note- Others* included Dunk cake, Char coal, Gobar gass, Coke & coal, Kerosene, Electricity and some non-reported numbers

Table 7: Percentage Distribution of Households by Primary Source of Energy used forLighting in Rural Indian States During 1993/94 - 2018

Year	1993-94				2001-02				2008-09			2011-12		
	Kero sene	Electri city	Others*	No lighting	Kero sene	Electri city	Others*	No lighting	Kero sene	Electri city	Others*	Kero sene	Electri city	Others*
Andhra Pradesh	50.5	49.2	0.3	0	22	77.6	0	0.4	5	94.1	0.9	2.1	97.6	0.3
Arunachal Pradesh	22.9	46.7	4	26.3	0	0	0	0	18.4	72	9.6	19.8	69.6	10.6
Assam	84.6	14.7	0.7	0	76.5	22.1	0	1.3	53.7	46	0.3	44.3	55.3	0.4
Bihar	92.8	6.3	0.8	0.2	92.3	7.6	0.2	0	80.5	18.6	0.9	73.9	25.8	0.3
Chhattisgarh	--	--	--	--	0	0	0	0	18.1	79.5	2.4	13.8	85.5	0.7
Gujarat	31.8	67.5	0.6	0.2	16.4	82.5	0	1	7.4	92.1	0.5	6.3	93.7	0
Haryana	23.5	74.6	1.9	0.1	12	85.9	0	2	4	94.8	1.2	1.7	95.5	2.8
Himachal Pradesh	7.9	91.4	0.7	0.1	4.1	95.3	0.2	0.4	2	97.9	0.1	1.1	98.6	0.3
Jammu and Kashmir	15.3	82.7	2	0	9.6	89.1	1.1	0.1	2.4	97.3	0.3	3.2	96.5	0.3
Jharkhand	--	--	--	--	74.3	25	0.2	0.4	54.2	45.7	0.1	36.8	62.2	1
Karnataka	44.8	54.5	0.6	0.2	24	75.5	0	0.5	4.9	95.1	0.1	4.5	95.2	0.3
Kerala	43.3	56.5	0.2	0.1	22.8	75.5	0	1.6	6	93.4	0.6	3.3	96.3	0.4
Madhya Pradesh	54	44.9	0.8	0.2	38.3	61.6	0	0.1	26.2	73.5	0.3	15.2	84.6	0.2
Maharashtra	41.1	58.6	0.3	0.1	22.8	76.9	0	0.3	15.4	84.4	0.2	10.3	89.2	0.5
Orissa	84.8	14.5	0.5	0.1	75.9	24.1	0	0	46.1	53.8	0.2	32.3	67.6	0.1
Punjab	10.9	87.2	1.7	0.1	9.1	89.9	0	0.9	1.5	95.8	2.7	1.5	97.4	1.1
Rajasthan	58	41	1	0.1	45.8	53.1	0	0.9	26.9	72.5	0.6	21.6	77.7	0.7
Sikkim	15.9	81.6	2.2	0.4	0	0	0	0	3.2	95.8	1	1.9	98	0.1
Tamil Nadu	45.7	54	0.3	0.1	27.5	71.9	0	0.5	3.6	96.1	0.3	3.1	96.9	0
Tripura	57.4	42.1	0.5	0.1	45.5	53.7	0	0.7	25.6	74	0.4	17.8	82	0.2
Uttar Pradesh	81	17.7	1.2	0.2	70.8	27.9	0.5	0.9	65.9	33.3	0.8	58.5	40.5	1
West Bengal	88.2	11.2	0.6	0.1	72.6	26.7	0	0.7	53.9	46	0.2	29.3	70.3	0.4
All India	62	37	0.8	0.1	48	51	0.3	0.6	33.5	65.8	0.6	26.8	72.7	0.5

Source: Various rounds of NSSO, Govt. Of India(MOSPI). Note: others included others oil, gas, candle and some non-reported household.

Table 8. Mean and Standard Deviation of the Explanatory Variables in Rural India During 1993/94- 2011/12

	1993-94		2000-01		2011-12	
Variables	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Katcha house	31.509	23.866	31.855	24.496	10.522	11.955
No Bathroom	76.848	26.852	52.567	18.176	55.035	25.801
No Latrine	68.822	33.994	69.800	22.403	47.096	27.574
Tap Water	25.926	24.429	32.614	27.526	39.826	28.903
LPG	2.170	1.785	7.523	6.163	18.526	13.729
Electricity	44.978	28.556	50.873	33.261	80.383	19.936

Source: Various rounds of NSSO data. PCA result in SPSS software.

Table 9: The Component Matrix of PCA in Rural India during 1993/94 – 2011/12

	1993-94		2000-01		2011-12	
Variables	1	2	1	2	1	2
Katcha House	-0.118	0.618	0.325	0.445	0.174	0.844
No Bathroom	0.291	0.652	0.413	-0.524	0.354	0.184
No Latrine	0.348	0.338	0.311	-0.625	0.490	0.004
Tap Water	0.443	-0.082	-0.349	-0.143	-0.418	0.368
LPG	0.519	-0.221	-0.534	-0.126	-0.481	0.292
Electricity	0.560	-0.148	-0.470	-0.317	-0.445	-0.180

Source: PCA result in SPSS software.

Note: The results are significant by Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) Test..

Aspects of Peasant Economy: A District Level Study on West Bengal

Piyali Chatterjee[1]

Abstract

The word 'agriculture' is a part and parcel of the Indian economy, and in its larger scenario of economic development. Agricultural growth in different Indian states has not only contributed to feed the teeming millions but in enhancing the GDP figures substantially. In agriculture we intensely study the vast crops sector and often the agricultural sector is linked with the allied sectors like livestock, fishery, poultry, etc.. The growth of agricultural production is a major concern for the policy makers since agriculture had been a pre-dominant sector in our country.

The introduction of Green Revolution in India in 1965 witnessed an increase in food grain production in states like Punjab, Haryana and Uttar Pradesh. Achieving phenomenal success in increasing agricultural production in selected areas, it was later introduced in other states. West Bengal has witnessed a late introduction of the new technology in the 1970s which led to increase in its foodgrain production.

The present paper intends to delve deep into the agricultural scene of West Bengal during the period 2000-2014, i.e., the beginning of the new millenium highlighting the significance of technological factors and the consequent transformation of agricultural production.

Keywords: Cropping Intensity, Net Area Sown, Current fallow, Gross Cropped Area, Irrigation, Boro, Agricultural Production, Technological factors, Trend.

JEL Classification Codes: O18, O47, P32, Q12

1. Scope of the Analysis

Statement of the Problem

It is of extreme significance to study the trends in the agricultural production of West Bengal with special emphasis on the reasons behind and the effect of it on the state's economy. West Bengal was indeed lagging behind the other developed states in terms of agricultural productivity, but soon it picked up in the decade of 1980s with surplus production and a widespread distribution of food grains among the starving population. The

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current study intends to manifest vividly the agricultural ups and downs through a trend analysis of the relatively economically developing state of the country.

Objectives

The present research work aims to do a comparative analysis of the trend in agricultural production in the period from 2000-2014. The period of analysis is essentially in the new millennium, which very much reflects the effects of the liberalization initiated in 1991, on the agricultural production of West Bengal. Therefore, the objectives of the study are as follows:To analyze the trend and highlight the factors behind the trend in agricultural production in West Bengal at the aforementioned period.

1. To explain the role played by technological factors in effecting agricultural production and productivity in the State of West Bengal.
2. To specify the impact of liberalization on the agricultural sector.
3. To elucidate the effect of the analyzed trend on the rural economy as a whole, throwing light on the recent development in the agricultural sector.
4. The above objectives are intended to draw a clear picture of the performance of the agricultural sector of West Bengal in the recent past in the post liberalization period.

Coverage (Universe)

The study is conducted by using secondary data collected on the agricultural performance indicators, from West Bengal and 2 districts of the state– Nadia and Birbhum, to give a comprehensive view on overall trend in agricultural growth.

Data Collection and Analysis

The current study is basically a historical analysis of the trend in agricultural growth in West Bengal. The data is collected from various research works and publications, websites of Indian Government Ministries, Economic Survey report, District Statistical Handbook and Statistical Abstract of the state. Data is analysed using tabular presentation to explain the trend. Apart from this, to do a comparative study diagrammatic representation of data is done through different bar diagrams to give a clear picture of the studied trend to give a vivid picture of the quantitative data and enables interpretation of the data.

II. Introduction:Agriculture in West Bengal- A Synoptic View

Agriculture is the main stay of the majority of the people living in Third World country. As a result the development of agriculture is synonymous with the development of majority of people living in these countries. In other words, the development of the econ-

omy of these countries is associated with the development of agriculture. Now two questions may be raised here: i) what is meant by development of agriculture and ii) how the development in agriculture could be realized?

In ordinary parlance development of agriculture refers to a situation of increase in yield per acre, increase in area of cultivation, increase in cropping intensity and so on. The alternative view in this respect is the transformation of agriculture from subsistence farming to commercial farming. The basic idea of this transformation is that surplus generated out of this transformation is to be used for meeting the needs of urban people and industrial workers. Early planners in our country had realized this inter- linkage between agricultural development and industry and formulated the agricultural policy accordingly. The Grow More Food Grains Campaign, the Green Revolution in 1966, the Essential Commodities Act, 1955 were examples in this context. In China, after the liberation, the simultaneous development of industry and agriculture was popularly known as "walking on two legs".

The *second aspect* related to agricultural development is how the process related to agriculture is to be adopted? There are two methods in this respect: i) promulgation of institutional reform and ii) adoption of technological solution. There is also a combination of these two that is adoption of technological solution and promulgation of institutional reforms. Institutional reforms refer to land reform that is re-distribution of land among the peasants or cultivators. This course of action was taken at first in Soviet Russia in 1917 and in People's Republic of China in 1949. In India this institutional reform was to some extent adopted in 1955 through the abolition of all intermediaries in land. As regards the technological solutions, Theodore Schultz, the Noble Laureate in 1964 pointed out that application of high yielding varieties of seeds, proper irrigation facilities and use of chemical fertilizers may transform the traditional subsistence farming into commercial farming. It should be mentioned that wheat revolution in Mexico in 1966 was an example of technological revolution in agriculture.

It should also be noted in this context that development of agriculture with the elimination of poverty of the rural people is a concern for all economists throughout the ages. A.V Chayanov in Soviet Russia examined the question of transformation of peasant economy as early as in 1920. Chayanov raised three questions in this respect:

i) How to transform traditional rural society so as to overcome the misery, squalor and illiteracy of the peasantry?

ii) How to get the peasants to modernize their agriculture, especially their farming techniques? and

iii) How to carry out this transformation and modernization so as to permit the development of the entire national economy?

(Cited here from Daniel Thorner 1965)

The state of West Bengal has suffered severely in the late 1950s and 1960s, coupled with severe food crisis for decades during the colonial rule. It is well documented in several scholarly works that the early travellers to Bengal were awestruck by its abundance and prosperity. Before the arrival of the British, land in Bengal was not considered a commodity which could be bought and sold. However in 1793, the British vested land ownership in the intermediaries known as *zamindars,* who had to pay an annual tax which nonetheless if not paid would lead to seizure of the land and auctioned for dues. Arguably, in the post-colonial era, the state failed to draw enough attention for its agricultural development. Some scholars have cited that the existence of the food crisis still widely existed. The mind-boggling situation led to the introduction of land reforms in West Bengal through *operation barga* launched in 1978 which concluded by the mid-1980s. Thus, from 1983-84, there were a steady improvement in the agricultural production and by 1991- 92 the figures had reached around 12.7 million tons, which was approximately 70% more than the production level in 1977. The decade of liberalization that is the '90s and the decades following the onset of the new millennium, has a large influence on the Indian agriculture.

The growing competition in the international market with the foreign producers of agricultural products has had a deep impact on the Indian agriculture. It is of extreme importance to scrutinize the reasons behind the changing agricultural figures of the state and its implications on the economic condition of the region. Agricultural production and its anticipated growth, being the lifeline for survival of the nation has been a debatable topic as regards to its growth during different phases of introduction of economic policies and reforms. The agricultural growth affects not only the people involved in the agricultural sector but also other sectors dependent on it like the agro-based industry in the rural and urban sector. The agricultural growth is influenced by numerous economic activities which are adopted by the Government from time to time. The state of West Bengal has seen a wide variation in its agro-activities nonetheless, trying to cope with the changing times. Starting from the implementation of land reforms in the 1970s to the commercialization of agriculture in the post liberalization period, the agricultural production is affected by a number of causes which in turn created ripples among the common masses through the public distribution system and pricing policies. As regards the joint application of technological solution and promulgation of institutional reforms, in West Bengal in India during 1980s and 1990s is a classic example in this context.

After the partition of India, 1947 West Bengal accounts for 3% of the total geographical area of India while it accounts for 8% of the total population of India. The partition of India ravaged the entire economy of Bengal. However with the establishment of the several public sector units such as Durgapur Steel Plant, Damodar Valley Corporation and abolition of Zamindari System, perhaps saved the economy. With the passage of time the economy however dwindled due to stagnation in agriculture and simultaneous stagnation in Jute Industry on both sides of river Hooghly. The Left Front government with the introduction of Operation Barga and tacit support of technology that is supply of fertilizer, irrigation facility and power at a moderate price was able to overcome the situation. The economy moved progressively up to the first decade of this millennium. The second decade of this millennium witnessed a new type of philosophy in West Bengal. Instead of focusing on growth oriented activities and long term solution to the problem the government focuses on the immediate benefits of the people and peasantry in question. With this background in mind let us explore few facts with respect to *rural households* and *operational holdings* as follows:

Estimated number of Rural Households and farmer households in India & West Bengal as on 2003

No. of families in Agricultural Sector in West Bengal		
	West Bengal	**India**
Estimated no. of rural households in '000	12166700	1478988
Estimated no. of farmer households in '000	69226	893504
Estimated no. of farmer households as a percentage of estimated no. of rural households	56.89%	60.41%

Source: Sachinandan Sau(2008), Database for Planning and Development in West Bengal, pg – 52.

Thus, we can see in the above table that around 56.89% of rural households were farmer households in West Bengal and the same figure was 60.41% for India.

Percentage Distribution of Operational Holding, West Bengal

Cultivator	1971-72	1982	1992	2003
Marginal farmers (0-1 hectare)	61.2	74.3	80.7	58.8
Small farmers (1-2 hectares)	22.8	15.8	13.4	8.9

Semi-medium farmers (2 – 4 hectares)	12.0	8.1	5.0	2.1
Medium farmers (4-10 hectares)	3.0	1.7	0.9	0.2
Large farmers (10 & above hectares)	0.1	0.1	0.0	0.0
All	100.0	100.0	100.0	100.0

Source: Sachinandan Sau(2008), Database for Planning and Development in West Bengal, pg – 52.

We can see in the above table that West Bengal's agriculture was predominantly a marginal and small farmer dominated state. This was mainly caused due to the land reforms executed through Operation Barga in the decade of 1980s which led to the rise in marginal farmers.

III. A Brief History of Agriculture in West Bengal

The story of West Bengal's vibrant agriculture undeniably needs to be preceded by a vivid disclosure of certain facts related to the state's agriculture and its development along with time. Travelling centuries back and delving into the past, quite blatantly reveals the agrarian relations and agriculture in West Bengal. So taking a snapshot of the 14thC, historical evidences speaks of the fact that 'undivided' Bengal was endowed with the most fertile land for its position being in the delta created by three great rivers, the Ganges, the Brahmaputra and the Meghna. The presence of sufficient rainfall, accompanied by abundant surface water along with underground aquifers and the warm temperature all-round the year, had made Bengal a highly privileged state for the flourish of agriculture. There had been a lot of evidences regarding the suitable agro-conditions in the state manifested in different travelogues and historical accounts.

In the Mughal period, a bulk of income was derived from agricultural production. The agents of the state, namely, revenue assessors, collectors, record keepers, intended to control rural society in order to ensure that cultivation took place and the state received its taxes from the produce. Perhaps, a large number of crops (around 39) were grown during the Mughal period. For instance, rice was cultivated in Bengal, Orissa, Assam valley and in other parts of the country, wheat and barley were grown intensively in the central plains and Gujarat, and maize was grown as a kharif crop in eastern Rajasthan from 1664. However, varied types of food crops, fruits, vegetables and crops were grown in the Mughal India. Coming to cash crops, cotton and sugarcane were cultivated widely during the Mughal era. Cotton was cultivated all over Northern India and also in Bengal, nonetheless, its cultivation declining in the later period. Bengal also produced good qual-

ity sugar in huge volumes during the Mughal times, the production of which declined in the later period. Bengal was also involved into producing Indigo, the dye-producing crop, apart from growing long pepper. Bengal produced large quantities of mulberry silk and engaged into the practice of sericulture. Silk was undeniably an important export product during the Mughal period, which witnessed a huge decline during the 19th century during the British reign. Thus, Bengal had an overpowering role in the agricultural production of food as well as cash crops with high export potentiality during the span of the Mughal rule, producing around 50 varieties of rice alone.

Tenancy and Tenurial Relations

In the history of Bengal, tenancy reform and consequently tenancy played a pivotal role in the performance of the agriculture. The agrarian system in India consisted of extraction of surplus produce from the peasants through what is known as 'land revenue'. It has been estimated by different scholars that in different era of ancient and medieval India, the land revenues varied in nature from 1/12 to 1/3 of the produce. However, sharecropping eventually emerged as an essential element in determining agrarian relation, important to mention that according to authors sharecropping dates back to the ancient period.

During the colonial era, the British East India Company pursued the rights of revenue collection over Bengal Presidency in order to establish a monopoly over the profitable textile trade in Bengal and on the exceedingly productive fertile land of Bengal.It seems important to mention that, the evolution of the tenancy system, the terms and conditions of tenancy agreements, coupled with the effect of the prevailing tenancy structure in the then British India, on the agricultural production and productivity of Bengal, has undeniably remained a subject matter of intense debate in the field of social science research throughout the years.

Colonial Period

In 1793, Lord Cornwallis entered into what was known as 'permanent settlement' with landlords of some states including Bengal, where the landlords or zamindars functioned as intermediaries between the cultivators and the State in collecting land revenue. In the pre-permanent settlement time, the zamindars who collected revenues for Nawabs of Bengal were identified as intermediaries by the British for collecting revenue. However in the zamindari system, a unique agrarian structure was formed all over the economy. Since the zamindars were conferred with unlimited rights to extract rent as much as they desired, around 25 per cent of the produce was taken away by the intermediaries in the form of rent. The consequence was certainly detrimental for agricultural growth since that hampered capital formation and economic development. The poor cultivator was left with hardly any surplus or no surplus, to invest in better implements, improved seeds or fertil-

izers and as such, there was no incentive for him to increase agricultural production and productivity. Apart from that, the development of credit institutions were very slow and public investments in agriculture were very less, in zamindari areas Thus, agricultural production dropped down drastically and from 1880s to 1940s, it increased quite slowly to lead to stagnation.

In the early 19th C, the failure of various legislations introduced by the British rulers to protect tenants in Bengal resulted in movements by sharecroppers, which quite intensified since the beginning of the 20thC. There existed a lot of uncertainties in agriculture, which nonetheless made the sharecroppers movements widespread. As mentioned before , the introduction of permanent settlement led to fall in agricultural production and productivity. In the early 20th C, whole of Bengal being an alluvial plain, could be divided into two parts - land of agricultural downfall i.e., West and Central Bengal, and land of agricultural prosperity i.e., East Bengal and Ganges-Brahmaputra Doab.

East Bengal

The major part of East Bengal was created by the deltas of the Ganges and the Brahmaputra. The occurrence of flood every year, led to the accumulation of fresh and fertile layer of silt every year. Districts like Dacca, Mymensingh, Khulna, Chittogong, Faridpur, Tippera, Bakerganj and Noakhali, comprised the area of East Bengal. The abundance of moisture in the fertile soil and the inundated plains, was generously producing aman rice in large quantities. East Bengal also produced one variety of jute in low flooded land and another variety which had to be manured in the absence of inundation silt. Apart from rice and jute, other crops like sugarcane, pulses, oilseeds, wheat, barley, tobacco and oats were also grown in this region.

West Bengal and Central Bengal

This region is very much the oldest agricultural settlement in India. Since the 17th C, there had been a change in the course of the rivers of the region towards the east, which aggravated in the 19th C leading to silting up of the rivers along with fall in sub-soil water levels, which led to agricultural decline. Districts like Malda, Dinajpur, parts of Rajsahi and Bogra were part of alluvial zone. However, the crops grown in old alluvial zone were aus rice, sugarcane, millets, maize, jowar, oilseeds, pulses, wheat, barley and jute to a small extent. There existed dominance of aus rice cultivation in the alluvial zone of West Bengal where there had been a lack of fresh flow of water due to salinity of the rivers. There had been a shift to inferior crops due to loss of silt-laden red water, which resulted in drastic fall in yields.

However in the middle of 19th C, the natural drainage system deteriorated due to the construction of rail and road embankments which in turn led to stagnant water and the on-

set of malaria. Consequently rural population declined and also cultivated land between 1891 and 1931.By the end of the 19th C, it seems important to mention here that jute became the most cash crop, specifically in East Bengal. Rice and jute played a pivotal role in Bengal's agricultural scenario. Rice was essential not only for consumption but also for earning cash through selling surplus produce.

20th C

1920 onwards, the growth in cultivation in East Bengal declined. The main reason behind the agricultural downfall was rapid growth of population. Between 1929 and 1933, there had been a fall in prices of rice and jute by 68 per cent and 61 per cent respectively. The farmers who were utterly deprived and neglected formed the 'Bongiyo Krishak Sava' in 1937. Starting from 1938 farmers' struggle gradually turned into 'farmers' revolt' in Bengal in the last part of the year 1946(Mukherjee & Mukherjee, 2015). Under 'Bongiyo Krishak Sava', farmers' primary demand was three-fourth of the produce from the share cropped land should come to the share-cropper (or *bargadar*). Apart from this, they also demanded abolishing zamindari system and the share cropper or *bargadar*has to be awarded 'Dakhali satta'(or right on land).The movement, however, did spread over 19 districts of Bengal from 1938 to 1946.

The Second World War along with rise in prices of rice coupled with the series of natural disasters between 1942 and 1943, the lack of attention of the British Government in market intervention to control the prices of food grains and hoarding of food grains by traders, led to famine and resultant death due to starvation of many people. In 1939 due to the onset of the Second World War, the imperialist was under pressure and consequently the 'Quit India' Movement started in 1942. This movement did spread in many villages against the tyrannical British rule. At certain places, there were oppression by landlords and moneylenders which dragged the villagers to involve in slavery. Starving farmers sold or mortgaged their land against a small sum and were themselves becoming share croppers and also landless farm labourer. The sharecropper incurred the entire cultivation expenses along with his labour but received only 50% of the produce.

In A.Mukherjee's work entitled 'Agrarian Problems' published in 1928 it has been said that, the average size of the holdings of Bengal was 2.59 acre. However in another scholarly work published in 1982, such were the estimates on land holdings and their size groups that small estates of 500 acres size were 85, 500 in number, 500-20,000 acres were 10,000 in number, larger than 20,000 acres were 500 in number. However, in another estimate, since 1875 number of landless cultivators constantly increased from 80 lakh in 1875 to 3 crore 40 lakh in 1901, 5 crore in 1911, 3 crore 70 lakh in 1921.

The independence of India and partition of Bengal, affected the state economically and socially. For instance, jute mills which were mainly on the banks of river Ganga in West

Bengal, were produced in East Pakistan area. Large number of farmers living in colonies and camps could not apply their skill in crop cultivation. West Bengal started its post-independence journey as a food-deficit state. Indian agriculture was nonetheless, struggling due to lack of good irrigation system as well as satisfactory fertiliser-use. States with comparatively less population started developing fast through faster development of irrigation facilities. However, Bengal's agriculture had to face another problem, that is of, ownership of agricultural land, i.e., through Permanent Settlement as previously described. This led to continued exploitation of farmers, share-croppers and poor farm labourers, who faced obstacles in crop cultivation out of free will. Thus, agriculture suffered massively at the micro level and at the macro level of the State.

In 1940s, there was a food crisis in India and as such during 1942-43 innumerable people died in Bengal. The Government post-Independence, realised the importance of food production and as such emphasised agriculture in the First Five Year Plan (1951-56).One study revealed that the area under tenancy decreased from around 42 per cent in 1950-51 to between 20 and 25 per cent by the early 1960s.

It must be mentioned that West Bengal was in fact the first state to impose ceiling on agricultural holdings by enacting the West Bengal Land Reforms Act in 1955 and uniform family ceiling of 10 hectares was introduced. In the mid-60s, the economy witnessed downfall of the economic and political scenario due to several factors like inflation, Indo Pak War & emergence of Naxalite movement in Bengal and in other parts of the country. The decade of 60s also saw the phenomenal initiative called "green Revolution' taken in the agricultural sector. The technology used in Green Revolution introduced high yielding variety (HYV) seeds that worked along with chemical fertilisers and heavy irrigation to increase crop production. However, the result of such a big leap was actually enjoyed by states having better infrastructural facilities (of assured water supply and a package of inputs on whose availability the productivity of HYV seeds was dependent), like Punjab, Haryana and western Uttar Pradesh. In the state of West Bengal where the growth of food grains output showed down during 1967-68 to 1977-78, showed a marked improvement in performance in agriculture in the period after 1977-78. The state of Bengal performed spectacularly in the period 1981-82 to 1990-91 by surpassing all other states in food grains output growth with a Compound Annual Growth Rate (CAGR) of 6.1 per cent. As far as food grains yield per hectare is concerned, West Bengal recorded a growth rate of around 5.05 per cent per annum in the period 1981-82 to 1990-91. Various research works have pointed the reason behind the successful growth as the result of agrarian reforms which helped in changing the nature of the agrarian production relations that in turn led to a more efficient utilisation of resources and widening the accessibility to Green Revolution.

Post - liberalization

Due to the economic reforms in 1991, the agricultural sector in India, did not derive the expected benefits from trade liberalisation and also failed to experience any significant growth as a result of initiation of the economic reforms. Compared to the pre-liberalisation period the decade of 80s, agricultural growth recorded a significant deceleration in the post-liberalisation period, i.e., the decade of 90s. West Bengal recorded a yield growth rate of 4.81% p.a during 1980-83 to 1990-93 which drastically dropped down to 1.90% p.a in the period 1990-93 to 2003-06.

The *current study* intends to delve deep into the trend of agricultural productivity in the West Bengal at the district level, in the new millennium. The effect of major technological factors like irrigation will be highlighted to enhance the reason of the achieved trend. District level data for 2 districts will be analysed to interpret the trend and draw conclusion by using some important parameters which are indicators for agricultural growth and productivity. For this purpose two districts are selected Nadia and Birbhum, for drawing a clear picture of the agricultural trend. The district level analysis will highlight the factors behind the trend through emphasizing on a couple of agricultural performance indicators. Consequently, the effect on the agricultural productivity will be highlighted through pointing on socio-economic indicators which affects the rural life and rural development.

IV. Research on Trends in Agricultural Production

The present research is an extensive study on agricultural trends in West Bengal and considering the time spent, the study has some definite objectives which it intends to achieve. The objectives for the present analysis on agricultural trends intends to create a path for the project to reach its conclusion. As such, the following *objectives* are elucidated to emphasize the significance of such objectives:

1. Analyze trend and highlight the factors behind the trend in agricultural production

A trend reflected by a given time series data is caused by certain factors. The trend shows the general tendency of the data to increase or decrease during a long period of time. Thus, it might be stated that a trend is a smooth, long-term, average tendency of a time series data.

The calculation and analyses of the trend of agricultural production will effectively focus on the factors behind the trend and the significance of the factors in playing an important role in affecting the trend. Thus, a trend analysis is done to explain how the agricultural sector performed in the state of West Bengal in the selected period of analysis, i.e., 2000-2014.

2. Emphasize the role played by technological factors

The agricultural sector of West Bengal was a late-receiver of the benefits of the green revolution. The state was deprived of certain supporting factors, like technological and institutional factors, to reap the full advantage of the green revolution. However, with the initiation of the land reforms through Operation Barga in the late 1970s and introduction of technological factors in later period of time like irrigation, etc. the state started performing well in the 1980s.

The paper intends to highlight the technological factors like irrigation, high-yielding variety seeds in affecting the trend in agricultural production, considering the period of time i.e., in the new millennium, when technological factors gained a lot of importance in influencing the agricultural production.

3. Specify the impact of liberalization

The period of the analysis for the agricultural trend is from 2000-2014. Hence, given that the liberalization occurred in the year 1991, it can be fairly stated that the current study will nonetheless imply, that the opening up of the economy through the process of liberalization had an effect on the agricultural production in the state. In the new century which falls in the post-liberalization period, there was an emerging trend in marketing activities in the agricultural sector. The trend in agricultural production given the effect of technological factors also indirectly speaks of the influence of marketing activities on the agriculture of the state.

4. Effect of the analyzed trend on the rural economy

The study on trend in agricultural production of West Bengal will be incomplete without analyzing the effect of such a trend on the lives of the rural people. Hence, the project intends to study the impact of the trend on the rural economy through certain parameters which are important in rural development. Agriculture is an important source of livelihood in the rural sector in any states of India. So change in agricultural production and productivity, undeniably affects the lives and livelihood of rural people since majority of rural people depends on rural economy, specifically on the farm sector in various agricultural and allied activities.

V. Trend of Agricultural Production - An Analysis & Interpretation

In this section, the trend of agricultural production is analyzed and interpreted effectively to give a vivid picture of the state of agriculture in the state of West Bengal. As such, on the basis of a few important performance indicators the trend is analyzed using tables and bar graph. The agricultural performance of the two districts of Nadia and Birbhum is studied to get a picture of the trend at the district level.

Nadia Table: 1 Cropping Intensity Nadia (2000-2014)

(Area in thousand hectares)				
Year	Current fallow	Net area sown	Gross Cropped Area(GCA)	Cropping Intensity
2000-01	8.53	298.49	307.02	102.86
2001-02	5.42	306.86	312.28	101.77
2002-03	3.61	310.8	314.41	101.16
2003-04	3.94	307.22	311.16	101.28
2004-05	4.29	299.94	304.23	101.43
2005-06	5.25	291.99	297.24	101.79
2006-07	6.90	290.00	296.9	102.38
2007-08	5.83	289.25	295.08	102.02
2008-09	5.05	289.17	294.22	101.75
2009-10	4.40	290.74	295.14	101.51
2010-11	4.18	290.45	294.63	101.44
2011-12	4.26	292.94	297.20	101.45
2012-13	3.43	293.55	296.98	101.17
2013-14	2.94	294.30	297.24	100.99

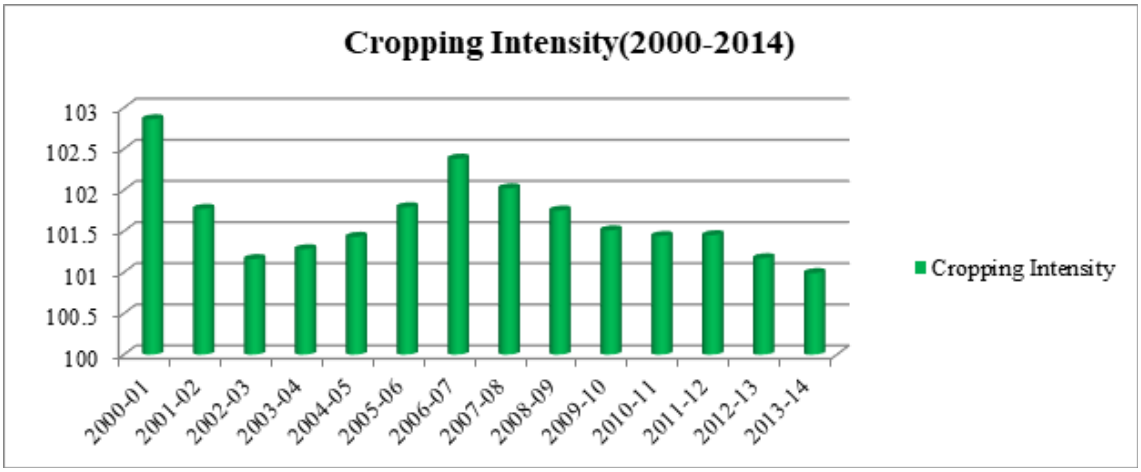
Source: District Statistical Handbook (Nadia), Bureau of Applied Economics and Statistics,

Department of Statistics & Programme Implementation, Government of West Bengal. Cropping Intensity = (Gross Cropped Area/Net Cropped Area)* 100

The above table describes the cropping intensity of Nadia district. *Cropping intensity* is defined as the ratio of gross cropped area to net cropped area.*Gross Cropped Area* is defined as the total area sown once and/more than once in a particular area, i.e., the area is counted as many times as there are sowings in the year. *Gross Cropped Area* = Current Fallow + Net Area Sown. *Current fallow* is the land which is left without cultivation for one or less than one agricultural year.*Net area sown* represents an area in which total crops are grown only once in a year.

As we can see, that the cropping intensity was 102.86 in the year 2000-01. There onwards it was fairly stable from the year 2001-02 to 2005-06. Again it increased to around

102 from 2006-2008, and then after that falling to around 101. The cropping intensity was least in the year 2013-14. Thus, there was very less fluctuation in the cropping intensity.



The cropping intensity is portrayed using a bar graph where intensity is highest in the year 2000-01. Thus a fairly stable cropping intensity is observed throughout the study period.

Table: 2 Non-traditional irrigation as % of GCA Nadia (2000-2014)

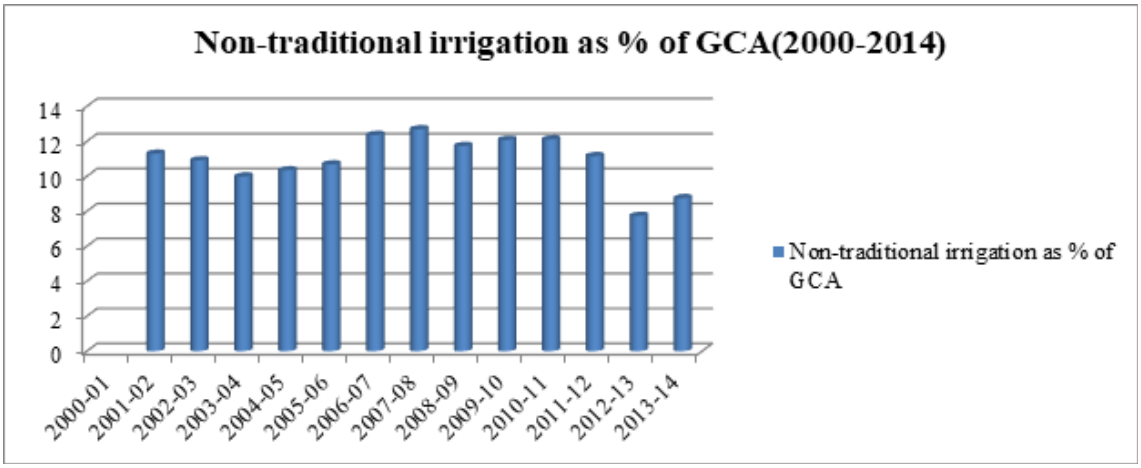
(Area in thousand hectares)						
Year	HDTW	MDTW	LDTW	RLI	Non-tra-ditional Irrigation	Non-traditional irrigation as % of GCA
2000-01	NA	..	..	..	-	-
2001-02	22.15	0.67	1.8	10.65	35.27	11.29
2002-03	22.07	0.64	1.28	10.32	34.31	10.91
2003-04	19.42	0.6	1.04	10.01	31.07	9.99
2004-05	19.38	0.29	0.6	11.19	31.46	10.34
2005-06	19.71	0.32	0.65	11.07	31.75	10.68
2006-07	24.21	0.56	0.96	10.98	36.71	12.36
2007-08	25.40	0.55	0.97	10.52	37.44	12.69
2008-09	21.56	0.66	1.40	10.90	34.52	11.73
2009-10	22.03	0.62	1.31	11.70	35.66	12.08

2010-11	22.09	0.60	1.30	11.70	35.69	12.11
2011-12	21.85	0.60	1.30	9.40	33.15	11.15
2012-13	11.79	0.44	0.06	10.68	22.97	7.73
2013-14	14.96	0.40	0.04	10.61	26.02	8.75

Source: District Statistical Handbook (Nadia), Bureau of Applied Economics and Statistics, Department of Statistics & Programme Implementation, Government of West Bengal.

HDTW = High capacity Deep Tubewell, MDTW = Middle capacity Deep Tubewell, LDTW = Low capacity Deep Tubewell, RLI = River lift Irrigation

Non-traditional irrigation is another important performance indicator of agricultural production trend. The above table has four types of non-traditional irrigation, High capacity Deep Tubewell, Middle capacity Deep Tubewell, Low capacity Deep Tubewell, and River lift Irrigation. It can be seen that there is a non-avalability of data for the year 2000-01. From the year 2001-02 to 2003-04, there has been a decline in the non traditional irrigation as a percentage of GCA. From 2004-05 to 2005-06, the figures declined to around 10 and thereafter it increased to 12.36 in the year 2006-07 and 12.69 in the year 2007-08. Thereafter, the percentage of non-traditional irrigation as a percentage of GCA fluctuated till the year 2011-12and then gradually declined till 2013-14. Thus we can see that the significance and usage of non-traditional irrigation methods changed over the years. There has been quite a significant fluctuation in the area covered by all the medium of irrigation. Area covered by HDTW is comparatively more than the area covered by the other modes of irrigation. Next to HDTW, the second highest contributor of irrigation is RLI. The area covered by MDTW and LDTW is quite low.



The above diagram showing a bar graph is depicting the non-traditional irrigation as a

percentage of GCA. There is more or less stagnation in the usage of non-traditional methods, the highest being in the year 2007-08.

Table 3: Non-traditional irrigation as % of GCA, Area under Boro, HYV (High Yielding Variety) as % of GCA (2000-2014)

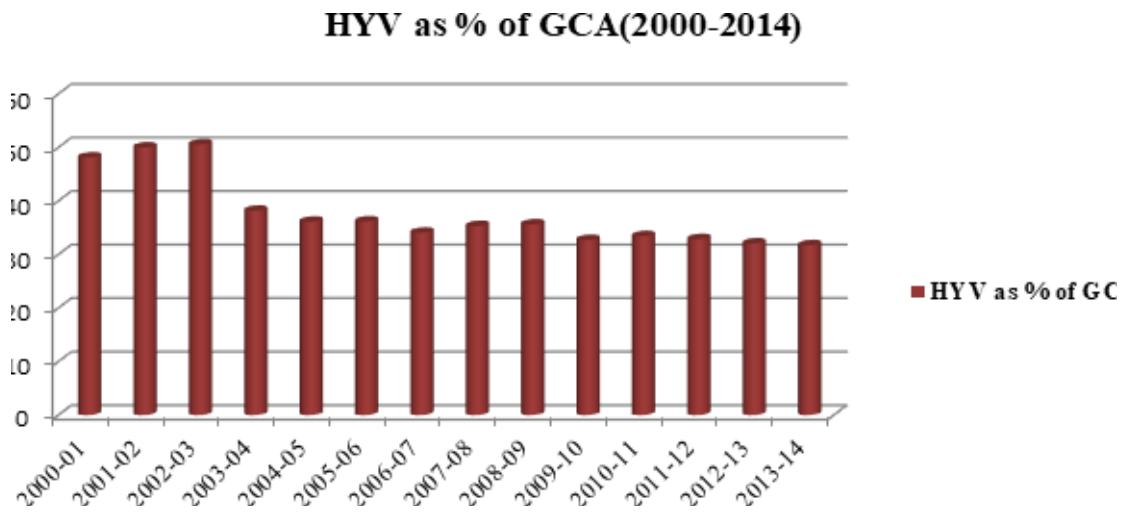
(Area in thousand hectares)

Year	Gross Cropped Area (GCA)	Non-traditional Irrigation	Non-traditional irrigation as % of GCA	Area under Boro	HYV as % of GCA
2000-01	307.02	-	-	147.7	48.12
2001-02	312.28	35.27	11.29	156.1	49.99
2002-03	314.41	34.31	10.91	158.9	50.54
2003-04	311.16	31.07	9.99	118.8	38.18
2004-05	304.23	31.46	10.34	109.9	36.12
2005-06	297.24	31.75	10.68	107.5	36.17
2006-07	296.9	36.71	12.36	101.1	34.06
2007-08	295.08	37.44	12.69	104.2	35.31
2008-09	294.22	34.52	11.73	104.8	35.62
2009-10	295.14	35.66	12.08	96.5	32.69
2010-11	294.63	35.69	12.11	98.5	33.43
2011-12	297.2	33.15	11.15	97.7	32.87
2012-13	296.984	22.97	7.73	95.2	32.06
2013-14	297.242	26.016	8.75	94.3	31.73

Source: District Statistical Handbook (Nadia), Bureau of Applied Economics and Statistics, Department of Statistics & Programme Implementation, Government of West Bengal.

The above table shows the area under Bororice and HYV as percentage of GCA. Boro rice is commonly known as winter rice. In the table we can see, that there has been an overall fall in the area under Boro. As regarding HYV as percentage of GCA, there was rise in the percentage from the year 2000-01 to 2002-03 from 48.12 % to 50.54%. Thereafter there has been a gradual fall in HYV as percentage of GCA. The area under Boro has seen a gradual decrease in thousand hectares, from 147.7 thousand hectares in 2000-01, to

156.1 thousand hectares in 2001-02, and then decreasing continuously to 94.3 thousand hectares in 2013-14.



The table is depicted in the graph. There have been minor fluctuations in the years post 2002-03, showing a slow and falling trend in the area cultivated under HYV crop. HYV as a percentage in GCA was highest in the year 2002-03. Thereby it rose and fell in different years. However, in the years 2000-01 to 2002-03, the value was the highest.

Birbhum

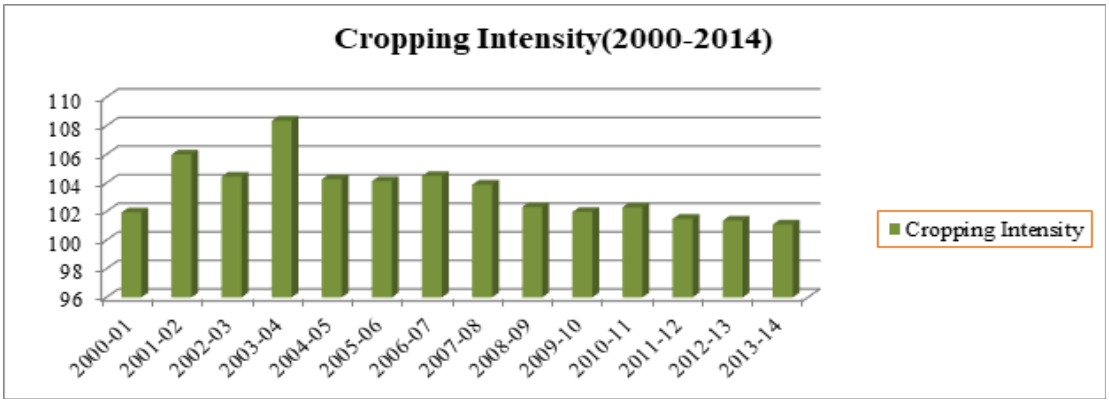
Table: 4 Cropping Intensity Birbhum(2000-2014)

(Area in thousand hectares)				
Year	Current fallow	Net area sown	Gross Cropped Area(GCA)	Cropping Intensity
2000-01	6.54	337.53	344.07	101.94
2001-02	19.21	320.32	339.53	105.99
2002-03	14.55	326.85	341.4	104.45
2003-04	26.03	311.45	337.48	108.36
2004-05	13.65	320.61	334.26	104.26
2005-06	13.23	319.96	333.19	104.13
2006-07	14.25	317.67	331.92	104.49

2007-08	12.35	318.54	330.89	103.88
2008-09	7.42	320.08	327.50	102.32
2009-10	6.36	322.23	328.59	101.97
2010-11	7.33	319.96	327.29	102.29
2011-12	4.85	325.39	330.24	101.49
2012-13	4.46	326.02	330.48	101.368
2013-14	3.60	327.01	330.61	101.1

Source: District Statistical Handbook (Birbhum), Bureau of Applied Economics and Statistics, Department of Statistics & Programme Implementation, Government of West Bengal.

The above table shows the cropping intensity of the district Birbhum in the period 2000-2014. Initially in the year 2000-01, the cropping intensity was 101.94. It gradually dropped down to 104.45 in the year 2002-03, and then again rose to 108.36 in the year 2003-04, implying rise in gross cropped area as percentage to net area sown. Post 2003-04 there has been stagnation for three consecutive years in cropping intensity till 2006-07, and then the cropping intensity has seen fluctuation and a gradual decline till 101.1, in the year 2013-14.



The cropping intensity for the district Birbhum is shown in the above diagram, where the highest value of cropping intensity is attained in the year 2003-04. Thereafter, there is a trend of gradual decline in the cropping intensity.

Table 5: Non-traditional Irrigation Birbhum(2000-2014)

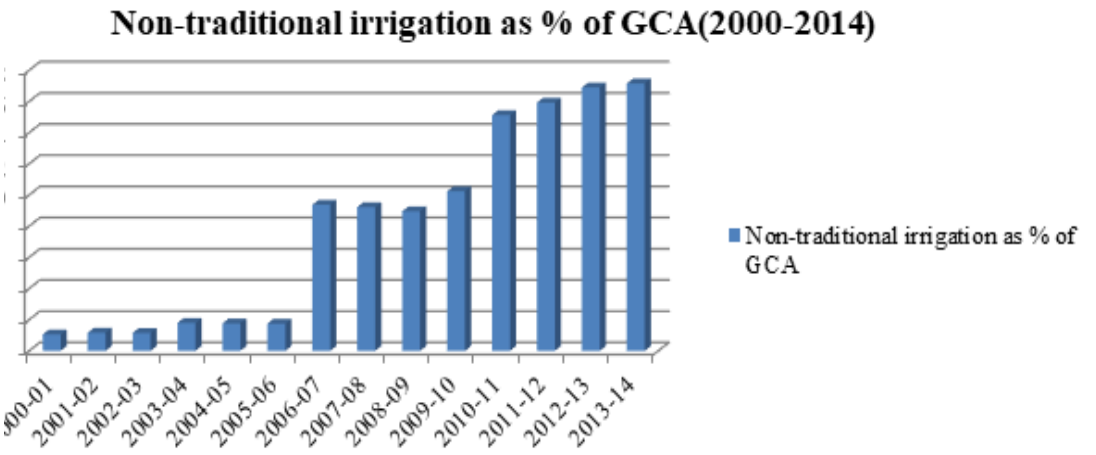
(Area in thousand hectares)						
Year	HDTW	MDTW	LDTW	RLI	Non-traditional Irrigation	Non-traditional irrigation as % of GCA
2000-01	_	0.75	0.82	2.05	3.62	1.05
2001-02	_	0.9	0.88	2.15	3.93	1.16
2002-03	_	0.9	0.88	2.15	3.93	1.15
2003-04	*	3.89	*	2.15	6.04	1.79
2004-05	*	3.74	*	2.15	5.89	1.76
2005-06	*	3.72	*	2.08	5.8	1.74
2006-07	1.00	16.80	7.70	5.60	31.10	9.37
2007-08	1.00	16.40	7.70	5.40	30.50	9.22
2008-09	1.40	15.30	7.90	4.70	29.30	8.95
2009-10	1.40	16.40	11.40	4.40	33.60	10.23
2010-11	1.21	18.08	24.63	5.53	49.45	15.11
2011-12	1.21	22.10	23.65	5.63	52.59	15.92
2012-13	0.87	28.47	21.97	4.51	55.82	16.89
2013-14	0.89	29.21	22.24	4.37	56.71	17.15

Source: District Statistical Handbook (Birbhum), Bureau of Applied Economics and Statistics, Department of Statistics & Programme Implementation, Government of West Bengal.

*included in MDTW

As per the data provided by the source, non-traditional irrigation as % of GCA was around 1% from 2000-01 to 2005-06. Thereafter there has been a sudden rise in the percentage to 9.37% in 2006-07, which was 9.22% in 2007-08. Again the percentage gradually fell to 8.95% in the year 2008-09. Then it continuously rose, and reached 17.15% in the year 2013-14. This is due to increase in usage of HDTW and LDTW, which are shown in the table. Then onwards there is a rising trend of the percentage of non-traditional irrigation to GCA till the year 2013-14. The area covered by MDTW has a sharp rise from 18.08 thousand hectares in the year 2010-11 to 22.10 thousand hectares in the year 2011-12, and continuously rose to 29.21 thousand hectares in 2013-14. Also the area covered

by LDTW has seen a rise from 11.40 thousand hectares in2009-10 to 24.63 thousand hectares in 2010-11 and continuously rose to 22.24 thousand hectares in 2013-14. The area covered by RLI was around 2 thousand hectareson and before 2005-06, and then it has a rising trend gradually with fluctuations in between, from 5.60thousand hectares in 2006-07 to 4.37 thousand hectares in the year 2013-14. However, as per figures available, the area covered by HDTW was quite low in comparison to other modes of irrigation.



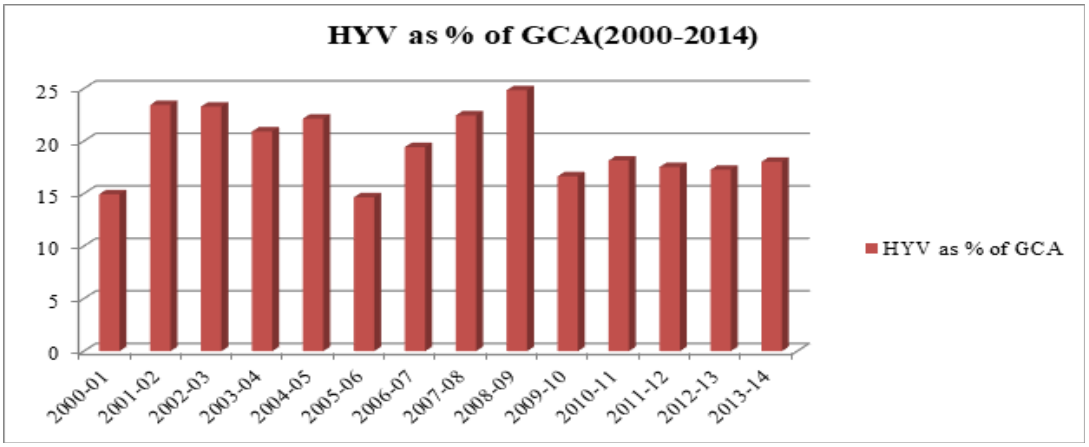
The above bar diagram exactly shows, as shown by the table, that there is a sudden increase in the figure of non-traditional irrigation as a percentage of GCA in the year 2006-07. Then onwards, there has been a gradual rise in trend in the percentage of non-traditional irrigation to GCA, from 2007-08 to 2013-14, with in-between fluctuations.

The table below is given to describe area under Bororice and percentage of HYV to GCA. The area under Boro was quite low at 51.4 thousand hectares in the year 2000-01 and rose to 79.6 thousand hectares in 2001-02 and was almost same 79.5 thousand hectares in 2002-03. In the next two years, it was 70.6 thousand hectares in 2003-04 and 74 thousand hectares in 2004-05. Thereafter there was a sudden drop in area under Boro to 48.8 thousand hectares in 2005-06, and with occasional fluctuations the area under Boro changed and was finally 59.6 thousand hectares in 2013-14. Thus, the percentage of HYV as percentage of GCA has seen considerable fluctuation, highest value being 24.85% in the year 2008-09. Thereafter, there has been a trend of gradual decrease.

Table 6: Non-traditional Irrigation as % of GCA, Area under Boro, HYV as % of GCA(2000-2014)

(Area in thousand hectares)					
Year	Gross Cropped Area(GCA)	Non-traditional Irrigation	Non-traditional irrigation as % of GCA	Area under Boro	HYV as % of GCA
2000-01	337.53	3.62	1.05	51.4	14.94
2001-02	320.32	3.93	1.16	79.6	23.44
2002-03	326.85	3.93	1.15	79.5	23.29
2003-04	311.45	6.04	1.79	70.6	20.92
2004-05	320.61	5.89	1.76	74	22.14
2005-06	319.96	5.8	1.74	48.8	14.65
2006-07	317.67	31.1	9.37	64.5	19.43
2007-08	318.54	30.5	9.21	74.3	22.45
2008-09	320.08	29.3	8.95	81.4	24.85
2009-10	322.23	33.6	10.23	54.7	16.65
2010-11	319.96	49.45	15.11	59.4	18.15
2011-12	325.39	52.59	15.92	57.9	17.53
2012-13	326.02	55.82	16.89	57.1	17.28
2013-14	327.01	56.71	17.15	59.6	18.03

Source: District Statistical Handbook (Birbhum), Bureau of Applied Economics and Statistics, Department of Statistics & Programme Implementation, Government of West Bengal.



The above chart shows diagrammatically the fluctuations in the figures of HYV as a percentage of GCA, highest value being 24.85% in the year 2008-09.Thus there has been a high fluctuations in the calculated percentage, showing frequent fluctuations in the area under Boro. However, the trend is falling from the year 2009-10.

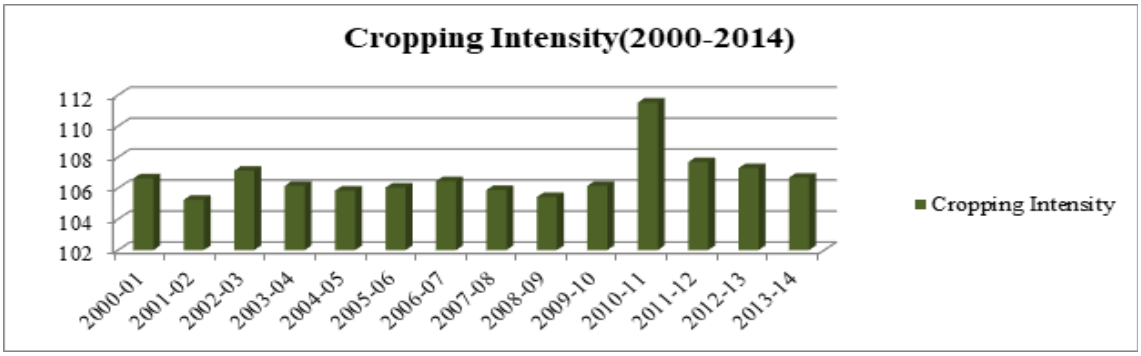
West Bengal

Table 7: Cropping Intensity West Bengal (2000-2014)

(Area in thousand hectares)				
Year	Current fallow	Net area sown	Gross Cropped Area (GCA)	Cropping Intensity
2000-01	358.36	5417.38	5775.74	106.62
2001-02	289.46	5521.58	5811.04	105.24
2002-03	381.25	5354.19	5735.44	107.12
2003-04	333.37	5427.67	5761.04	106.14
2004-05	314	5374.71	5688.71	105.84
2005-06	319.24	5294.7	5613.94	106.03
2006-07	341.23	5296	5637.23	106.44
2007-08	310.78	5295.77	5606.55	105.87
2008-09	287.18	5294.04	5581.22	105.42
2009-10	322.73	5255.81	5578.54	106.14
2010-11	574.24	4991.22	5565.46	111.51
2011-12	398.73	5198.15	5596.88	107.67
2012-13	379.44	5204.9	5584.34	107.29
2013-14	349.3	5233.73	5583.03	106.67

Source: Statistical Abstract, Bureau of Applied Economics and Statistics, Department of Planning, Statistics and Programme Monitoring, Government of West Bengal.

In the above table, the cropping intensity of the entire state of West Bengal is shown. GCA in the year 2000-01 was 5775.74 thousand hectares, which rose in the next year to 5811.04 thousand hectares, and finally dropped down gradually to 5583.03 thousand hectares in the year 2013-14.However, regarding the cropping intensity of the state, there were fluctuations from 2000-01 when the value was 106.62. Then it increased and decreased along with time. The highest value of cropping intensity was in the year 2010-11, when it was 111.51. Henceforth, it dropped gradually to 106.67 in the year 2013-14.



The above diagram reflects the data of Table 7 in a Bar graph. There is a frequent fluctuation in the values of the cropping intensity, 2010-11 having the tallest bar among all the bars. Thus, considering the fact that the state of West Bengal is pre-dominantly having an agro-based economy, the cropping intensity is not quite impressive down the years in the new millennium.

Table 8: Non-traditional irrigation as % of GCA West Bengal (2000-2014)

(Area in thousand hectares)

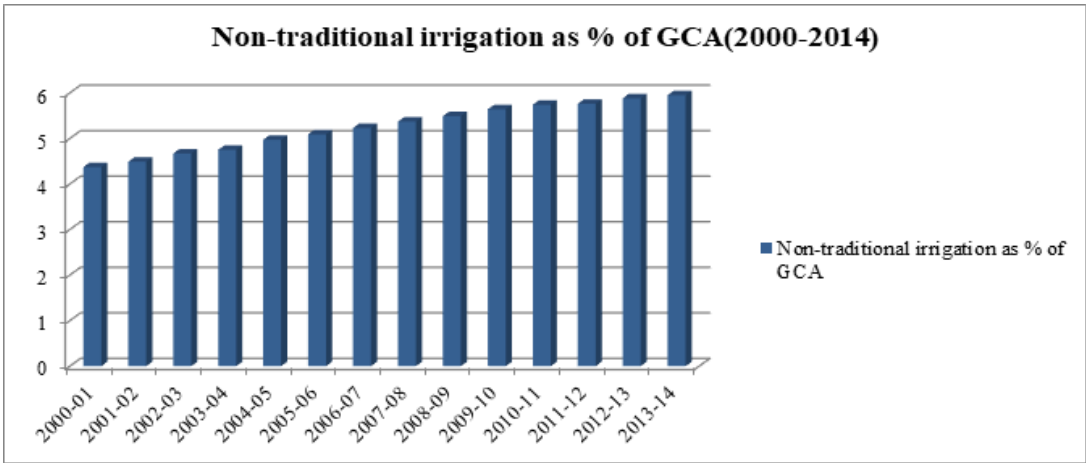
Year	HDTW	MDTW	LDTW	RLI	Non-traditional Irrigation	Non-traditional irrigation as % of GCA
2000-01	150.28	9.4	15.545	77	252.225	4.37
2001-02	151.8	10.34	15.89	82.76	260.79	4.49
2002-03	152.4	10.64	16.285	88.76	268.085	4.67
2003-04	153.8	11.02	16.78	92.16	273.76	4.75
2004-05	153.68	11.52	18.2	99.42	282.82	4.97
2005-06	153.76	12.18	18.515	101.64	286.095	5.09
2006-07	156.48	13.48	19.62	105.04	294.62	5.23
2007-08	157	14.68	21.07	108.48	301.23	5.37
2008-09	157.68	15.42	22.5	111.16	306.76	5.49
2009-10	159.12	15.32	23.37	116.72	314.53	5.64
2010-11	158.16	16	24.36	120.8	319.32	5.74
2011-12	157.8	16.78	25.34	122.36	322.28	5.76

2012-13	159.56	17.5	29.35	122.08	328.49	5.88
2013-14	158.32	18.34	32.465	123.62	332.745	5.95

Source: Statistical Abstract, Bureau of Applied Economics and Statistics, Department of Planning, Statistics and Programme Monitoring, Government of West Bengal.

HDTW/MDTW/LDTW = Command Area under HDTW/MDTW/LDTW * No. of Tube wells

The table 8 shows the non-traditional irrigation, as percentage of GCA, the non-traditional irrigation being HDTW, MDTW, LDTW and RLI. The area covered by HDTW is more than the other modes of irrigation. The command area for HDTW is 40 hectares, for MDTW is 20 hectares, for LDTW is 5 hectares and for RLI (mini) is 20 hectares. There has been a gradual increase in area covered (in thousand hectares) by these medium of irrigation. Initially area covered by HDTW was 150.28 thousand hectares, MDTW was 9.4 thousand hectares, LDTW was 15.545 thousand hectares and RLI was 77 thousand hectares. After HDTW, RLI is the second biggest contributor in irrigating the GCA. As such, area covered by non-traditional modes of irrigation saw a gradual increase from 252.225 thousand hectares to 332.745 thousand hectares. Therefore, the percentage of non-traditional irrigation to GCA also steadily increased from 4.37% in 2000-01 to 5.95% 2013-14.



The above diagram aptly reflects the steady increase in the percentage of non-traditional irrigation to GCA, reflecting a growing importance of non-traditional irrigation in the agriculture of the state. Thus we can see that the modern techniques are more in use in agricultural growth along the years. The length of the bar has gradually increased in all the years.

Table 9: Non-traditional Irrigation as % of GCA, Area under Boro, HYV as % of GCA West Bengal (2000-2014)

(Area in thousand hectares)					
Year	Gross Cropped Area(GCA)	Non-traditional Irrigation	Non-traditional irrigation as % of GCA	Area under Boro	HYV as % of GCA
2000-01	5775.74	252.225	4.37	1401.8	24.27
2001-02	5811.04	260.79	4.49	1455	25.04
2002-03	5735.44	268.085	4.67	1406.1	24.52
2003-04	5761.04	273.76	4.75	1390.1	24.13
2004-05	5688.71	282.82	4.97	1376.4	24.13
2005-06	5613.94	286.095	5.09	1381.9	24.62
2006-07	5637.23	294.62	5.23	1401.2	24.86
2007-08	5606.55	301.23	5.37	1511.6	26.96
2008-09	5581.22	306.76	5.49	1556.7	27.89
2009-10	5578.54	314.53	5.64	1429.7	25.63
2010-11	5565.46	319.32	5.74	1369.9	24.61
2011-12	5596.88	322.28	5.76	1221.1	21.82
2012-13	5584.34	328.49	5.88	1228.3	21.99
2013-14	5583.03	332.745	5.95	1287	23.06

Source: Statistical Abstract, Bureau of Applied Economics and Statistics, Department of Planning, Statistics and Programme Monitoring, Government of West Bengal.

The above table 9 clearly shows the area under Boro rice, in thousand hectares. In the previous table 8 we saw the rise in non-traditional irrigation as percentage of GCA and rise in area covered by non-traditional irrigation. Thus, along with irrigation the area under Boro has fluctuated by occasionally rising and falling. In the year 2000-01, the area under Boro was 1401.8 thousand hectares which sharply rose to 1455 thousand hectares in the year 2001-02 and then gradually started falling till 2005-06 and then again sharply rose to 1511.6 thousand hectares in the year 2007-08 and 1556.7 thousand hectares in the year 2008-09. Then again in the upcoming years it started falling till reaching 1287 thousand hectares in the year 2013-14.Regarding HYV as percentage of GCA, there was

stability in the values surrounding 24% to 26% in the initial years till 2007-08, 2008-09 having the highest value of 27.89%. Thereafter there is a falling trend from 25.63% in 2009-10 to 23.06% in 2013-14.

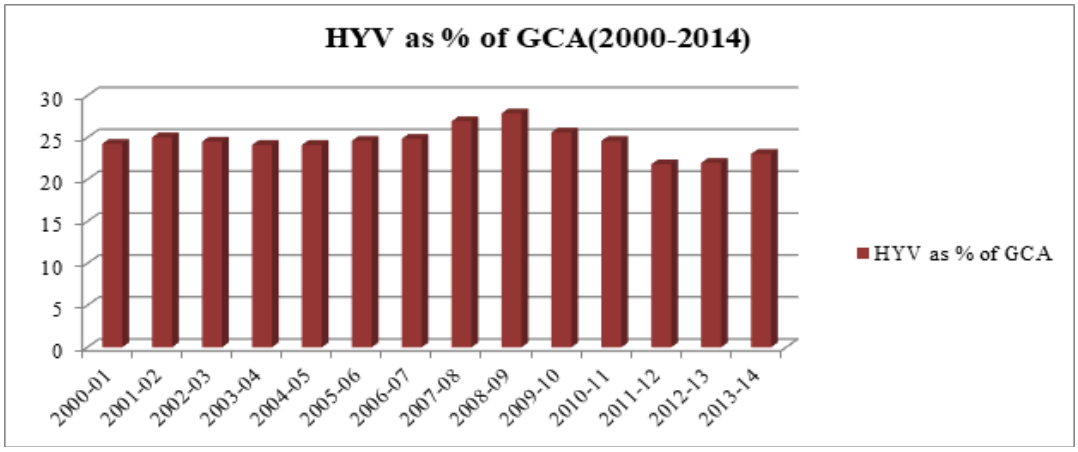


Table 9 is reflected in the above diagram with 2008-09 having the highest value of 27.89%. The bar graph has a rising trend in the initial two years and then falling and steeply rising till 2008-09. Then post 2008-09, the bar graph is seen falling till 2012-13 and then slightly rising in 2013-14.Thus in the middle years of the study period there was a rise in the percentage of HYV to GCA and then falling till 2013-14.

Comparative Study: West Bengal, Nadia and Birbhum(2000-2014)

Table: 10 Cropping Intensity

(Area in thousand hectares)

Year	West Bengal	Nadia	Birbhum
2000-01	106.62	102.86	101.94
2001-02	105.24	101.77	105.99
2002-03	107.12	101.16	104.45
2003-04	106.14	101.28	108.36
2004-05	105.84	101.43	104.26
2005-06	106.03	101.79	104.13
2006-07	106.44	102.38	104.49
2007-08	105.87	102.02	103.88

2008-09	105.42	101.75	102.32
2009-10	106.14	101.51	101.97
2010-11	111.51	101.44	102.29
2011-12	107.67	101.45	101.49
2012-13	107.29	101.17	101.368
2013-14	106.67	100.99	101.1

Source: Bureau of Applied Economics and Statistics

The above table no. 10 helps us to compare the cropping intensity of West Bengal and the districts, Nadia and Birbhum. The cropping intensity of West Bengal is higher .than the districts Nadia and Birbhum

Table11: Non-traditional irrigation as % of GCA

(Area in thousand hectares)

Year	West Bengal	Nadia	Birbhum
2000-01	4.37	-	1.05
2001-02	4.49	11.29	1.16
2002-03	4.67	10.91	1.15
2003-04	4.75	9.99	1.79
2004-05	4.97	10.34	1.76
2005-06	5.09	10.68	1.74
2006-07	5.23	12.36	9.37
2007-08	5.37	12.69	9.22
2008-09	5.49	11.73	8.95
2009-10	5.64	12.08	10.23
2010-11	5.74	12.11	15.11
2011-12	5.76	11.15	15.92
2012-13	5.88	7.73	16.89
2013-14	5.95	8.75	17.15

Source: Bureau of Applied Economics and Statistics

As regards, non-traditional irrigation as percentage of GCA, in the initial years of the study period 2000-2014, it was highest in district Nadia compared to West Bengal and Birbhum. In the overall data, the percentage is lowest in West Bengal, compared to the districts Nadia and Birbhum.

Table 12: HYV as % of GCA

(Area in thousand hectares)

Year	West Bengal	Nadia	Birbhum
2000-01	24.27	48.12	14.94
2001-02	25.04	49.99	23.44
2002-03	24.52	50.54	23.29
2003-04	24.13	38.18	20.92
2004-05	24.13	36.12	22.14
2005-06	24.62	36.17	14.65
2006-07	24.86	34.06	19.43
2007-08	26.96	35.31	22.45
2008-09	27.89	35.62	24.85
2009-10	25.63	32.69	16.65
2010-11	24.61	33.43	18.15
2011-12	21.82	32.87	17.53
2012-13	21.99	32.06	17.28
2013-14	23.06	31.73	18.03

Source: Bureau of Applied Economics and Statistics

In the above table no.12, HYV as percentage of GCA has a falling trend both for West Bengal and the districts Nadia and Birbhum. The percentage was highest in Nadia in the initial years of the study period, and lowest in Birbhum. There have been fluctuations in value in the districts. However, for overall state it was quite stable in the study period.

VI. Impact on the Rural Economy

To study the impact of trends in agricultural production on the rural economy, it is important to mention that the rural economy is dependent highly on the farm and the

non-farm sector in the rural area. As such, if there is a decline or stagnation in agricultural production which leads to fall in employment, there undoubtedly exists the 'rural push factor', such as decline in income from agriculture, lack of alternative job, declining local economy and lack of access to basic facilities, which results in large-scale migration to the cities. In India, the post-Independence times have seen such migration from rural to urban areas. In the context of the current study, the impact of stagnation or decline in the agricultural production of West Bengal has been captured in the following table showing data on rural-urban migration:

Growth rate of migration in West Bengal during 1991 – 2011 (Rural –Urban)

No. of migrants			Annual Growth Rate	
1991	2001	2011	1991-2001	2011 - 2001
2727946	3405729	5658340	2.48%	6.61%

Source: D series Census data (1991, 2001, 2011)

In the above table, we can see that there has been a rise in migration from rural to urban areas post-liberalization, from 2727946 in 1991 to 3405729 in 2001. It further increased to 5658340 in 2011. Thus, it can be fairly concluded that despite the liberalization which led to the opening up of the economy, agriculture in West Bengal faced a dismal situation, specifically after the year 2000, when the agriculture in the state had a stagnating tendency over the years. This led to widespread rural-urban migration in West Bengal. Also, there has been a rise in annual growth rate of rural-urban migration from 2.48% in 1991-2001 to 6.61% in 2001 – 2011.

VII. Recommendations

On the basis of the analysis of trends done in West Bengal and the two districts of Nadia and Birbhum, the following recommendations can be given as mentioned below:

West Bengal agriculture is dominated by marginal and small farmers. As they are poor, they have not enough capital to invest. Therefore, capital should be provided in the form of subsidised fertiliser, power rate, etc.. Thus, input price should be reduced. Price of input should not be guided by market forces but should be fixed.

The farming technique should be redesigned so that new method of paddy cultivation is introduced. It has to be decided whether to use new or existing technology. Farming should be modified following SRI(System of Rice Intensification), which is a farmimg methodology aimed at increasing the yield of rice produced in farming. It is a low water, labour-intensive, method that uses younger seedlings singly spaced and typically hand weeded with special tools.

The form of organization needs to be planned and implemented – individual or cooperative. Collective farming might be introduced.

Marketing of the paddy produced has to be done in a better way, following the recommendations of the Swaminathan Committee. One of the recommendations of the Swaminathan Committee report is the MSP(Minimum Support Price) should be at least 50 per cent more than the weighted average cost of production. Another important recommendation with respect to marketing of agricultural produce is State Agriculture Produce Marketing Committee Acts [APMC Acts] relating to marketing, storage and processing of agriculture produce need to shift to one that promotes grading, branding, packaging and development of domestic and international markets for local produce, and move towards a Single Indian Market.

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