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Sustaining Large Data Centers: Machine Learning and Optimization

Saibal Kar[1] and Snehanshu Saha[2]

Abstract

It is well known that the exponential growth of social networks and economic activities supported by use of technology have made data centers invaluable to human existence. The pervasive use of information spills over to all forms of businesses and individual users, entrenched in private and public spheres, influencing growth and distribution in several ways. The dynamics of adjustments facing data centers as host for the rapid technological spread, however, remains relatively underemphasized. Potential reorganization, even firm level concentration, in the respective service industry owing to rising cost of power supply, the imminent crisis in storage space due to high real estate prices, input cost inflation, etc., indicate the need for crucial adjustments within the data centers. The economic and social implications of such adjustments can alter both business practices and organizations. We estimate the optimal size of operations in data centers to maximize profit adjusted for the cost dynamics.

Keywords: Data centers; revenue; optimization; concentration, Asia-Pacific

JEL Classification Codes: C45,G00

I. Introduction

The advent of utility computing through cloud based re-source development has significantly transformed the interface of information technology and its users (Mitra, O'Regan, and Sarpong 2018). The cloud computing services in turn depend heavily on data centers located all over the world. It is well-known that a data center is a facility, which houses a large number of computing equipment like the servers, the routers, the switches and the firewalls. Supporting components like air conditioning, the backup equipment, and the fire suppression tools are also indispensable for activities in data centers.

According to the broad classification, a data center can be 'complex' if it requires a dedicated building, or it can be 'simple' if it requires a smaller space, say a room, with a few servers. Further, the facility may be shared by multiple organizations (shared data centers), or it may be owned by a single organization (private data center), most of which use cloud computing facilities intensively. The main feed to the data centers, i.e., the

cloud computing service is defined as a pool of computing resources that cater computing functionality mainly as utility services. For example, companies like Microsoft, Google, Amazon, and IBM, that constitute the leading body of information technology (henceforth, IT) sector engaged with cloud computing, also invest significantly in data distribution and computational hosting services (Heller, Choi, and Lumb 2009). Importantly, internet-based services being essential in recent times, and the prices more-or-less uniform across markets (see (Poudou and Roland 2014)) the questions regarding firm-level adjustments to costs affecting efficiency and welfare are integral to the organizational structures (also see (Briglauer, Cambini, and Grajek 2018)). Indeed, one of the most important questions we encounter is whether the required adjustments between rising costs and falling prices leads to a rapid changes in the industrial structure - which evidently have direct consequences for consumer welfare.

It is expected that the establishment and sustenance of big data centers generate large economic and social impact. Let us offer an example from a recent report on the economic impact of data centers (see, Levine 2018) (Levine 2018). The report claims that Google data centers for the year 2016 alone generated 1.3 billion in economic activity, 750 million in labor income, and approximately 11, 000 jobs spread over different locations of the United States. The break-up by employment structures further suggest that out of these 11, 000 jobs, an estimated 1, 900 people are directly employed in the data center campuses. However, the employment data is collected from six data centers only. Apart from these, data centers have also created corporate jobs in banking, insurance, non-bank financial sector, that provide support via remote access (e.g., from Bay Area, California). The data centers regularly incorporate newer technologies and expand to meet growing demand which creates strong spillover effects on the regional economies. The report shows that on average across the six campuses, Google data centers via changes and reconstructions of the working space, help to offer employment for approximately 1,100 construction workers annually. It follows that disruption in these activities for reasons we explore in this paper, could cost a large share of jobs (six centers created an overall 6073 jobs cumulatively over time, of which some are renewable contracts), income and general economic activities, with widespread regional impact. The report applied a difference-in-difference estimate (replaced by a synthetic control in some cases) across treatment and control counties in the US states to measure the specific effects of large data centers maintained by Google. With cross-country vertical and horizontal linkages the crisis in a large data center gets magnified. During economic crisis of 2008, the employment growth in these data centers was very little – reduced to a few hundreds only. Apart from usual concerns associated with loss of jobs and economic activities, inability of data centers to cope with falling product prices and higher costs may lead to concentration of firms in the industry. The pseudo-monopoly effects that higher concentration creates in an industry have sever-

al untoward consequences for consumers surplus and institutional quality. An estimate of the net social benefit that follow from these changes including the environmental effects, is not part of the current paper, but shall be taken up for subsequent research.

Note that, a data-center is a huge investment by any organization. Directly, as well as indirectly, employment, economic growth, income distribution, etc., get affected by spread of data centers. Blazques et al. proposed a big data architecture, which takes into account the salient aspects of the social and economic analyses, such as wide ranges of the heterogeneous sources of information, ideally to forecast economic and social changes. (Blazquez and Domenech, 2017). In a similar vein, RTI International has investigated various impacts of the Facebook data center fleet on community, environment, and the economy (Facebook Data Centers 2018). Some of these are presented below.

- The data center in Georgia has drawn investment of $1.2 billion, and has created 1,147 jobs. This amounts to a direct contribution of $121 million to the gross domestic product (GDP) and a combined income of $8 million on a rolling basis (Settle 2018).
- The announcement of data centers, or those undergoing construction can also generate economic activities that range from ancillary services to real estate and creates a multiplier effect.
- Facebook's data center operations have contributed $5.8 billion to U.S. GDP and 60,100 jobs between 2010 and 2016. In other words, Facebook has contributed $835 million in U.S. GDP per year and approximately, 8,600 jobs annually. At the unit level, a typical Facebook data center has on average 196 employees after 5 years of operations.
- Related reports indicate that Facebook uses energy efficient procedures along with effective use of water resources. The energy consumption by the Facebook data centers has fallen by 38% and water usage by 50%relative to an average data center. RTI has estimated that Facebook has avoided over 2.5 MWh of carbon-intensive electric consumption by energy-efficient data center designs.
- Facebook data centers have a community impact as well. It conducts three grant programs serving 155 organizations via a total of 292 projects, creating technical resources and equipment in elementary, middle and high schools.

Over the last few years data centers have received large-scale investments, principally for creating provisions for cloud computing and data repositories for large organizations with millions of client services, which may create cost-push inflation in the related product market. At the same time, the market structure of the back-office is comprised of many firms of small and medium sized operations which often face problems with rising

costs. It directly affects their scale of operations and they use cost-cutting innovations to stay competitive. This is not straightforward either, since a large sunk-cost is involved with research and development leading to innovations, that usually is the prerogative of larger firms. The issue lends itself to empirical estimates following rise in the cost of servers, power usage and general maintenance of data centers over the last decade. (Arrow et al. 1961).

According o a survey by the Gartner Group, the energy consumption accounts for up to 10% of a data center's operational expenses (denoted as OPEX) and this may go up to 50% in near future (Pettey 2016). The power consumed by the computing system dissipates as heat and this is responsible for up to 70% of the total heat generated from the infrastructure of a typical data center (Rasmussen 2016). Needless to mention, a powerful cooling system is therefore required for mitigating the effects of overheating. The cost of the cooling system may range between $2 to $5 million per year for a conventional data center(Moore *et al*. 2005). It is obvious that the failure to keep temperatures within technologically accepted limits may disrupt cloud services, which in turn may result in violation of Service Level Agreements (SLA). No less importantly, the price of per unit service supplied by these centers has been falling over time making revenue maximization a complex exercise. The question of sustainability of the facility via use of big data (for a detailed discussion on how big data facilitates predictions of socio-economic and behavioral changes, see, Blazquez and Domenec, 2017, 2018) has been the primary motivation behind this exercise.

Section II discusses our contribution and the analytical exercise. Section 3 offers estimates on firm concentration and section 4 concludes.

II. Contribution and Analytical Specifications

Consequently, we investigate the cost components and estimate the implications for operational reorganization within data centers in view of the sustenance of such facilities. To this end, we primarily use Hamilton (2008) to lend a general structure to the components of cost (Hamilton 2008). Let us consider a data center which houses 50,000 servers and built with state-of-the-art techniques and equipment. Table I provides the major cost segments associated with such a data center. We assume that the costs are amortized, i.e., a one-time investment is allocated over a reasonable time-frame, with the opportunity cost of investment held at 5%. For the analytical exercise, we will limit the cost types to get insights on the adjustment patterns of the data centers. With this simple framework in mind, and given the possibility that firms could realign their energy-budget without sacrificing SLA, we re-frame the purpose of this research as follows. What is the optimal operational (price and size-wise) strategy for a firm engaged with large data centers and what is the most appropriate model of production – one that would optimize revenue in

the face of steadily escalating costs of equipment and maintenance? In the process, we investigate if cost minimization in large data centers needs a much better reconnaissance than is available in the literature.

Notably, a large amount of data is generated every day due to business operations in the form of e-mails, messages, transactions, videos, etc. An organization needs to store the unstructured data somewhere in order to process it, such that valuable information can be extracted from this huge stock as and when necessary. Using this information, enterprises may be able to make important decisions regarding output, costs and generally profitability and subsequently, forecast growth. It is easy to recognize that traditional infrastructure is not suitable for processing unstructured data. Hence scalable, cost effective cloud computing comes to the picture as a support for this data requirement. Estimates suggest that about 2.5 billion gigabytes of data is being created on a daily basis, which comprises of 200 million tweets and 30 billion pieces of contents shared on Facebook over a month alone, as part of all other activities. It has been projected that the amount of data will reach 43 trillion gigabytes, given that approximately 6 billion people shall possess cell phones in another 5 to 7 years (Coward 2023).

Apparently, cloud computing and big data both offer new paradigms and processes of the rapidly evolving technology. The speed with which companies adopt these is mainly driven by the fact that cloud computing in particular can be used as a utility service for big data analysis. The cost effectiveness of such actions needs a much better reconnaissance than is available in the literature.

Now, the reason behind choosing revenue optimization is straightforward. Every firm makes a set of fundamental decisions related to the sales strategy, price, and volume for every product or service offered. In particular, for firms operating in competitive environment, the best answers to these questions lead to decisions that maximize revenue. The firms usually face a time constraint for addressing these issues, and that too influences the optimal decision. We summarize key findings in the context of novel modeling of revenue, optimization techniques adopted, forecasting and subsequent social implications below.

We show that the revenue and profit are optimized at low elasticity of substitution. This implies that the quality of services and minimization of disruptions due to factor substitution are violated at higher levels of substitution, thereby constraining easy replacements. However, constant elasticity of substitution seems to lower the amount of revenue for data centers, such that the presence of zero flexibility among factors is not convenient either. It shows that the profit has risen secularly since 2002 despite rise in cost, which seems to be driven by market restructuring when high factor substitution is not an option. We calculated the concentration index for firms with the help of Hirschman-Herfindahl

Index (HHI) below for Data Centers in the Asia Pacific Economic Zone. The index shows moderate to high concentration in present times.

The present exercise is also fairly significant in view of the economic and social implications these carry. These can be categorized as arising from, occasional disruptions, such as call drops if substitution is infeasible; rise in price per unit of the product despite increasing dependence on telephone and internet facilities; effects on rentals and prices of devices that are necessary to get access to these facilities; increasing spatial inequalities and income gaps, etc.

In the extant literature, convex optimization principle has been used in the recent past to solve fundamental problems in science (Bora et al. 2016, Ginde et al. 2016). Notwithstanding, optimization associated with technology related to performance in data centers and the problem of cost minimization remains an important issue. We are aware of the cross-effects of reducing the use of one factor vis-à-vis another and apply the CES production function to estimate the impact of reducing the cost of the contributing factors on revenue maximization at the data centers. It is well-known that CES belongs to the family of neoclassical production functions and the CES production function for two inputs can be represented in the form below:

Consider an enterprise that has to choose its input bundle, (S, I, P, N) where S, I, P and N are the number of servers, the investment in infrastructure, the cost of power and the networking cost of a cloud data center, respectively. We determine the (global) cost of minimizing and profit maximizing input bundles for such a production outlay. The enterprise wants to maximize its production, subject to the cost constraint.

$$Q(L,K) = (\alpha L^{\rho} + (1-\alpha)K^{\rho})^{1/\rho} \qquad (1)$$

where
Q= Quantity of output
L, K =Labor and capital, respectively
$\rho = \frac{s-1}{s}$
$s = \frac{1}{1-\rho}$, Elasticity of substitution
and α = Share parameter

The CES function is written as:

The Optimization problem for output maximization is received as:

1) Global Minima for Cost minimization: A heuristic approach:

We use the Gradient Descent method to retrieve the values of elasticity ensuring cost

$$y = f(S, I, P, N) = (S^\rho + I^\rho + P^\rho + N^\rho)^{\frac{1}{\rho}} \quad (2)$$

Let m be the upper bound of cost of the inputs.

$$w_1 S + w_2 I + w_3 P + w_4 N = m \quad (3)$$

w_1: Unit cost of servers
w_2: Unit cost of infrastructure
w_3: Unit cost of power
w_4: Unit cost of network

minimization. For simplification of equations, let us consider two cost segments X and

max $y = f(S, I, P, N)$ subject to m
The following values of S, I, P and N thus obtained are the values for which the data center has maximum production of satisfying the given constraints on the total investment.

$$S^* = \frac{m w_1 \frac{1}{\rho-1}}{w_1^{\frac{\rho}{\rho-1}} + w_2^{\frac{\rho}{\rho-1}} + w_3^{\frac{\rho}{\rho-1}} + w_4^{\frac{\rho}{\rho-1}}} \quad (4)$$

$$I^* = \frac{m w_2 \frac{1}{\rho-1}}{w_1^{\frac{\rho}{\rho-1}} + w_2^{\frac{\rho}{\rho-1}} + w_3^{\frac{\rho}{\rho-1}} + w_4^{\frac{\rho}{\rho-1}}} \quad (5)$$

$$N^* = \frac{m w_3 \frac{1}{\rho-1}}{w_1^{\frac{\rho}{\rho-1}} + w_2^{\frac{\rho}{\rho-1}} + w_3^{\frac{\rho}{\rho-1}} + w_4^{\frac{\rho}{\rho-1}}} \quad (6)$$

$$P^* = \frac{m w_4 \frac{1}{\rho-1}}{w_1^{\frac{\rho}{\rho-1}} + w_2^{\frac{\rho}{\rho-1}} + w_3^{\frac{\rho}{\rho-1}} + w_4^{\frac{\rho}{\rho-1}}} \quad (7)$$

Y. [3]

w_1 and w_2 are unit prices of X and Y. Rewriting the cost function using the newly selected variables, we obtain

3. Gradient descent is best used when the parameters cannot be calculated analytically (e.g. using linear algebra) and must be searched for by an optimization algorithm.

III. Concentration of Firms

$$c = w_1 X + w_2 Y$$

The CES function thus formed is,

$$y_{tar} = (X^\rho + Y^\rho)^{\frac{1}{\rho}}$$

$$y_{tar}^\rho = X^\rho + Y^\rho$$

$$X^\rho = y_{tar}^\rho - Y^\rho$$

$$X = (y_{tar}^\rho - Y^\rho)^{\frac{1}{\rho}}$$

where y_{tar} is the optimal output level.Substituting the value of X in the cost function equation i.e.(12), we obtain

$$c = w_1 \left(y_{tar}^\rho - Y^\rho\right)^{\frac{1}{\rho}} + w_2 Y$$

Therefore, differentiating with respect to the elasticity of substitution, we get

$$\frac{\partial c}{\partial \rho} = \frac{-w_1 \left(y_{tar}^\rho - Y^\rho\right)^{\frac{1}{\rho}}}{\rho^2} ln\left(y_{tar}^\rho - Y^\rho\right) \left(y_{tar}^\rho ln y_{tar} - Y^\rho ln Y\right)$$

The partial derivative is used in gradient descent method for cost minimization.

Gradient Descent Algorithm:

1) **procedure** GRADIENTDESCENT()
2) $\frac{\partial c}{\partial \rho} = \frac{-w_1 (y_{tar}^\rho - Y^\rho)^{\frac{1}{\rho}}}{\rho^2} ln\left(y_{tar}^\rho - Y^\rho\right)$ $(y_{tar}^\rho ln y_{tar} - Y^\rho ln Y)$
3) **repeat**
4) $\rho_{n+1} \leftarrow \rho_n - \delta \frac{\partial c}{\partial \rho}$
5) $\rho_n \leftarrow \rho_{n+1}$
6) **until** $(\rho_{n+1} > 0)$
7) **end procedure**

Using the above algorithm, the optimal values of α and cost have been computed(cf. Section 4). The dual is of course, profit maximization as we show below.

Hirschman-Herfindahl Index (HHI) is a widely used technique for measuring the degree of market concentration. It is calculated by summing the squared market share of each firm competing in a given market. The value of HHI can vary between approximately zero to 10,000.

The HHI is expressed as: $$HHI = s_1^2 + s_2^2 + s_3^2 + ... + s_n^2 \quad (8)$$

Here s_n is the market share of the i^{th} firm.

High HHI implies that only a few firms control the business. Thus, new cost outlay compensates the firms for such investments more than proportionately. And despite higher costs, it raises revenue and profit. To begin with, if the market is shared by a large number of firms, the HHI value shall be low, but positive shocks in the cost outlay could make some firms disappear from the market. Since, HHI also offers a legal dimension the U.S. Department of Justice considers a market to be competitive if it shows a HHI score less than 1000. Conversely, if the score is between 1000 and 1800, the market is deemed as moderately concentrated, while a score above 1800 suggests a highly concentrated marketplace (D. and Velasquez, 2022). In the Asia-Pacific Economic Cooperation (APEC) zone, the concentration is moderate and tending towards a highly concentrated marketplace. Interestingly, for a global distribution of technology firms, the spatial variations in profitability and hence concentration is of wider interest.

Let us discuss the degree of market concentration for firms present in the Asia-Pacific region. The region has generated just over USD 20 billion in data center infrastructure revenues for the world's leading technology vendors and the market and has grown by 23% from the previous year, according to data from Synergy Research Group (HP, IBM and Dell lead the burgeoning APAC Data Center Infrastructure Market 2022). Here HHI stands at 1708.

In comparison, the level of firm concentration in Infrastructure as a Service (IaaS) is much higher. The IaaS market share data is collected from Business Insider (2016) (Weinberger 2022). The HHI for IaaS market share is calculated as 2456.34

If we exclude 'others' (retaining rest of the firms apart from Amazon, IBM, Oracle, Google and RackSpace) from HHI calculation, it becomes 1167.53. And yet, it cannot be considered as a competitive market. Thus, only a few firms seem to control the major share of the market for infrastructure as a service. These firms however generate a lot of employment, potentially bringing positive change in the society.

IV. Concluding Remarks

Revenue optimization in data centers around the world is not a well researched topic, despite the fact that the outreach of information technology into daily activities has been enormous. The inability of large and small service providers to sustain under escalating

costs of equipments, power usage, etc should not only imply potential disruption for the firms alone, but shall evidently jeopardize almost all other activities globally. A detailed analysis of the cost components and their role in revenue optimization for technology service-providing and server maintaining firms is therefore imperative and timely. This paper identified the major cost components influencing optimal revenue generation in large data centers. Assuming CES production function for such firms, it was established that firms register maximum profit closer to the point where the elasticity of substitution is low, and close to 0.1. This is not surprising, but the exact magnitude at which the rising cost components maximize revenue is an important finding in view of sustainability of the services over time. For this matter, we considered the server cost, power& cooling, and infrastructure cost as inputs to the cost function - notably, the physical space required for each of these are crucial considerations, which most discussion related to service sector seem to undermine.

We used the model designed to minimize cost by maintaining target revenue. The proposed model has been applied on a data set to obtain the optimal elasticity, for maximum revenue generation in the large data centers. Subsequently, the flexibility of CES functions allowed us to incorporate additional input variables. Indeed, the model was applied to real-time data set on server cost and various components of it. We showed that the optimization estimates are quite consistent with what is experienced on the cost structure in several such firms across important regions hosting the service sector facilities.

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Revisiting Rural Infrastructure Development Fund in West Bengal

Aman Deep Kumar[1] and Pranjal Narain Saxena.[2]

Abstract :

*This article presents an analysis of district wise support extended by NABARD under RIDF to West Bengal State for creation of quality rural infrastructure. It is kindly submitted that "the views in the article are entirely personal" and do not intend to directly or indirectly affect the institution in any way***.**

Keywords : Rural Infrasructure, RIDF, Agriculture, Regional Pattern

JEL Code: Q18, R00, R51

I. Introduction

Rural Infrastructure is a necessity for agriculture, agro-industries, small industries and for overall economic development of rural areas. It further improves the quality of life of the rural population. However, infrastructure projects including those in rural sector involve huge initial investment, long gestation period, high incremental capital output ratio, high risk and low rate of returns on investment. All these factors are not conducive for private sector entry into infrastructure. Further there are many attributes of infrastructure that make it difficult for individuals to design, construct, operate and maintain these services effectively and efficiently. As a result of this, infrastructure services, the world over, are largely provided by the public sector.

The World Development Report of 1994 included the following in its definition of infrastructure

- Public utilities - power, telecommunications, piped water supply, sanitation and sewerage, solid waste collection and disposal and piped gas.
- Public works - roads, major dam and canal works for irrigation and drainage.
- Other transport sectors-urban and inter-urban railways, urban transport, ports and waterways, and airports. (World Bank, 1994).

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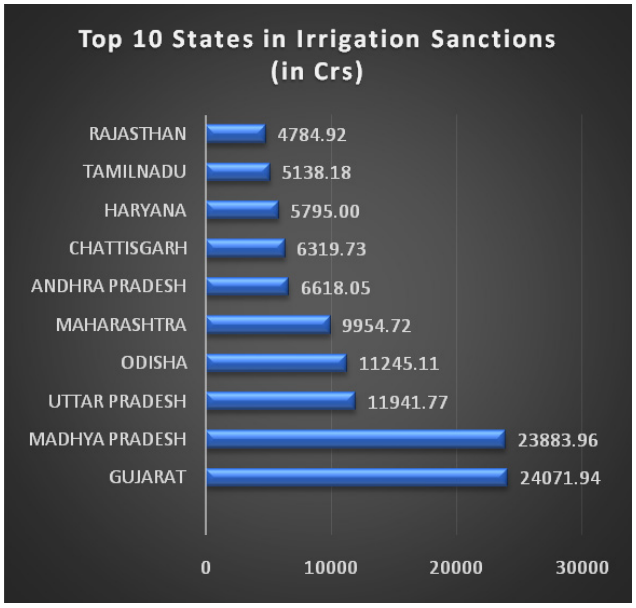
Adequate infrastructure raises productivity and lowers production costs, but it has to expand fast enough to accommodate growth. While the precise linkages between infrastructure and development are yet to be firmly established, it is estimated that infrastructure capacity grows step for step with economic output - a 1 per cent increase in the stock of infrastructure is associated with a 1 per cent increase in gross domestic product (GDP) across all countries (Summers and Heston, 1991).

II.Rural Infrastructure Development Fund (RIDF)

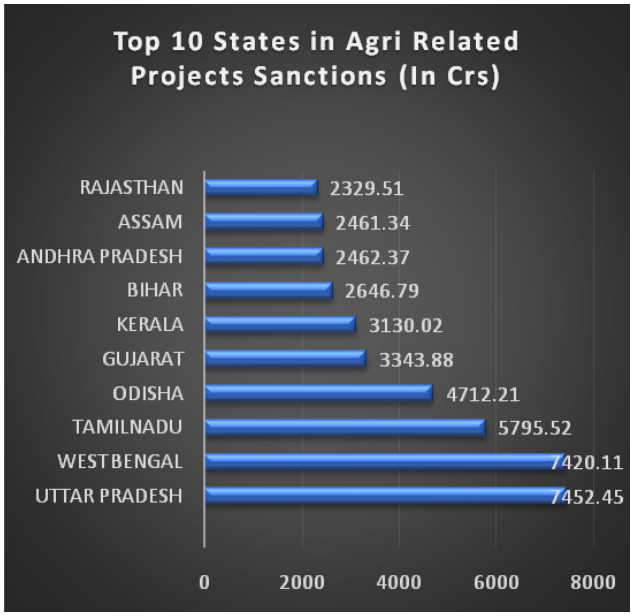
RIDF was instituted in 1995 to finance State Governments for completion of on-going projects to the extent of shortfall in mandatory stipulation for agricultural advances by commercial banks under priority sector advances. (Government of India, 1995). Reckoning the imperative need for creation of economic and social infrastructure on sustainable basis that truly reflects the development needs of rural economy and the local community, RIDF was created in NABARD as a follow-up to the amendment made in the Union Budget, 1995-96, with an initial allocation of Rs. 2000 crore with the objective of providing term loans at concessional rates to state governments for financing rural infrastructure projects. RIDF is strengthened every year with its corpus being announced every year in Union Budget in the form of aggregate allocation which is allocated to banks during the year on the basis of level of their shortfall in meeting the mandatory stipulations relating to priority sector lending. The main objective of the RIDF was to indirectly pressurise commercial banks to meet the priority sector stipulations through interest rate policy instrument i.e. lower interest on deposits under RIDF as compared to net returns on priority sector advances. Interest rates have been rationalised from time to time to discourage banks to deposit under RIDF as compared to lending under priority sector advances. However, with effect from 01 April, 2012, the interest rate payable to banks on deposits placed with NABARD for RIDF has been linked to Bank Rate prevailing at that point of time.

III.Progress and Performance of RIDF : All India Level

Since its inception RIDF has supported an infrastructure of Rs. 3.70 lakh crore (As per NABARD data as on 31st March 2022) with a total sanction of RS. 4.74 lakh crore. The sanctions are categorized in the five broad categories of Irrigation, Agri-related, Rural bridges, Rural roads and Social sector. Out of these, highest sanction of Rs. 1.42 lakh crore has been done under irrigation sector followed by rural roads and social sector with a sanction of Rs.1.37 lakh crore and Rs.0.93 lakh crore respectively.



Top 10 States in Agri-Related Sanction as on 31st March 2022. (https://www.nabard.org/auth/writereaddata/File/annexure-i.pdf)



Top 10 States in Agri-Related Sanction as on 31st March 2022.

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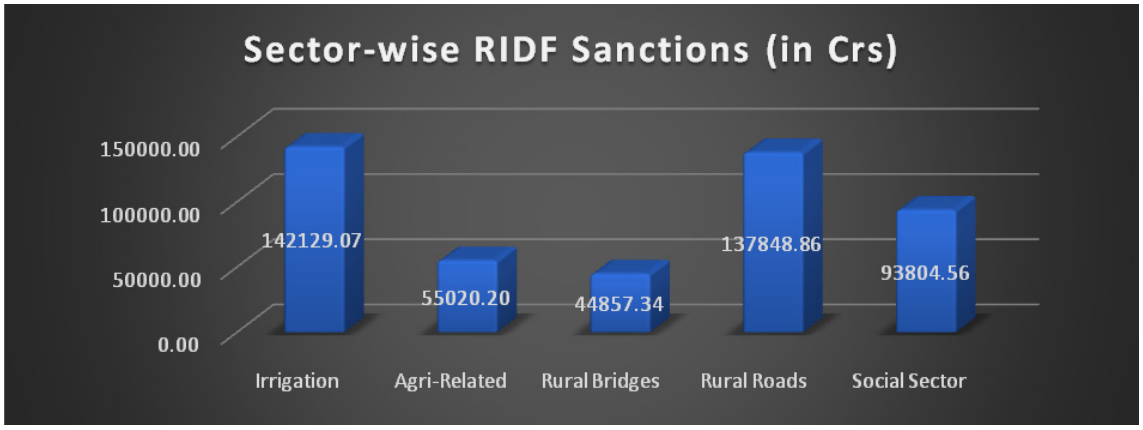
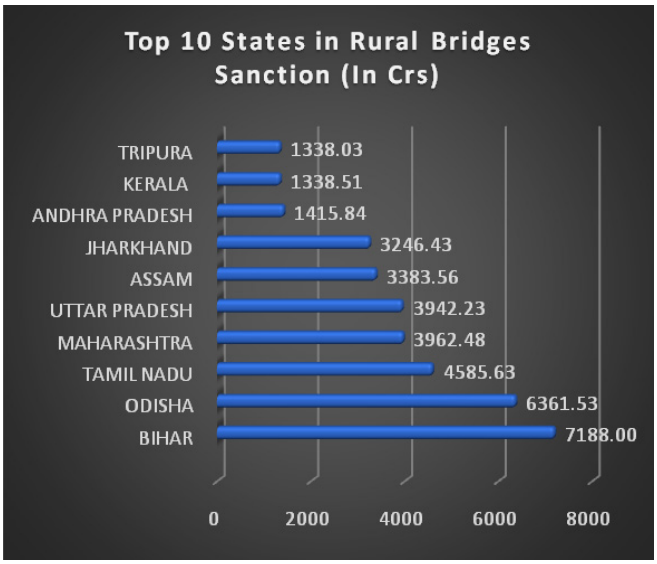


Data as per NABARD website as on 31st March 2022.



Top 10 States in Rural Brides Sanction as on 31st March 2022.
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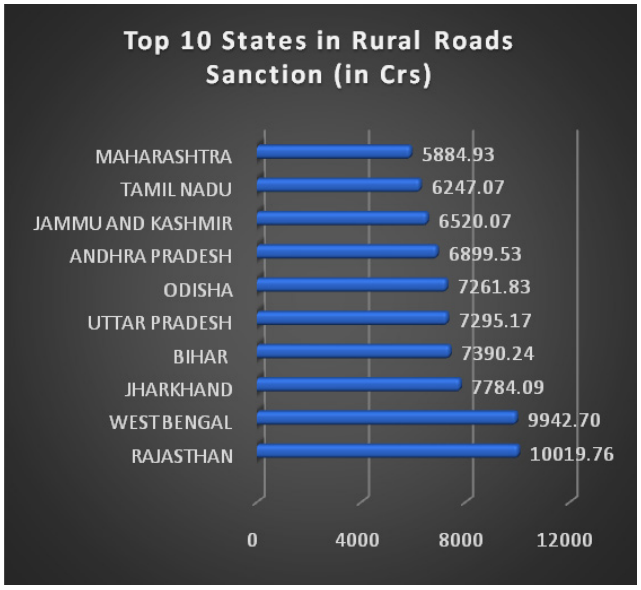

Top 10 States in Rural Brides Sanction as on 31st March 2022.
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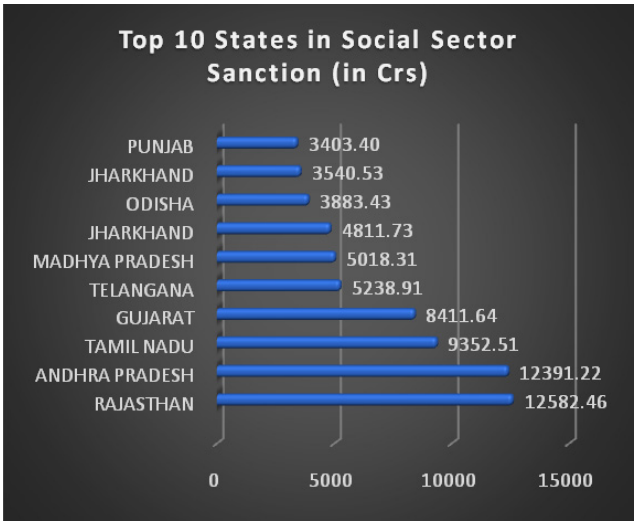

Top 10 States in Rural Brides Sanction as on 31st March 2022.
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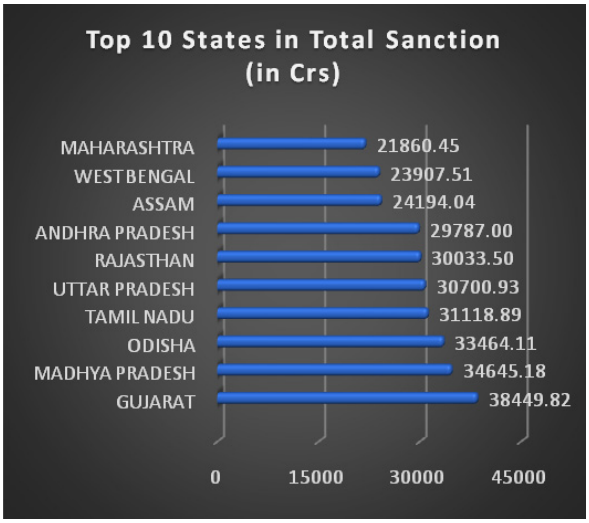


Top 10 States in Rural Brides Sanction as on 31st March 2022.

(https://www.nabard.org/auth/writereaddata/File/annexure-i.pdf)

Among these different categories, states have received varied sanctions based on their respective needs. While Gujarat has received the highest sanction under irrigation sector, Uttar Pradesh has received the highest sanction under Agri-related sector. In case of rural bridges, Bihar has been sanctioned the highest sum of Rs. 7,188 crore. Rajasthan has received the highest sanctions under Rural roads and social sector categories. Gujarat has received the highest allocation of Rs. 38,499crore followed by Madhya Pradesh and Odisha with Rs. 34,645 crore and Rs. 33,464 crore respectively.

IV. Infrastructure Financing in West Bengal

Infrastructure plays a greater role in stimulating economic growth by raising factor productivity and enhancing quality of life through provision of necessary amenities. RIDF schemes with its projectbased approach, wider all-India coverage, operational flexibility, social focus, community's involvement in planning, designing, managing and execution of works, etc., mark a watershed in the participatory planning process and prioritization of infrastructure as well as in the process of identification of critical infrastructure in the country.

Over the years, RIDF has emerged as a dependable source of public funding of impactful rural infrastructure projects. Assistance from RIDF constitutes a significant proportion of investments by West Bengal Government in rural infrastructure sector.

RIDF which started as a "last mile approach" to facilitate completion of ongoing irrigation, flood protection and watershed management projects during the early years of its inception, today covers as many as 39 activities which are broadly classified under three categories as (i) Agriculture and Related Sector, (ii) Social Sector and (iii) Rural Connectivity

Table1 :Eligible activities under RIDF

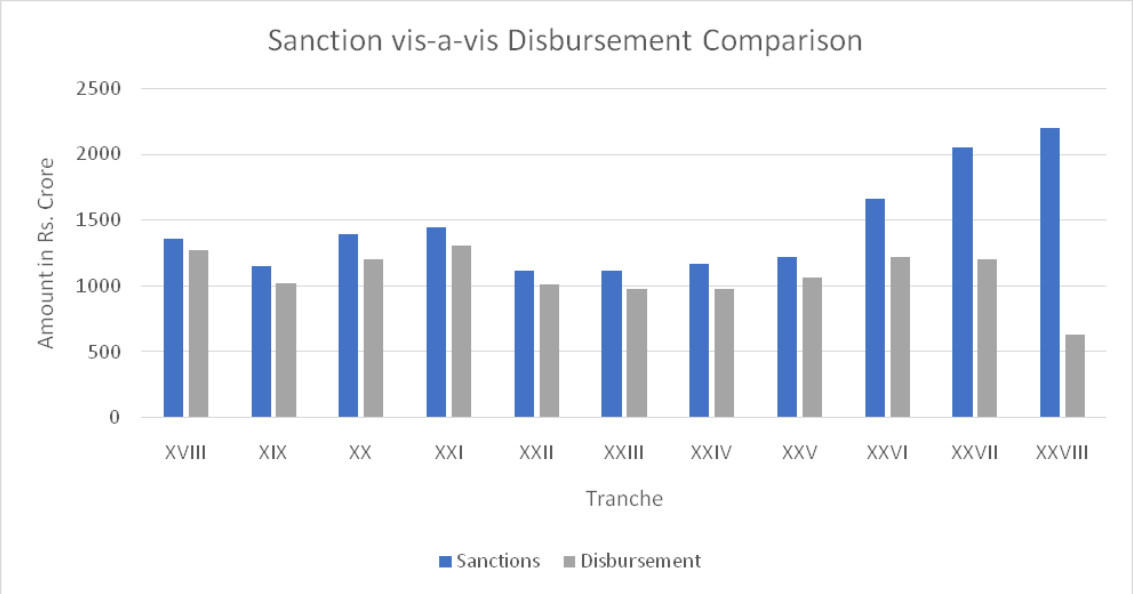
Sr. No	**Agriculture and related sectors**	**Social Sectors**	**Rural Connectivity**
	Minor Irrigation Projects/ Micro Irrigation	Drinking Water	Rural Roads
	Soil Conservation	Infrastructure for Rural Education Institutions	Rural Bridges
	Flood Protection	Public Health Institutions	Road over Bridges
	Watershed Development/ Reclamation of waterlogged areas	Construction of toilet blocks in existing schools	Ropeways
	Drainage	"Pay & use" toilets in rural areas	
	Forest Development	Construction of Anganwadi Centres	
	Market Yard, Godown, Mandi, Rural Haat, Marketing Infrastructure	Setting up of KVIC industrial estates/ centers	
	Cold storage, Public/ Joint sector cold storage at various exit points	Solid Waste Management and Infrastructure works related with sanitation in rural areas	

	Seed/ Agriculture/ Horticulture Farms		
	Plantation and Horticulture		
	Grading/ certifying mechanisms; testing/ certifying laboratories		
	Community irrigation wells for the village as a whole		
	Fishing harbour/ jetties		
	Riverine Fisheries		
	Animal Husbandry		
	Modern Abattoir		
	Medium Irrigation Projects		
	Mini Hydel Projects/ Small Hydel Projects (upto25 MW)		
	Major Irrigation Projects (already sanctioned and under execution)		
	Village Knowledge Centres		
	Desalination plants in coastal areas		
	Infrastructure for Information Technology in rural areas		
	Infrastructure works related with alternate sources of energy viz. Solar, wind etc. & energy conservation		
	5/10, MW Solar photo voltaic Power Plants		
	Separate Feeder Lines		
	Establishment of dedicated Rural Industrial Estates		
	Mechanisation of Farm Operations and Related Services		

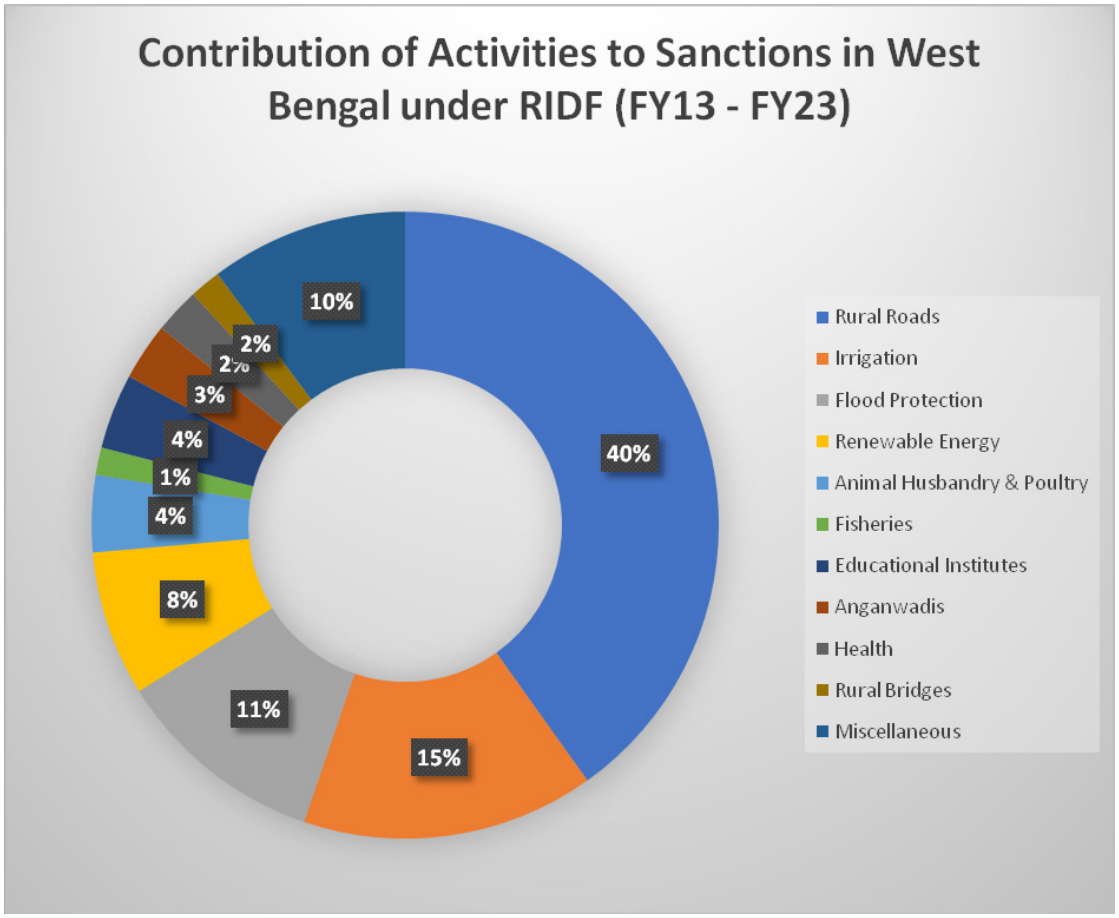
TABLE 2: Tranche-wise details of RIDF in West Bengal (LAST 11 YEARS)
(AS AT END-MARCH-2023) Amount in Rs. Crore

Year	RIDF Tranche	Net Number of Projects Sanctioned (Excluding Withdrawn/ Deleted projects)	Total Financial Outlay	RIDF Loan Sanctioned	Total Disbursement as on 31.03.2023	Percentage of amount disbursed to sanctioned
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2012-13	XVIII	380	1522.24	1360.05	1272.58	93.57
2013-14	XIX	433	1329.18	1149.32	1024.69	89.16
2014-15	XX	420	1587.24	1389.37	1199.30	86.32
2015-16	XXI	363	1617.17	1448.2	1310.24	90.47
2016-17	XXII	193	1284.64	1116.76	1011.44	90.57
2017-18	XXIII	364	1276.58	1111.78	977.22	87.90
2018-19	XXIV	285	1310.03	1167.16	979.42	83.91
2019-20	XXV	3716	1424.42	1218.98	1066.46	87.49
2020-21	XXVI	2284	1931.38	1659.61	1216.73	73.31
2021-22	XXVII	1774	2340.9	2054.43	1198.36	58.33*
2022-23	XXVIII	2099	2574.35	2199.51	629.63	28.63*
Total		**12311**	**18198.13**	**15875.2**	**11886.07**	

*Projects have been sanctioned in recent years and are in active phasing which accounts for low disbursement to sanction ratio.



During last 11 years, RIDF has made rapid strides in terms of allocations, number of projects, amount sanctioned and amount disbursed. Around 12,000 projects involving an amount of Rs. 15,875.2 crore have been sanctioned in various tranches under Rural Infrastructure Development Fund (RIDF) in West Bengal. Over the years, the sanctions under RIDF in West Bengal has seen a rise from Rs. 1360.05 crore during 2012-13 to Rs. 2199.51 crore during 2022-23, an increase of 61.72%.As against this, cumulative disbursement under RIDF in West Bengal during last 11 years stands at Rs. 11886.07 crore constituting about 74.87 % of amount sanctioned. Further, significant disbursement is expected for projects sanctioned under recent tranches (RIDF XXIII – RIDF XXVIII) which would increase the disbursement to sanction ratio.



Pie chart depicting the sanctions under different activities during past 11 years under RIDF in West Bengal has been shown below:

Rural Roads (40.14%) received maximum assistance of total loan followed by Irrigation (15.09%), Flood Protection (10.89%), Renewable Energy (7.49%), Animal Husbandry & Poultry (3.97%), Fisheries (1.41%) while remaining Agri & Related Sectors constituted 10.21% of the total sanctions. Social Sector viz Rural Educational Institutes (3.88%), Anganwadis(2.96%) and Health (2.35%) cumulatively accounted for 9.19% of the total sanctions during past 11 years. Rural Bridges also constituted 1.61% of the sanctioned amount. Detailed analysis of the prominent sectors is as under:

V.Agriculture and related sectors

V.1 Irrigation

Development of agriculture in the State is essentially dependent on irrigation in rabi/ boro season as well as in kharif season in the event of drought or inadequate rainfall. Harnessing of available water resources and creating additional irrigation potential for increasing agricultural production and productivity is the critical requirement for economic growth of the State Government especially when the majority of the land holdings are small and marginal. Such holdings cannot afford the individual investment for creation of irrigation facility in their command area. Therefore, with a view to boosting up agricultural production in a large scale and to promote rural economy, RIDF assistance is available for creation of new irrigation source as well as retrieving the lost irrigation potential.

More than 2000 projects (inclusive of minor irrigation) with total cost of Rs. 2521.85 crore and RIDF assistance of Rs. 2395.75crore were sanctioned for creation of irrigation potential of more than 200000 ha. Cumulative disbursement against the projects stood at Rs. 2016.12 crore by the end of 2022-23.

V.2 Flood Protection Projects

Under Flood Control Sector, 414 projects were sanctioned with a total cost of Rs. 1819.93crore and RIDF assistance of Rs. 1728.93crore.The total amount disbursed to those projects was Rs. 1183.06crore.

V.3Animal Husbandry and Poultry

Under the Animal Husbandry and Poultry sector, 80 projects were sanctioned with total cost of Rs. 663.35crore and RIDF assistance of Rs. 630.18 crore during the past 11 years. However, the cumulative disbursement against the projects stood at Rs. 318.96 crore as on 31st March, 2023.

VI. Social Sectors

VI.1 Rural Education Institute

Construction / Additional Infrasructure in School Buildings in rural areas of various districts were sanctioned with a total cost of Rs. 732.98crore and RIDF assistance of Rs. 615.38crore. The total amount disbursed was Rs. 577.21 crore.

VI.2 AnganwadiCentres

More than 3300 Anganwadis with an outlay of Rs. 552.18 crore and RIDF l0an of Rs. 469.30 crore have been sanctioned in the past eleven years which are expected to benefit lakhs of children and pregnant women of the State. The cumulative disbursement against the projects stood at Rs. 273.16 crore as on 31st March, 2023.

VII. Rural Connectivity

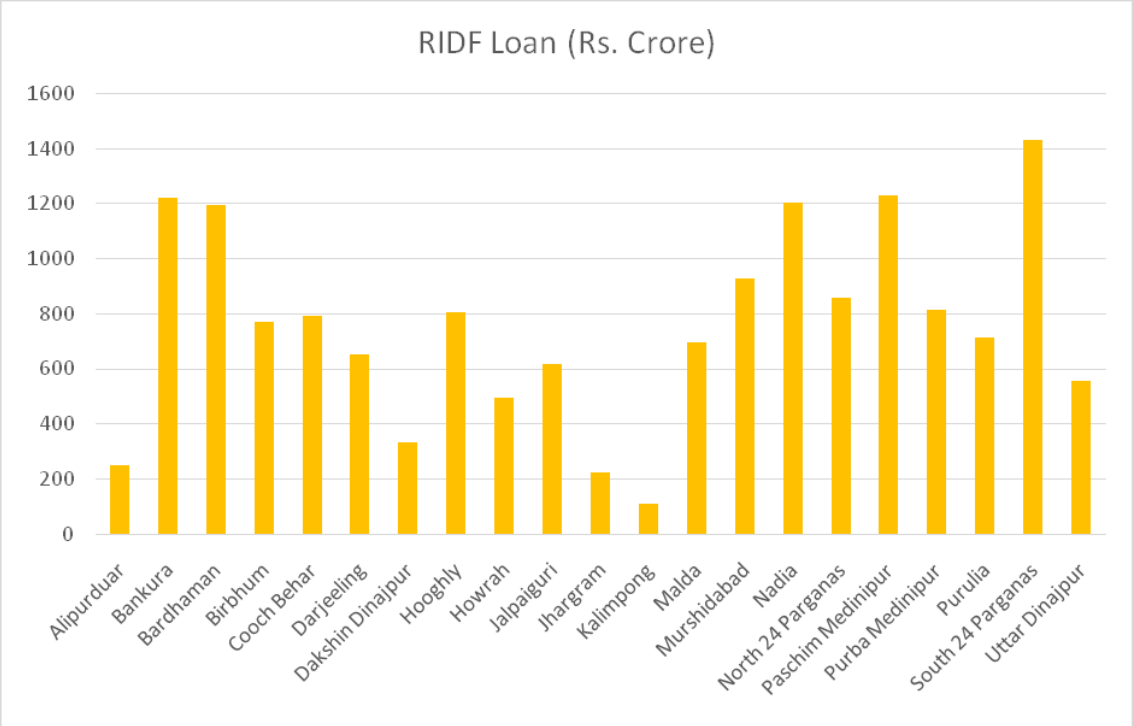
VII.1 Rural Road:

During last 11 years, 1543 projects for Construction / Strengthening of road length of more than 9000 km were sanctioned with a total cost of Rs. 7963.03crore and RIDF assistance of Rs. 6372.08crore while the total amount disbursed to these projects as on 31.03.2023 stood atRs. 5855.12crore.

VII.2 Rural Bridge:

68 projects for creation of bridge span of around 3300 m were sanctioned with a total project cost and RIDF assistance of Rs. 319.35crore and Rs. 255.48crore respectively while total amount disbursed to these projects as on 31st March, 2023 was Rs. 188.03 crore.

VIII. District Wise Analysis of Sanctions – Past 11 Years



Out of total sanctions of Rs. 15,875.2 crore during past 11 years in West Bengal, South 24 Parganas holds the largest share of sanctions amounting to Rs. 1428.81 crore which constitutes 9% of the sanctions. Districts in the plains continue to dominate the ma-

jor chunk of the sanctioned amount, probably due to high population density and needs of critical infrastructure. The 8 districts namely Bankura, Bardhaman (Purba Bardhaman& Paschim Bardhaman), Hooghly, Murshidabad, Nadia, Paschim Medinipur and South 24 Parganas together make up more than 50% (50.44%) of the sanctioned amount in the state during past 11 years.

IX. Benefits of RIDF

NABARD's support for creation of Rural Infrastructure through RIDF has resulted in considerable benefits such as:

- Commitment of funds under RIDF sanctioned projects has enabled State Governments to take up the implementation more expeditiously.
- Financing incomplete projects has resulted in unlocking of investments already made by the State Governments, thus, realising the full benefits of the projects.
- Creation of additional irrigation potential, generation of non-recurring employment and creation of jobs has contributed to the economic prosperity in the rural areas.
- Monitoring of the projects has resulted in timely implementation of majority of the projects and has reduced the time and cost overrun. Further, completion of projects through RIDF assistance from NABARD has helped in growth of core sectors in rural areas by spurring the demand for credit from banks.

X. Implications

A) Commercial Banks Benefitted Through alternate medium of priority sector lending

Despite rationalisation of interest rate deposits with RIDF is a favourable business proposition for banks as otherwise they are required to provide crop loans at 7 per cent interest under priority sector lending (4 per cent interest from farmers and 3 per cent interest subvention from Government) Incidentally they get 6.5 per cent interest on RIDF deposits at lower end of shortfall spectrum.

B) State Governments Recipient of Tangible Benefits

As mentioned earlier, though RIDF was designed to provide finance to State Governments to enable them to take up incomplete rural development projects, it has emerged as additional source of concessional funding for the State Governments. State Governments are financed at 1.5 percentage amount lower than Bank Rate under RIDF which are otherwise heavily dependent on the Union Government for funding at rates higher than Bank Rate. Over the years RIDF has emerged as an attractive financing option for the State Governments.

C) Union Government Recipient of an Intangible Benefit

RIDF Scheme has also benefitted Union Governments albeit indirectly. Normally Union Government is expected to make budgetary provisions for providing financial assistance to State Governments for taking up rural development projects in general and rural infrastructural projects in particular. This would have in turn aggravated fiscal deficit to the tune of few thousand crore annually at the present level of allocation. By way of RIDF Scheme Union Government has not only helped itself on a regular basis but also helped other organizations such as banks and state Governments etc. It goes without saying that as a result of RIDF, Union Government averted incidence of fiscal deficit at least to some extent.

XI. Summing Up

Infrastructure isan enabler for growth. The RIDF projects consistently deliver positive outcomes for rural production, productivity, income, employment, environment, and sustainability. Over the years, the cumulative RIDF sanctions to the regions with low credit–deposit ratio have witnessed a steady upward trend. If we look at the sanctions from RIDF, it is seen that the districts with higher credit flow made higher demands for resources under the fund. On the contrary, districts with lower creditflow were lagging in borrowing funds from RIDF. Thus,the least developed districts which are already credit starved are getting lower share of funds from the RIDF. Thishighlights the need to break this vicious cycle and think of certain measures by which funds can be earmarked to the most backward/ credit starved regions to ensure speedier development of the most backward areas in the country. We may also have to think of ways to incentivize banks to lend in these backwardareas so that both demand and supply side issues are addressed. Apart from that, banks will have to undertake innovative agricultural financing models so that environment friendly and sustainable projects can be supported. In February 2019, RBI too had set up an Internal Working Group (IWG), to understand the issues of agriculture and the recommendations of the IWG include building up of an enabling ecosystem through digitisation of land records, reforming of land leasing framework, creation of a national level agency to build consensus among the state governments and central government with regard to agriculture-related policy reforms and innovative digital solutions to bridge the information gap between the banks and farmers for expediting the credit delivery process.

To ensure that even the most remote villages attain SDGs by 2030, a micro-infrastructure approach could revolutionisepoverty alleviation through a highly decentralised, smart, clean, climate-resilient system. And thus, all the ongoing major government initiatives like the Mahatma Gandhi National Rural Employment Guarantee Scheme, AatmaNirbhar Bharat, Pradhan Mantri Awaas Yojana–Gramin

(PMAY–G), Pradhan Mantri Gram Sadak Yojana (PMGSY), SP Mukherjee Rurban Mission, Swachh Bharat Mission–Gramin (SBM–G), Jal Jeevan Mission, Pradhan Mantri Kisan Sampada Yojana, Deen Dayal Upadhyhay Gram Jyoti Yojana, Pradhan Mantri Jan DhanYojana (PMJDY) and Pradhan Mantri Sahaj Bijli Har Ghar Yojana–Saubhagya package, all should also run in parallel to bring more progress in rural infrastructure as they address major sectors of rural economy. Effective coordination may be ensured through creation of a dedicated forum of all concerned stakeholders which will discuss the regional need of rural infrastructure at grass-root level. There lies the importance of RIDF in strengthening rural India through its timely flow of funds.

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Artha Beekshan, Volume 32, No. 4, March 2024.

Market Structure, Supply Chain and Agricultural Price: A Study on Potato and Vegetables in Paschim Medinipur District of West Bengal

Mousumi Bakshi*[1] and Joydeb Sasmal **[2]

Abstract

This paper makes a study on the market structure, supply chain and prices of agricultural commodities like potato and vegetables using data from primary survey in Paschim Medinipur district of West Bengal. These products are sent for sale in the markets of cities and towns in Kolkata, Kharagpur and Midnapore from the local markets of the district. The study finds that the products are supplied from local markets to the consumer markets via wholesale markets.This study analyses the prices at different stages of the marketing channel. The marketing margin has been defined as the difference between the price paid by the consumer and the price received by the farmer. On an average, the marketing margin is found to be 61% of the retail price which goes to the traders as profit or is used to cover the costs of marketing. If MM is higher the farmer gets a lower share of the price paid by the consumer. The whole chain of marketing is dominated by few traders. So, this paper concludes that if the dominance of the traders can be curtailed, the marketing costs can be reduced, and the markets of high prices can be explored, the farmers can have higher prices for their products.

Keywords: Market imperfection, few traders, marketing margin, wholesale market, profit, farmer's price

JEL Nos.: Q_{11}, Q_{13}

I. Introduction

Agricultural production and agricultural price, both exhibit some special features in marketing and demand-supply conditions. The production in agriculture is not fully determined by the factors of production. Many exogenous factors like weather, rainfall, agro-climatic conditions, crop-disease and pest attack also affect yield and total production to a large extent. Naturally, productions show seasonal variations and year to year fluctuations. Similarly, agricultural prices also exhibit sharp fluctuations over time compared to non-agricultural prices (Sasmal, 2003). The demand for agricultural commodities is relatively inelastic. The demand generally do not respond much to the changes in price and income. However, demand is elasticfor high value products like fruits, vegetables,

cereals, milk, fish, mutton etc. When prices fall or income rises, in general, the demand remains relatively inelastic. So, given inelastic demand if supply rises due to better harvest, prices fall significantly and the opposite situation occurs when supply declines due to crop failure as a result of drought or any other natural reasons. Another aspect is that unlike industrial production, the production and supply of agricultural commodities can not be immediately adjusted with the changes in demand or price. So, sharp fluctuations in the prices of agricultural products are witnessed on regular basis. It is an irony that good harvest does not always bring good fortune for the farmers, specially in the developing countries. The total revenue of a farmer is output multiplied by price. As quantity of output rises, prices fall. As a result, revenue remains more or less unchanged. It is also found that income of the farmers falls in the year of goods harvest due to significant fall in price. An important aspect of agricultural marketing is that the market is very imperfect in nature and the wholesale market is almost fully controlled by a few traders known as oligopsonists and oligopolists. The local market of the farmers and the retail market for the consumers are more or less competitive. Large number of buyers and sellers are found to operate in such markets (Shepherd, 1947).

So, to ensure a remunerative price to the farmers for their products is a big issue in agriculture. In India, nearly 80% of the farmers are marginal and small farmers. To ensure remunerative prices to the farmers is not only important for increasing the income of the farmers, it is also necessary to boost up investment in agriculture for higher production. The role of price in increasing production in agriculture was also emphasised by Dantwala (1967) and Bharadwaj (1998). Feder (1980) shows that higher price of output and reduction in input cost encourage adoption of modern technology in agriculture leading to higher production. It is also found that if supply or production lags behind increasing demand, the price will rise (Sasmal, 2015; 2016).To ensure remunerative prices to the farmers, the Agricultural Price Commission (APC) was set up in 1965 with the objective that the Commission will fix up minimum support prices (MSP) for major crops like paddy, wheat, bajra, sugarcane etc. The cost of cultivation is estimated by this commission and on the basis of that the MSP is announced for particular crops. If the market price falls below MSP, the government will purchase crops from the farmers at announced prices. For procurement of foodgrains, the Food Corporation of India (FCI) plays an important role. The FCI not only procures from the farmers and supplies foodgrains to the consumers at subsidised prices but also transfer food-grains from surplus states to deficit states. However, the government can not purchase all items of agricultural products at MSP. Neither do they purchase the entire marketable surplus of the products. For example, in the year 2022-23, the total production of foodgrains in India is 330 million tonnes. Out of this, only 76 million tonnes have been purchased by the government and it is 23% of total production. In case of paddy, the procurement ratio in production is 42% while in wheat it is 17% only.

So, the major part of the production in agriculture are marketed through private channels. Here lies the importance and problems of agricultural marketing. A distinguished feature of agricultural marketing is that the bulk of the products are not directly sold to the final consumers by the farmers. The products reach the consumers in the retail market from the farmers through a typical marketing channel or supply chain. For example, a farmer of Midnapore or Hooghly district does not directly sell vegetables or potato to the consumers in Kolkata. Similarly, an apple grower in Himachal Pradesh does not sell his product in Ahmedabad directly. The products pass through a marketing channel in which there are a number of intermediaries at each level of marketing in local, wholesale and retail markets. A typical marketing channel for agricultural products is: Farmer →Local Traders → Central Wholesale Market → Retail Market → final consumer. These markets are dominated or controlled by a few traders or agents.

The objective of this paper is to study the market structure in the supply chain of agricultural products and examine its effects on the prices received by the farmers and the prices paid by the consumers. The difference between these two prices is called marketing margin (*M*) i.e., *M* is price paid by the final consumer in the retail market (P_C) minus the price received by the producer (farmer) in the local market (P_f). *M* includes costs of transportation and labour, storage, processing and packaging, and the profits of the traders in the entire supply chain. The costs of transportation and handling is high if distance of the market is long and infrastructure for storage and processing is less. The profit element will be high if the markets are less competitive and the number of intermediaries is high. Nicholls (1955) and Sasmal (2003) explain that in the local markets where the products are assembled from the farmers, are dominated by small number of local traders or agents. In the second stage of marketing, the local traders from different regions sell the products to the traders of the wholesale market which is dominated by few traders. They control the market both as buyers and sellers. When they buy from local agents, they behave as oligopsonistsThe retail traders buy the products from the wholesale markets and sell them to the consumers in the retail market. The wholesale traders behave as oligopolists while selling products to the retail traders. The retail market is close to competitive market with large number of buyers and sellers. Given the costs of marketing, the imperfect market conditions exploit both the farmers and consumers. The farmer's price (P_f) is equal to consumer's price (P_c) minus marketing margin (*M*). If *M* is high, a small fraction of the consumer's price goes to the farmer. Thus the farmer is exploited by the marketing system (Thomsen, 1951). Similarly, if the wholesale traders raise the selling price by controlling supply, the price in the retail market will rise. Then the consumers will be exploited.

The market structure and supply chain of agri-products outlined above determine the prices at different levels of marketing. Two crops have been selected in this study – potato

and vegetables which are important crops in the district of Paschim Medinipur in West Bengal. The data have been collected by primary survey in local, wholesale and retail markets in some cities and towns of West Bengal. A theoretical framework has also been used for the analysis of empirical data. The Section 2 provides the theoretical background. The data have been analysed in Section 3. Section 4 gives the summary and conclusions.

II. A Theoretical Backup

A part of total production of an agricultural crop in a particular region is used for local consumption. The larger part of the production is sent to urban markets, industrial belts and to other areas where the crop is not grown but consumed. The local traders or agents assemble the surplus product from the local market directly from the farming households. The farmers are large in numbers whereas few traders collect the product from the farmers. Therefore, the local assembling market is characterised by few buyers and large number of sellers. The buyers behave like oligopsonists who offer higher price if they want to purchase a larger quantity. Naturally, the average price in local market (AP_l) rises with quantity of purchase. As AP_l curve is upward-sloping, the marginal price curve (MP_l) is also rising and remains above theAP_l. As demand curve is downward sloping in normal situations, the marginal revenue curve (MR_l) is also downward-sloping as usual. The equilibrium quantity of sale is determined in the local market by the intersection of MR_l and MP_l curves and price paid to the farmer (P_f) is equal to AP_l (see Panel A of Figure 1). If the demand and price in the wholesale and retail markets in the supply chain decline MR_l will shift downward and price paid to the farmer will also decline (from P_f to P'_f in Panel A).

The wholesale market which is controlled by few big traders, plays a vital role in agricultural marketing and determining the prices for agro-products. The local traders from different regions will sell the product to the buyer in the wholesale market. The buyers in the wholesale market can control both price and market supply. As in Panel A, here in Panel B also, the purchase is determined at the point where MR_w and MP_w curves intersect each other. Accordingly, the buying price in the wholesale market isP^b_W. If traders control price, it is reflected in the decline of price (P^b_{Wl} in Panel B).

The sellers in the retail market who are large in numbers, procure the product from the wholesale market where the same few traders exercise their control on price and supply as oligopolists. It is shown in Panel C of Figure 1 that the price at which the traders of retail market purchase from wholesale market is P^S_W . This price may go up to P^S_{Wl} if the wholesalers increase price due to get higher profit or higher marketing cost.

The Panel D of Figure 1 shows the determination of price in the retail market. The demand curve (D_R) is downward-sloping as usual and inelastic. So, price depends mainly on supply. At the beginning, the equilibrium retail price for a product (say, potato), is

P_C. Now, if the supply curve shifts to the left (from S_R to S'_R) due to lower production, higher profit-margin of the traders in the supply chain or higher marketing cost, the price will rise to P'_C (see Panel D in Figure 1). Then the consumers will be losers. The final demand remaining more or less unchanged, the price to be paid by the consumers will be determined by supply or production, control of the traders (mainly of the wholesale traders) and the costs of marketing such as transportation, storage, labour cost of handling, wastage etc. The same factors will determine the fraction of the consumer's price to be received by the farmers. Thus it follows from theoretical analysis, if a higher price is to be ensured to the producers (farmers), the government can develop infrastructure to reduce marketing cost and resist fall in price in the year of good harvest by providing facilities for storage and preservation. The other important factor is to control the monopoly power of the traders, specially in the wholesale market.

Local Market

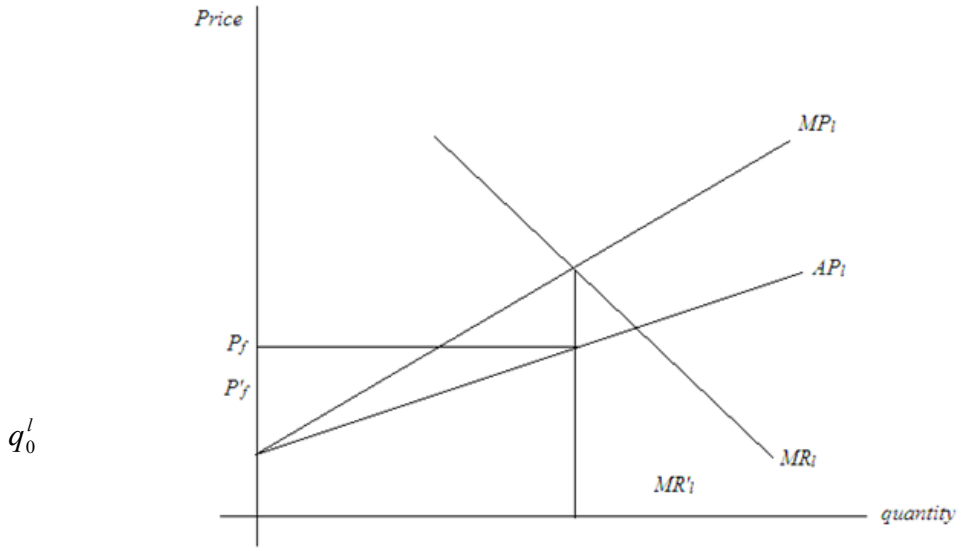
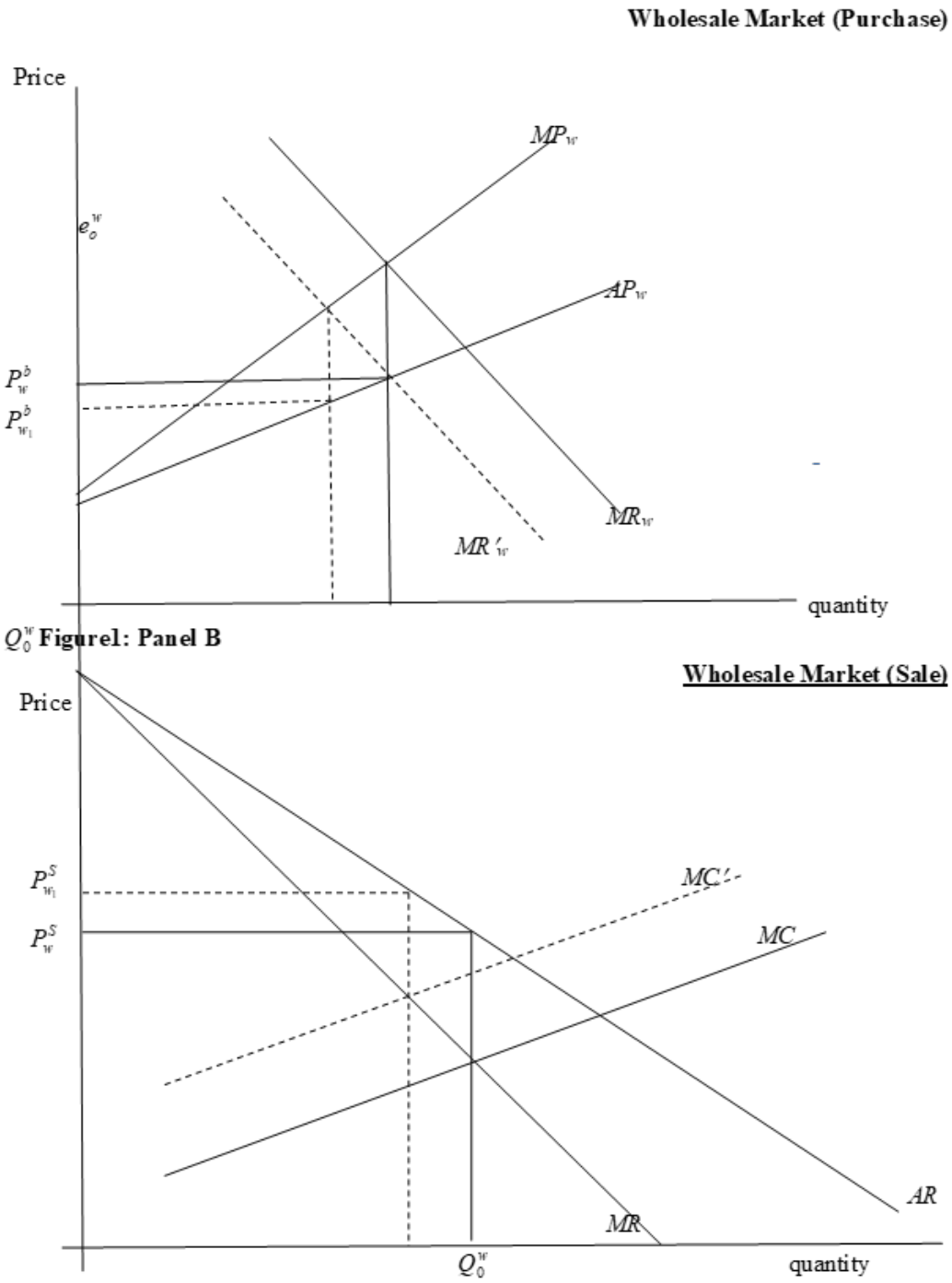


Figure 1 : Panel A



Figurel: Panel B

Figure 1 : Panel C

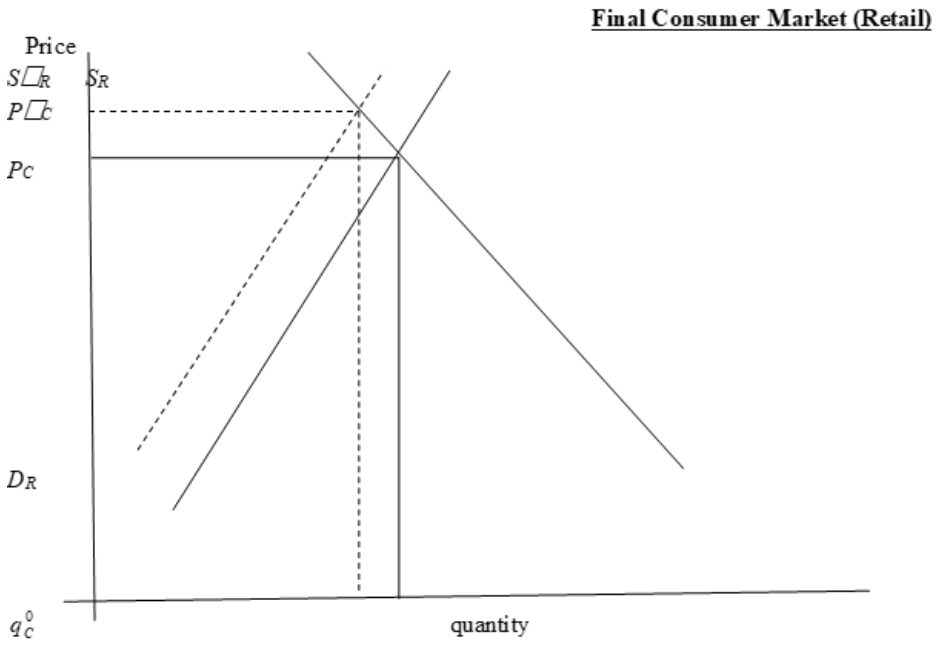


Figure 1 : Panel D

III. Empirical Evidences

III.1 Marketing of Potato – Supply Chain and Prices

West Bengal is one of the major potato growing states in India and potato is a major crop in Paschim Medinipur district of West Bengal. This district is adjacent to Hooghly district which is the most important potato growing belt in West Bengal. In Paschim Medinipur District (PMD), there is surplus production and excess production after local consumption, is sent to different wholesale and retail markets for sale within and outside the state. A primary survey was conducted on the supply chain, market structure and prices of potato in this district in 2019. Potato is a crop which is produced once in a year but consumed throughout the year. So, its preservation (in cold storages) and flow of supply over the year is very important. The survey was conducted in 3 cold storages/warehouses in Garbeta and Chandrakona areas of the district. At the same time survey was done in the wholesale markets of Kolay Market in Sealdah(famous for wholesale trading of agricultural crops and vegetables), Jaan Bazar Market and Barra Bazar market of Kolkata where potato is sent for sale from cold storages of the district. Two retail markets inManicktala

and College Street of Kolkata were surveyed at the same time. The retail traders purchase from the above wholesale markets and sell the products in the local retail markets.

The prices of potato (per quintal) received by the farmers, price of potato at the gate of cold storage (at the time of release from the store), buying and selling prices in the wholesale market and price in the retail market, and also the costs of marketing at different stages of marketing have been examined and analysed.

(i) The price received by the farmer at the time of storage after harvest is Rs. 550 per quintal.

(ii) The price of potato at the time of release from the store after few months is Rs. 815 per quintal.The cost of storage including store rent, labour cost and others is Rs. 178 per quintal.

(iii) If the farmer or the trader keeps the potato in the store, his profit is Rs. 815 – Rs. 550 – Rs. 178 = Rs. 87/- per quintal.

The traders in the second stage bring the potato to sell it in the wholesale market at a higher price.

(iv) The buying price of the wholesale trader is Rs. 850 per quintal excluding the costs of transportation and handling.

(v) The handling cost of this trader is Rs. 15 per quintal. The traders at the second stage get profit per quintal is Rs. 850 – Rs. 815 – Rs. 15 = Rs. 20.

The wholesale trader bears the costs of transportation, loading, unloading and handling from the coldstore to the godowns of the wholesale market and this cost is Rs. 80 per quintal.

(vi) The selling price of potato by the wholesale traders to the retail traders is Rs. 1064 per quintal. So, the profit margin of the wholesale trader is Rs. 1064 – Rs. 850 – Rs. 80 = Rs. 134 per quintal.

The price of potato in the retail market is Rs. 1400 per quintal (Rs. 14 per kg.). This is the price paid by the final consumer. The retail trader has to incur marketing cost (including transportation, labour, local storage and others) of Rs. 120 per quintal.

(vii) So, the profit margin of the retail trader is Rs. 1400 – Rs. 1064 – Rs. 120 = Rs. 216 per quintal.

The interesting results follow from this study:

(1) The marketing margin (M) = Rs. 1400 – Rs. 550 = Rs. 850 per quintal. It includes both profit of the traders and cost of marketing.

(2) The share of profit of the traders in the marketing margin is Rs. 87 + Rs. 20 + Rs. 134 + Rs. 216 = Rs. 457 (per quintal).

(3) The cost of marketing including storage, transportation, labour and others is Rs. 178 + Rs. 15 + Rs. 80 + Rs. 120 = Rs. 393 per quintal.

The following 3 conclusions follow from this analysis.

I. The consumer's price is Rs. 1400 per quintal. The farmer / producer gets only 39.28% of the price paid by the final consumer. This price is not net of production cost. If cost of production is deducted from the farmer's price, it will be seen that the farmer gets only a fraction of the price paid by the consumer.

II. The profit margin of traders at different stages is 32.64% of the price paid by the consumers. This profit is net of all marketing costs.

III. The marketing cost is 28.07% of the price paid by the consumers.

IV. The share of the farmers in the price paid by the consumers can be increased if (a) no. of intermediaries in marketing chain can be reduced, (b) the monopoly profit of the traders can be reduced by govt.-regulation and (c) reducing the cost of marketing through development of storage facilities, transportation and use of technology.

It is also found that when potato is supplied to the retail market in Kolkata directly from the cold stores in Garbeta, the retail price becomes Rs. 1300 per quintal. It is Rs. 100 less than the price when potato reaches to the retail market avoiding the wholesale market. In this case, the consumers are gainer. As the no. of intermediaries declines or wholesale profit is avoided, the product becomes cheaper in the final consumer market.

It has been reported by cold storage owners that potato from Garbeta region in Paschim Medinipur district is sent to Kolkata, Medinipur Town, Kharagpur, and to some markets in Orissa and Jharkhand. The survey could not be conducted in other states. But survey was done in Kharagpur and Midnapore town side by side with Kolkata at the same time. Kolkata is 160 km away from Garbeta while the distance between Garbeta and Kharagpur is 60 km. Almost same distance is for Midnapore Town. As distance is less, transport cost declines and also the no. of intermediary may be less. As a result, the consumer price in retail market is Rs. 1300 per quintal against Rs. 1400 in Kolkata. From consumer's point of view, if the distance between production point and consumption point is high, the consumer will have to pay a higher price. However, the producer (i.e., farmer) may get a share of this extra price if marketing system is efficient.

Finally, it is found that the share of the farmers in total potato preservation in cold storage is 25% to 50%. There is seasonal variation in price of potato. The price in August is different from that in June. The traders or agents enjoy high profit margin in lean season (August to November). If the farmers have the scope of keeping potato in larger proportion and for a longer period they can have some extra profit or income. The govt. can help them in this matter by fixing their quota in stores and providing loans to them for this purpose.

III.2. Supply chain and prices of vegetables

(1) The marketing margin (M) = Rs. 1400 – Rs. 550 = Rs. 850 per quintal. It includes both profit of the traders and cost of marketing.

(2) The share of profit of the traders in the marketing margin is Rs. 87 + Rs. 20 + Rs. 134 + Rs. 216 = Rs. 457 (per quintal).

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III.2. Supply chain and prices of vegetables

West Bengal is one of the major vegetable producing states of India and Paschim Medinipur district in West Bengal produces plenty of vegetables such as cauliflower, cabbage, brinjal, bitter gourd, chilli, cucumber and many others. Since total productions of these crops are greater than local consumption, the surplus is supplied to the towns, cities and industrial belts for consumption. These vegetable items reach the final consumers through marketing channel and a supply chain. In the field survey on the marketing of vegetables in this study, a multi-layer marketing system has been found. At the first stage local markets are there where the local agents or traders purchase the products from the farmers for the wholesale markets. The local markets in this study are Daspur, Lankagarh and Colora in Paschim Medinipur district. The vegetable items are cauliflower, cabbage, chilli, brinjal, bitter gourd and cucumber. These items were sent to the wholesale markets in Kolkata (SealdahKolay market), Kharagpur and Midnapore Town. From these wholesale markets, the retailers procure the vegetables and sell them in the retail markets to the final consumers. The retail markets surveyed are Manicktala and College Street in Kolkata, Golbazar in Kharagpur and Rajabazar in Midnapore town. The survey was conducted in these markets simultaneously in the last week of December in 2018.

Table 1. The average prices in local market, wholesale market and retail market of the following crops in Paschim Medinipur and Kolkata.

Crops	Price in local market (Rs.)	Price in wholesale market (Rs.)	Price in retail market (Rs.)	Marketing margin (Rs.)
Cauliflower (per piece)	7.7 (40%)*	12.25	19.22	11.52 (50%)**
Cabbage (per kg)	4.66 (31%)*	7.25	15.00	10.34 (122%)**
Brinjal (per kg)	8.44 (34%)*	13.5	25	16.56 (96%)**
Cucumber (per kg)	15.77 (39%)*	22.50	40	24.23 (54%)**
Bittergourd (per kg)	16.88 (39%)*	2	43.33	26.45 (57%)**

* farmer's price as % of retail price.

** marketing margin higher than the farmer's price as percentage.

Source: Primary Survey.

Table 1 shows that the average price of cauliflower per piece in the local markets of Paschim Medinipur district is Rs. 7.7 per piece. In the wholesale market of Sealdah in Kolkata the price is Rs. 12.25 per piece. In the retail markets it is sold to the final consumers at a price of Rs. 19.22 per piece. Here, the marketing margin (MM) is Rs. 11.52 per piece which includes marketing costs like transportation, storage, labour etc. and the profits of the intermediary traders. It is important to note that marketing margin is 50% higher than the price received by the farmer. It also reveals that the farmer gets only 40% of the price paid by the consumers. The remaining 60% goes to the traders as profit and covers the cost of marketing.

In case of cabbage, the local price (received by the farmers) is Rs. 4.66 per kg. It is sold at a price of Rs. 15 per kg to the consumers in the retail market. So, the marketing margin is Rs. 10.34 which is 122% higher than the farmer's price. The farmer gets only 31% of the price paid by the consumers in the retail market.

The average price of brinjal in the local markets is Rs. 8.44 per kg. Its wholesale price in Kolkata is Rs. 13.5 per kg. In the retail market it is sold at a price of Rs. 25 per kg. The marketing margin is Rs. 16.56 per kg which includes profits of the traders in the supply chain and cost of marketing. It is important to note that the price received by the farmer is only 34% of the retail price paid by the consumers. But the marketing margin which includes profits of the traders and marketing cost is 96% higher than the farmer's price.

In case of cucumber, the local price is Rs. 15.77 per kg which is only 39% of the price paid by the consumers in the retail market (Rs. 40 per kg). Here, the marketing margin is Rs. 24.23 which is 54% higher than the farmer's price.

For bitter gourd, the average price in the local markets of Paschim Medinipur district is Rs. 16.88 per kg. In the wholesale market of Sealdah in Kolkata, this price rises to Rs. 28 per kg. and in the retail markets of Kolkata it is sold to the final consumers at a price of Rs. 43.33 per kg. The marketing margin stands at Rs. 26.45 which is 57% higher than the price received by the farmers. It is also revealed that only 39% of the retail price goes to the farmer and 61% of it is appropriated by the traders as their profit and costs of marketing.

So, it is very clear that nearly 40% of the price of vegetables paid by the consumers in the retail market actually goes to the producers. The remaining share goes to the traders as profit or is used to meet the costs of marketing . Now, if the marketing cost can be reduced by better storage facilities, transportation etc. and the profit margin of the intermediary traders can be reduced by govt. intervention and greater competition, the marketing margin (MM) will decline. Then the local producers can get a higher price. Also, the consumers will gain from lower retail prices if marketing margin can be reduced.

Table 2. OLS Regression of farmer's share in retail price (farmer_share_retail-price) on retail price (retail-price), share of wholesale price in retail price (share_WP_RP) and marketing margin using cross section data.

farmer_share_retail-price	Coeff.	t – value	Prob.
retail-price	1.98	10.25 *	0.000
share_WP_RP	0.072	1.31	0.20
marketing margin	□ 3.75	□ 10.01 *	0.000
constant	32.05	10.13 *	0.000

* significant at 1% level.

R2 = 0.86, n = 25, F (3, 21) = 44.71

The results in Table 2 show that the coefficient of farmer_share_retail-price is positive and statistically significant. It implies that if the price in the retail market increases, the share of the farmer in the retail price will increase. This is quite consistent with market behaviour in agricultural commodities. The implication is that if the product can be sold in a market where the retail price is high, the farmers will be gainer. On the other hand, the marketing margin (MM) has negative impact

Table 3. OLS regression of price of agricultural crops in local market (local_price) on the price in retail markets in city (retail_price) and share of wholesale price in retail price (share_WP_RP) using cross section data.

local_price	Coeff.	t – value	Prob.
retail-price	0.40	12.41*	0.000
share_WP_RP	0.050	1.41	0.17
constant	□ 3.64	□ 1.83**	0.08

* significant at 1% level.

** significant at 5% level.

R2 = 0.88, n = 25, F (2, 22) = 93.22

on the farmer's share in retail price. The coefficient of MM is negative and significant. This problem is very relevant for Indian agricultural marketing. MM includes the profits of the intermediary traders and the costs of marketing. If the traders try to extract more profit or marketing cost is high, the farmers will get a lower share of the price paid by the final consumers.

The results of Table 3 supplement these results. If the price in the retail market increases, the farmers will be benefitted from higher prices in the local market. Both in Table 2 and 3, it is found that the share of wholesale price in retail price has no effect on local price or on the share of the farmers in retail price. To ensure higher prices to the farmers, the profit of the traders in the marketing channel and the costs of marketing are to be reduced and the price in the retail market requires to be high. So, the markets of high prices where the products can be supplied for sale are to be explored. The export of the goods may be an option in this context.

IV. Summary and Conclusions

The marketing of agricultural products is very important from the viewpoint of the farmer's income and consumer's interest. The production of agricultural commodities and their prices have some typical features which are different from the products of other sectors. The bulk of the production in agriculture is not directly sold to the consumers by the farmers. They pass through a marketing channel in which there are a number of

intermediary traders who control the supply and price in the market. Particularly, the wholesale market is controlled by a few traders. As a result, the producers (farmers) and consumers are subject to oligopsonistic and oligopolistic exploitations. The difference between the price paid by the consumer and the price received by the farmers is called marketing margin (MM). The MM includes the costs of marketing and the profits of the traders or agents in the supply chain of the marketing process. If the traders extract high profit by virtue of their dominance in the market or the marketing cost is high due to high transportation cost or lack of storage facilities, etc. the farmer will get a smaller share of the price paid by the final consumers.

This paper examines the prices at different stages of marketing channel, marketing margin and farmer's share in retail price in case of vegetables and potato in the Paschim Medinipur district of West Bengal. This district is an important producer of vegetables and potato which are sent to wholesale markets in cities and towns like Kolkata, Kharagpur and Midnapore for sale from the local markets. Primary survey has been done on the marketing of these products and the prices and market structure have been analysed in this study. The major findings are as follows: In case of potato, the farmers get Rs. 550 per quintal while the retail price in the consumer market is Rs. 1400 per quintal. So, the farmers get only 39% of the price paid by the consumers. The remaining 61% goes to the traders as profit at different levels of the marketing channeland is used as marketing cost. This paper concludes that if profit margin of the traders can be reduced or the costs of marketing can be reduced, the share of the farmer in retail price can be increased.

In the marketing of vegetables, five crops have been considered and they are cauliflower, cabbage, brinjal, bitter gourd and cucumber. Here, also, the crops are sent to the wholesale market of Kolkata from where the products are procured by retail traders for sale in the retail markets in the adjoining areas. From the analysis of the data, it is found that 30-40% of the price paid by the consumers in the retail market goes to the farmers. The remaining 60-70% goes to the traders as profit or is used to meet the costs of marketing. The marketing margin (MM) ranges from 54% to more than 100%. The simple regressions on cross section data show that if MM rises the farmer's share in retail price declines. On the other hand, if retail price increases, the share of the farmer in consumer price rises. This paper suggests that if infrastructure can be developed for storage facility,better transportation and lower wastage, the farmer can have higher prices for their products. Similarly, if the profit of the traders, or the number of intermediaries can be reduced by govt. intervention, farmers' cooperatives and loan facilities to the farmers for holding potato and other crops in cold stores and warehouses, then the actualproducers can have better prices for their crops. Lastly, new markets of high prices can be explored to sell the products at high prices, along with effective marketing network.

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Challenges to Biological Diversity in Agriculture with Special Reference to Genetic Diversity of Rice in India

Arup Ratan Mukhopadhyay[1] and Ramyani Mukhopadhyay[2]

"In the agriculture of Asia we find ourselves confronted with a system of peasant farming which in essentials soon become stabilised. What is happening in the small fields of India and China took place many centuries ago. The agricultural practices of the Orient have passed the supreme test—they are almost as permanent as those of the primeval forest, of the prairie or of the ocean." Sir Albert Howard, AN AGRICULTURAL TESTAMENT.

Abstract

The agricultural system of the Orient had been enriched with the accumulated wisdom of the generations of cultivators, who could evolve, through indigenous breeding experiments, seeds, suitable to a varied range of agroclimatic situations. Genetic diversity of rice in different parts of India and the loss of bio-diversity of our eco-system through the onslaught of HYV technology , are discussed and analysed with the help of important case studies in this paper.

Keywords :Biological Diversity, Agriculture , Genetic diversity of Rice in India, Sustainability.

JEL Classification Codes : Q10, Q56.

I. Introduction

The vision of agriculture of the Orient had been developed as 'Nature's agriculture'. Mixed farming was the rule. The soil was always protected from the direct action of sun, rain and wind. The rainfall in particular was carefully conserved. The forest manured itself. The mineral matter needed by the trees and the undergrowth was obtained from the subsoil. The soil always carried a large fertility reserve. The crop and livestock looked after themselves. In nutshell, the agricultural system of the Orient was developed on Nature's principles.[3]

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3.. Sir Albert Howard, An Agricultural Testament, 1940.

The agricultural system of the Orient had been enriched with the accumulated wisdom of the generations of cultivators, who could evolve, through indigenous breeding experiments, seeds, suitable to a varied range of agroclimatic situations. The genetic resource of rice is considered as an important source of global food security. That is why, the genetic erosion of rice base is of great concern to the people all over the world.

According to the classical economists[4], the emergence of surplus output over the subsistence needs due to higher carrying capacity of land led to the growth of human population. Malthus[5] thought the growth of human population was to be in geometric progression, while food production would grow in arithmetic progression due to the fixity of land. As a result, there ensued a long period of struggle between human population and food production, one chasing the other. This struggle resulted in the history of degradation of ecosystems of the Earth as inhabited by the humans. In agriculture, this degradation took place through the intensification of cultivation by use of irrigation and fertilizer.[6]

The expansion of science and technology has increased the agricultural production many folds. The High Yielding Variety (HYV) of seeds, developed by Sir Norman Borlaug[7], ensured bumper crop with the use of chemical fertilizer, pesticide and water. The 'miracle seeds' by character are highly responsive to chemicals, unlike the indigenous varieties. It was expanded in the regions having fortunate in water availability. The threat that comes out of this expansion process towards biodiversity is the tremendous extraction of natural resources. Each technological advance has a price attached to it, mainly environmental, with a corresponding reduction of sustainability and justice. In this paper, we will focus on the challenges to genetic diversity of rice in India during the post-independence period.

II. Rice Diversity in India

India is considered to be the origin of rice. The Eastern Himalayan region of Northeast (NE) India is home to a large number of indigenous rice varieties. Asian rice (Oryza sativa L) and African rice (Oryza Glaberrima Steud) are the two independently domesticated rice species. The genetic and developmental basis of some of the domestic traits are conserved not only between Asian and African rice but also with other domesticated crop species. (Peterson, Marie, Robert Henry, 2021).Prior to the Green Revolution in the 1960s, India was home to more than 100,000 rice varieties, encompassing a stunning di-

4. Classical school comprised of Adam Smith, David Ricardo and Thomas Malthus.
5. Thomas Malthus, Essay on the Principle of Population, 1798.
6. Ramprasad Sengupta, Extreme events, Neo-Malthusianism and Challenges of Sustainability, Arthaniti Katha, 2021. (ISBN 978-81-932331-2-2)
7. Sir Norman Borlaug was awarded the Nobel Peace Prize for developing HYV seeds in wheat and paddy, by pooling characters from two Japanese varieties Norin-10 and De-Geo-Woo-Gen, which were believed to address world hunger by ensuring food security.

versity in taste, nutrition, pest-resistance and adaptability to a range of biotic and abiotic traces. Today, much of this biodiversity is irretrievably lost, forced out by the quest for HYVs and Hybrids. Nevertheless, a significant number of traditional varieties of rice are still grown by small and marginal farmers across India, where they cater for local consumers' quality preferences and market niches.[8]

A series of ingenious selective breeding experiments carried out over the millennia, by generations of unknown farmers in the Indian subcontinent, have enormously expanded the genetic diversity of the Indian rice, *Oryza sativa var. indica*. This diversity is embodied in thousands of varieties of rice, also called landraces[9]. As a result, the Indian subcontinent had a multitude of rice breeds adapted to different types of soil conditions -- dry upland, inundated lowland, rainfed medium land -- and to climatic vagaries: drought, late rain, early rain, too much rain, excessive cold, and so on.[10]

In India, many folk varieties like *Athikaraya, Dudh-sar, Kayame, Neelam samba, Srihati, Maharaji* and *Bhejri* are known in folk medicine to enhance milk production in lactating women. Other traditional varieties like *Kelas, DudheBolta* and *Bhutmoori* are rich in iron and can be included in diet of mothers to treat anaemia. *Tilak Chandan* is a thick, small-grained rice famous for its fragrance and cultivated in Uttar Pradesh's Bijnore and Rampur. *Bindli*, a once famous rice variety of Uttar Pradesh, cultivated under rain-fed, irrigated as well as waterlogged conditions, is now virtually out of cultivation, with only a few farmers cultivating it in the plains of Pauri district, Uttarakhand. *Kalanamak*, a scented rice variety grown in Uttar Pradesh, is fast going out of cultivation. Seven rice varieties of North-East India — *Meghalaya lakang, Chingphourel, Manuikhamei, Kemenyakepeyu, Wainem, Thekrulha, and Koyajang* — has the potential to resist leaf and neck blast disease in rice plants.[11]

Indian farmers could evolve nearly 237 aromatic rice varieties through traditional selection, hybridisation, and back crossing with locally adapted high yielding lines. Such scented varieties are *Chinnor, Dubraj, Kali Muchh,Ambemohar, Mullan Kazhama, Gobindo Bhog, Seeraga Samba, Mushk Budji, Radhuni Pagol* and *Chak Hao Amubi*.[12]

A field study conducted by the Agro-Economic Research Centre, Visva-Bharati University, Santiniketan, West Bengal, India, found that, there are many traditional vari-

8. Max Zieren, An Indian farming biodiversity success story, UN Environment Program, February 18, 2020.
9. A landrace is a domesticated, locally adapted, traditional variety of a species of animal or plant that has developed over time, through adaptation to its natural and cultural environment of agriculture and pastoralism, and due to isolation from other populations of the species.
10. Debal Deb, In Search of Forgotten Rice Varieties. January 2000.
11. Susan Chacko, September 2021.
12. Bharat Dogra, The Life and Work of Dr.R. H. Richaria 1991

eties of rice being cultivated by farmers in *Sundarban delta* (Eastern part of India) which are known for their salt tolerant property, locally concentrated in practice. The seeds of such varieties are not commercially available in the market. They are preserved and continued across family lines or neighbourhood. In spite of low productivity, one dominant reason for survival of the low yielding varieties is their high capability to withstand land salinity. There are pockets in *Sundarbans islands* which are very susceptible to salinity ingress because of their proximity to saline rivers and the bad condition of the protective embankments. In such locations, farmers hedge their risk of total crop loss during a season by compromising with low productivity. Cyclone *Aila* in May 2009, had devastated the *Sundarban Island* of West Bengal (Eastern part of India), with salt water overflowing from surrounding rivers to the agricultural fields, had ushered in a new realisation among island dwellers regarding their food security. They realised, after that painful experience, that preserving and practicing local salt tolerant varieties is a viable coping strategy against such threats in future. The realisation translated into, even without any outside support or counselling, renewed interest among farmers to organize themselves to create local seed banks for such rice varieties. A study conducted on farmers' choice of traditional varieties vis-à-vis HYV seeds revealed that,six of the traditional varieties had been cultivated by at least ten respondents after *Aila* compared to four types of HYV rice. It also reveals that *Dudhersar* is the most popular traditional variety among the respondents while *CR1017* tops the list among the HYV . (Table 2). [13]

III. Loss of Genetic diversity of Rice

Until the advent of the Green Revolution, over 42,000 folk landraces were recorded to have existed in India. Since 1965, the propaganda of 'miracle seeds', have systematically pushed most of these folk crop varieties to extinction. Roughly, 2000 folk rice varieties are still in cultivation in the fields of marginal farmers who couldn't afford the cost of cultivation of HYV (High Yielding Variety) seeds. This indicates an erosion of the gene pool of rice varieties. Homogenisation of rice through HYV monocultures, leading to genetic uniformity, would entail that a single disease or pest outbreak will ruin all crops in the field, just as a single disease agent caused the Irish potato famine.[14]

The study of Nivedita Sigh and others (BMC Genet 2016)[15] reveals that, the Indian rice varieties harbour huge amount of genetic diversity. However, the trait based improvement program in the last decades forced breeders to rely on few parents, which resulted in loss of gene diversity during 2006 to 2013. The present study indicates the need for broadening the genetic base of Indian rice varieties through the use of diverse parents in the current

13. Santadas Ghosh and Kali Sankar Chattopadhyay (February 2017).
14. Debal Deb, January 2000, In Search of Forgotten Rice Varieties.
15. Nivedita Singh and others (2016), Genetic Diversity Trends in Indian Rice Varieties : An analysis Using SSR Markers.

breeding program. The present study based on 36 HvSSR markers distributed over all 12 chromosomes of rice suggests that, after Green Revolution breeders have used different parentage for improving the yield, quality and plant architecture, but after 2006 priority of breeders have changed and instead of plant architecture, more focus was on breeding for biotic and abiotic stress tolerance and trait-specific improvement. This could be the possible reason that allele number recorded over the period has not decreased, but genetic diversity and PIC have shown a sudden decrease after 2006. To broaden the genetic base, there is an urgent need to incorporate more diverse donor parents in the breeding program for varietal improvement in rice.

The study of Baharul Chaudhuri and others(2013)[16] tried to explore the genetic structure and diversity of rice varieties in NE India. They genotyped 300 individuals of 24 indigenous rice varieties representing sali, boro, jum and glutinous types, 5 agronomically improved varieties, and one wild rice species (O. rufipogon) using seven SSR markers. A total of 85 alleles and a very high level of gene diversity (0.776) were detected among the indigenous rice varieties of the region. Considerable level of genetic variation was found within indigenous varieties whereas improved varieties were monoporphic across all loci. The comparison of genetic diversity among different types of rice revealed that sali type possessed the highest gene diversity (0.747) followed by jum (0.627), glutinous (0.602) and boro (0.596) types of indigenous rice varieties, while the lowest diversity was detected in agronomically improved varieties (0.459).

Traditional rice varieties with high genetic variation overwhelmingly support the improvement of rice. India, rich in diversity of indica varieties of rice, accounts for approximately 80% of the cultivated rice. Indian rice varieties are evolved through traditional selection, hybridisation, and back crossing with locally adapted high yielding lines.The traditional varieties at the brim of extinction serve as donors of genes governing specific traits such as disease (gall-midge, bacterial resistance) and drought resistance for the improvement of the crop. However, due to high fascination of hybrid varieties, the traditional varieties with desirable traits were neglected and are now rare in cultivation. A high turnout to hybrid varieties as a consequence of Green Revolution resulted in an erosion of traditional varieties/landraces, which narrowed down the varietal diversity.[17]

The loss of genetic diversity in cultivated rice during domestication may have had serious consequences for its tolerance to diseases and adaptability to different environments. Most natural populations are genetically diverse. In host populations, genetic diversity is thought to increase the chance that one or more individuals in a population is resistant to

16. Baharul Chaudhuri and others(2013), Genetic structure and diversity of indigenous rice (Oryza sativa) varieties in the Eastern Himalayan region of Northeast India, Springer Plus , Article No.228, 2013.
17.Rekha and others (2011), Genetic Diversity Assessment of Rarely Cultivated Traditional Indica Rice (Oryza sativa L.) Varieties, Biotechnology Research International.

infection, and thereby reduces the likelihood of a parasite encountering a susceptible host. Genetically homogenous host populations are conversely believed to be more vulnerable to infection given the uniformity of host susceptibility. This relationship between low genetic diversity and high disease incidence is referred to as the 'monoculture effect' .

The issue of biodiversity from a third world perspective has been studied by Vandana Shiva.[18] She looked at the critical issues of biodiversity from a Southern perspective. The study analysed the issues in a North-South framework and indicated the primary causes and effects of biodiversity erosion. The study provided a critique of the dominant approaches to biodiversity conservation and suggested principles from a third world perspective, relevant to the Biodiversity Convention Process. The study pointed out the erosion of crop diversity during the phase of 'Green Revolution' in rice and wheat. Over the last half century, the enormous rice diversity of 30,000 different indigenous varieties, cultivated by the Indian farmers have been reduced to 50 varieties, with the top ten accounting for over three quarters of the subcontinent's rice acreage.[19] The dwarf varieties of wheat and rice that dominated the phase of 'Green Revolution' have been created by pooling characters from two Japanese varieties Norin-10 and De-Geo-Woo-Gen. The narrow genetic base has created alarming uniformity, causing vulnerability to disease and pests.[20] The study accused the dominant approaches to biodiversity conservation having suffered from 'Northern' bias and its blindness to the role of the North in the destruction of biodiversity in the South and benefit sharing for contribution of farmers and tribals as original producers over the millennia.

IV. Challenges to Biodiversity

In the field of agriculture, Challenges to biodiversity comes through two different directions, one comes through technology and other comes through property rights.

The process of seed being transformed from a renewable to a non-renewable input of production involves first, the replacement of indigenous seeds by HYV seeds; second replacement of HYV seeds by Hybrid seeds; last, replacement of hybrid seeds by Genetically modified seeds. In every step the direction of scientific innovation is towards monoculture and sterility of seeds. The challenges to biodiversity came with biotechnology revolution. The process of hybridization to genetic modification brought sterility in seeds and has transformed it from a regenerative to a non-regenerative input of production. Unlike other inputs of production, seed can reproduce itself. Farmers, from time immemorial, retain seeds, multiply seeds and exchange seeds with other fellow farmers. At this point seed is different from other inputs of production. The biological characteristic

18. Vandana Shiva, Biodiversity a Third World Perspective, Third World Network, Malaysia.
19. Pat Mooney, The Law of the Seed, in The Development Dialogue, 1983, p.14.
20. Jack Doyle, Altered Harvest, Viking, New York, 1985, p.205.

(regenerative property) of seed appeared as the impediment to accelerate the market for seed. Biotechnology attempts to remove this biological obstacle towards sterility in seed which is a threat to repository of life's future evolution. The challenges, through control over seed technology, to biodiversity came in the form of erosion of genetic diversity. Genetic modification is not found in nature under natural conditions of crossbreed or natural recombination. Natural gene transfers took place over centuries, giving every species time to adapt. The threat to biodiversity comes in the form of horizontal gene transfer and erosion of crop biodiversity. Through the process of genetic splicing GM crops have been developed in laboratory condition which is different from horizontal gene transfer between species.

GMOs are alien in the ecosystem in which they are released and can pose uncharted risks for the ecosystem. The potential threat of contamination of food, crops and landraces with GM seeds are coming through three major pathways: by cross pollination of traditional crops, landraces by GM crops, by negligent segregation of GM materials and by horizontal gene transfer from GM plants to other organisms, viz., soil, gut bacteria and fungi.

Gene Use Restriction Technology (GURT) prevents seed from germinating unless proprietary chemicals are applied. GURT is popularly known as 'terminator' technology which is designed to be instrumental where hybridization has been proved elusive and enforcement of IPRs are found to be ineffectual.

Corporate seed monopoly aims to replace the biodiversity-based farming systems with monocultures, replacement of renewable seeds of the indigenous farming communities with non-renewable hybrids or genetically modified seeds and tries to habituate the farming community with a farming practice where high valued seeds and chemical inputs have to be bought from market every year.[21] These are the preconditions of growth of corporate agriculture.

Seeds, chemicals and biotechnology research are being controlled by the same trans-national corporations (TNCs), who maintain three images, gene giant, chemical giant and pharmaceutical giant. The so called 'life science' TNCs, viz., Astra Zeneca, Aventis, Monsanto and Novartis have been merged with the so called 'industrial science' TNCs, viz., BASF, Bayer, Dow and DuPont to intensify the control over the global market of seeds.[22]

V.Sustainability in the Diffusion of Bt Cotton in India

Indian agriculture has entered in a new phase in 2002 with the introduction of trans-

21. Vandana shiva, Bhar, Jafri, Corporate Hijack of Biodiversity, Navdanya, 2002.
22. Vandana shiva, Bhar, Jafri, Corporate Hijack of Biodiversity, Navdanya, 2002.

genic crop or Genetically Modified (GM) Seeds, in case of cotton. The GM seeds have been named after a particular bacterium, Bacillus (B) thuringiensis (t). Bt cotton is the only transgenic cash crop that has been approved by the Genetic Engineering Approval Committee (GEAC) of India for commercial cultivation. It has been genetically modified to produce an insecticide to combat the cotton bollworm, a common pest. The commercial release of first GM (genetically modified) crop, Bt cotton in 2002 led to the beginning of a 'Gene Revolution' in India. Today, almost 90 per cent of cotton area is planted to Bt cotton in India, with farmers adopting it in a rapid manner.[23]

Bacillus thuringiensis[24] is a bacterium available in soil. This bacterium has the unique characteristic of creating nearly 170 types of proteins in the body of a living organism. These proteins have the capability to combat a particular pest, fruit and shoot borer (*Leucinoides Orabonalis*). The gene responsible for creating such protein is named Cry1Ac[25]. In the process of genetic modification, the gene is plucked from the DNA of B_t bacterium and is being inserted in the cell of a popular open pollinated seed variety of cotton. Thus, the open pollinated variety is genetically modified. The whole process of genetic modification is carried out in four phases in laboratory condition. Genetic modification is not found in nature under natural conditions of crossbreed or natural recombination. The Genetically Modified Organism (GMO) must be a biological unit which is able to multiply itself or to transmit genetic material.

The transnational seed corporation, Monsanto, first introduced *Bollgard* B_t cotton in 1986 which was commercialised in US in 1996. This transgenic technology later spread to many countries including India. In March 2002, the GEAC gave approval to Mahyco for the commercial production of some B_t cotton varieties in India viz., MECH 12Bt , MECH 162 Bt and MECH 184 Bt under the brand name *Bollgard* of Monsanto. Before the introduction of Bt cotton, the cotton fields of India had been covered by the indigenous and hybrid seeds. The commercial clearance of Bt cotton was granted on the basis of field trial assurance of Monsanto-Mahyco that, it would not require spraying of pesticides, would result higher yield and higher income. It was assured that, the GM Bt cotton would create rapid resistance evolution in pests because theBt toxin would be expressed in every cell of the plant.[26]

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23. Status Paper on Indian Cotton, Chapter 06, Bt Cotton in India, Directorate of Cotton Development, Government of India, January, 2017.
24. Bacillus thuringiensis (or Bt) is a Gram-positive, soil-dwelling bacterium, the most commonly used biological pesticide worldwide.
25. Cry1Ac protoxin is a crystal protein produced by the gram-positive bacterium, Bacillus thuringiensis (Bt) during sporulation. Cry1Ac is one of the delta endotoxins produced by this bacterium which act as insecticides.
26. Source ICAC, Status Paper on Indian Cotton, Chapter 03, World Cotton Scenario, Directorate of Cotton Development, Government of India, January, 2017.

Bt. Cotton was released in 2002-03 for commercial cultivation in India. Since the release of Bt. Cotton technology, it has emerged as an effective alternative to traditional cotton varieties by inhibiting bollworm attack, thereby improving yield and income. This has resulted in fast adoption of Bt cotton over conventional cotton. Cotton production in India has accelerated more than 4 times and reached a peak of 359.02 lakh bales during 2013-14 as compared to 86.24 lakh bales in 2002-03. Introduction of Bt cotton has played a catalytic role in enhancing cotton production in India.[27]

Bt cotton area, which was hardly 0.29 lakh ha (0.38 %) out of 76.70 lakh in 2002-03, increased to 119.40 lakh ha out of 128.19 lakh hectares in 2014-15 showing more than 93.14 % adoption within a span of thirteen years. Of the total area in the world, about 76% is contributed by the countries of India, China, USA, Pakistan, Uzbekistan & Brazil. During the period 2006-07 to 2015-16, the highest coverage under cotton was 361.63 lakh hectares in 2011-12 whereas the lowest was 303.02 lakh hectare in 2009-10. About 82.57% cotton is produced by India (22.67%), China (28.30%), USA (13.59%), Pakistan ((8.14%), Uzbekistan (3.93%) & Brazil (5.95%). The highest production received at 1637.52 in 2011-12 and minimum at 1293 in 2015-16. India ranked first in Cotton production during 2015-16.[28]

Bt cotton hybrids proved to be the most accepted technology in cotton cultivation. The main purpose of Bt-cotton is to control bollworms. Bt cotton-effectively controlled bollworms, especially the American Bollworm, Helicoverpa armigera, thus preventing yield losses from an estimated damage ranging from 30 to 60 % each year in India from 2002 to 2011. Biggest gain from the technology was in the form of reduced insecticides usage from 46 % in 2001 to less than 26 % after 2006 and 21% during the last two years 2009 and 2011. Prior to the introduction of Bt cotton, about 9400 M tonnes of insecticides were used for bollworm control in India, whereas in 2011 only 222 M tonnes were used. The intensity of bollworms reduced significantly on cotton and also on other host crops. Farmers are no longer scared of impending bollworm infestations and the subsequent stress of using insecticides cocktails. The quality of seed-cotton from Bt-cotton fields was found to be better than non-Bt cotton because of negligible loculi and fiber damage. The Bt cotton area, which was 0.29 lakh ha in 2002-03, increased to 128.19 lakh ha in 2014-15 due to preference by cotton farmers. The all India level yield of cotton, which was 191 kg lint per ha. in 2002-03, increased to 510 kg per ha. in 2013-14. The per hectare net income of farmers increased from Rs. 7058/- in 2001 to Rs. 16125/- in 2010 under rainfed con-

27. Source ICAC, Status Paper on Indian Cotton, Chapter 03, World Cotton Scenario, Directorate of Cotton Development, Government of India, January, 2017.
28. Source ICAC, Status Paper on Indian Cotton, Chapter 03, World Cotton Scenario, Directorate of Cotton Development, Government of India, January, 2017.

ditions and Rs. 25000/- under irrigated conditions. A record export of 129.57 lakh bales was in 2011-12 after meeting domestic consumption. The greatest environmental benefit with Bt cotton is the reduction in usage of insecticides.[29]

But the Bt cotton fields of Maharashtra, Andhra Pradesh, Karnataka and Madhya Pradesh had experienced devastating pest attacks by non-targeted sucking pests like *Jassids*[30], *Aphids*[31],*Thrips*[32],*Wilt*[33] *(Fusarium Oxysporum fsp. Vasinfectum)* and *Root rot*[34] *(Rhizoctoria Bactaticola)* apart from the substantial attack from Bollworm[35]. The monoculture in cotton cultivation encouraged pest build-ups and increased the vulnerability of pest attacks. The claim of higher yield of 15 quintals per acre was frustrated. Average yield ranged from 3 to 4 quintals per acre. The reason of this being short staple size of cotton. The Monsanto-Mahyco claim of staple size ranging from 26 to 29mm was frustrated. Actual staple size was hardly 15-20mm.[36] This has resulted lower income. The farmers could not afford the huge cost of cultivation of B_t crop. Institutional credit was provided to only 25% of farmers. As a result, the village money lenders emerged as the rescuers with high interest rate. Another reason of crop failure is the non-availability of water. 95% of the cotton growing fields remained unirrigated. Extension of cotton cultivation had been encouraged without developing infrastructural facility for the same. Fall in the international price of cotton has resulted to huge import, as a result the indigenous cotton growers couldn't find the market for their produce. All these factors have resulted farmers' suicide in cotton growing areas viz., Vidarbha, and Warangal. Farmers' suicide has been concentrating in the areas where the cultivation practice has been shifted from food-crop to cash-crop and farmers have switched over from traditional farming system with indigenous seeds to corporate farming system with transgenic seeds.

Over the last three years, the yield per hectare of Indian cotton has dropped below 500 kg per hectare despite a rise in the area under the fibre crop. Data show that though India

29. Source ICAC, Status Paper on Indian Cotton, Chapter 03, World Cotton Scenario, Directorate of Cotton Development, Government of India, January, 2017.
30. Jassid is a sucking pest occurring throughout the crop growing period on cotton in all the zones. The pest injects toxins into leaves while feeding.
31. Aphids are small, soft-bodied insects with long slender mouthparts that they use to pierce stems, leaves, and other tender plant parts and suck out fluids.
32. Thrips are minute slender insects with fringed wings and unique asymmetrical mouthparts.
33. Wilt, common symptom of plant disease resulting from water loss in leaves and stems. Affected parts lose their turgidity and droop.
34. Root rot is a disease that attacks the roots of trees growing in wet or damp soil. This decaying disease can cut the life short of just about any type of tree or plant and has symptoms similar to other diseases and pest problems, like poor growth, wilted leaves, early leaf drop, branch dieback, and eventual death.
35. Bollworm is the common term for a moth larva that attacks the fruiting bodies of certain crops, especially cotton.
36. Research Foundation of Science Technology and Ecology (2003).

is the largest producer of cotton globally, it ranks 34th in terms of yield, below Vietnam, Pakistan, Ivory Coast, Ethiopia and Myanmar.[37]

Over the last three years, the yield per hectare of Indian cotton has dropped below 500 kg per hectare despite a rise in the area under the fibre crop. Data show that though India is the largest producer of cotton globally, it ranks 34th in terms of yield, below Vietnam, Pakistan, Ivory Coast, Ethiopia and Myanmar.[38]

VI. Controversy Between TRIPS and CBD

Challenges to genetic diversity also comes from property rights under the international agreement on Trade Related Intellectual Property Rights (TRIPS). First step towards patenting life came with Article 27.3(b) which advocated for micro-organisms to be patented. However, it allows certain exclusions from patent protection viz., plants and animals other than microorganisms. Plant varieties can be protected either by patent or by an effective *sui generis* (self generating) system or by a combination thereof.

Catherine Monagle[39] reviewed the Intellectual Property Rights in the light of the objectives of Convention of Biological Diversity. She analysed the IPR related aspects of the CBD, and the biodiversity related aspects of TRIPS. The study summarized the most important issues arising from the substantive linkages between the CBD's objectives, IPRs and the TRIPS Agreement. The study cited the cases of *Neem, Basmati, Turmeric, Sweet Berries, Ayahuasca* etc. as 'bio-piracy' (misappropriation) of local community knowledge through IPRs and argued that, while a few of such cases of 'bio-piracy' have been overturned, countless others remained unchallenged. The study analysed in detail how the TRIPS agreement may affect benefit sharing for utilization of genetic resources, preservation of indigenous knowledge, transfer of technology and conservation and sustainable use of biological diversity.

Biswajit Dhar and others[40] have studied the question of protection of Biodiversity under the regime of Intellectual Property from a developing country's perspective. They argued that, the interest of Gene-rich South has been threatened by the strengthening of IPRS which protects the interests of the TNCs of North. The interest of South can best be served by implementation of the objectives of CBD, aimed at conservation and sustainable use of biodiversity. They argued that, though patentable modern scientific innovation finds its base on knowledge of local and indigenous communities, but this community

37.Subramani Ra Mancombu (July 30, 2021), www.thehindubusinessline.com Article 35602168
38.Subramani Ra Mancombu (July 30, 2021), www.thehindubusinessline.com Article 35602168
39. Catherine Monagle, Biodiversity and Intellectual Property Rights; Joint Discussion Paper of WWF & CIEL, Switzerland, March 2001.
40. Biswajit Dhar, Sachin Chaturvedi, R. V. Anuradha, Regime of Intellectual Property, Protection for Biodiversity : A Developing Country Perspective; RIS and IUCN, 2001.

right remained outside the purview of IPRs. The approach of CBD to recognize the right of the local and indigenous communities through 'benefit sharing' has also been criticized on the ground of quantifying the benefits derived from the use of local knowledge as a percentage of the profits derived from the final product. The study critically evaluates Article 7 and 8 of TRIPS agreement on the ground that, there remains an element of inconsistency between the stated objectives of the TRIPS agreement and the implication of its specific provisions regarding transfer and development of technology and abuse of IPRs by right holders, central to these articles, which have not found manifestation in any concrete provision in the agreement.

VII. Whether Genetic Diversity is a Global public Good?

Emerging regime of intellectual property protection is the most important dimension of the process of globalization. Trade Related Aspects of Intellectual Property Rights (TRIPS) is a concept that has been formalized and agreed upon at the end of the Uruguay Round of the General Agreements on Tariffs and Trade (GATT) negotiations. This has led the developing countries to amend their existing intellectual property protection disciplines, in order to make it compatible to the disciplines of the developed countries. Intellectual Property Rights (IPRs) refer to the legal ownership by a person or business of an invention/discovery, attached to particular product or process which protects the owner against unauthorized copying or imitation. Out of the forms of intellectual property rights covered by the TRIPS Agreement, two forms, viz. patents and protection of undisclosed information, which covers trade secrets, are directly relevant for the agricultural sector. Article 27.1 of the TRIPS Agreement argued for providing patent for all types of inventions, be it product or process, in all fields of technology. In case of litigation over process patent, Article 34.1(a) put the burden on the defendant to prove that, the process to obtain an identical product is different from the patented process. This clause prevents any substitute product to be produced and its process patented. This has implication in genetic modification of plants where a particular type of gene splicing has the potentiality of engineering multiple plants. In cases of genetic contamination farmers are sued with the charge of patent infringement where Article 34.1(b) stipulates that, the defendant will have to prove his innocence. By the strength of this Article, in case of genetic contamination 'Polluter Pay Principle' is transformed into the principle of 'Polluter Gets Paid.' Regarding duration of patent, Article 37 of the TRIPS Agreement sought to introduce uniformity across the countries by giving a substantially long term, twenty years of patent protection, thereby assuring a patentee an assured market during that period unless the technology gets obsolete by the time. A *sui generis* system provides liberty to the member countries to formulate a milder/diluted form of patent rule through which 'farmers' privilege' and 'researchers' rights' are proposed to be protected. Therefore, the last two options offer flexibility to members for formulating different types of protection system for plant varieties, which suit best to their domestic system. However, the TRIPS Agreement does not define differences between rights under *sui generis* and patent. The word 'effective'

used before *sui generis* is important. Since TRIPS Agreement intends to bring some sort of uniformity in the patent regime across the countries, therefore an international convention, viz., UPOV (International Union for the Protection of New Varieties of Plants)[41] can be referred to as a guiding principle in order to make the *sui generis* system effective.

UPOV has no developing country as its member. First convention of UPOV was held on December 02, 1961, and was revised successively on November 10, 1972, then on October 23, 1978 and lastly on March 19, 1991. UPOV 1978 does have farmers' exemption, which allows the farmers to save seeds of protected varieties for non-commercial purposes and also breeders' exemption for free access to protected varieties for research and breeding of new varieties. But UPOV 1991 removed such exemptions. It moved the plant variety protection nearer to patent system by imposing restrictions on the right of the farmers vide Article 14(Breeder's Right) to use the

a) propagating materials of a protected variety or

b) of a variety, essentially derived from a protected variety or

c) of a variety which is not clearly distinguishable from the protected variety or

d) of a variety whose production requires repeated use of the protected variety,

for production, multiplication, sale and marketing, export and import and storing for the aforesaid commercial purposes and attached payment of royalty to the breeders for using the protected varieties for breeding new varieties. This provision is also extended to the harvested material of any variety produced from the protected variety. The UPOV Convention provides the commercial plant breeders with breeder's right, an intellectual property right for breeding new varieties.

An Essentially Derived Variety is explained in UPOV resolution as one which is obtained by selection of a natural or induced mutant or transformed by genetic engineering. Article 15(1) of UPOV 1991 Convention provides exceptions to breeders' right for breeding other varieties, for experimental purposes and for non-commercial purposes. UPOV's mission is to provide an effective system of plant varieties protection.

Under Article 5(1) of UPOV 1991, to be eligible for Breeders' Right a variety must be new, distinct, uniform and stable. This means the variety shall be deemed to be new, easily distinguishable from any other variety, its characteristics will exhibit uniformity and stability in successive propagations.

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41. http://www.upov.int/portal/index.html.en UPOV stands for international Union for the protection of New Varieties of Plants, convention of which were held in 1978 and 1991 respectively with different exemptions.

Article 17 says that Breeder's Right can only be restricted if it is contradictory to public interest.

Article 19 of UPOV 1991 argues that, the protection should not be less than 20 years which is in perfect tune with Article 37 of TRIPS Agreement.

The TRIPS Agreement is centred on the fact that, in the knowledge-based industries—pharmaceuticals, biotechnology and software—the cost of research 26 associated in developing a new product is large, while the cost of reproducing the product is comparatively low.

VIII.Conclusion

In the member countries of UPOV there is no existence of individual farmers and the farming community as such, because corporate agricultural has taken its grip. Plant breeding is done by professional breeders. Therefore, the plant breeder's right, as proposed in UPOV, is consistent with the developed countries' agriculture. In the developing countries like India, where plant breeding is generally done by the farming community, the UPOV resolution displaces the farming community by the corporate seed companies. Provisions laid down in Breeder's Right gives monopoly power to the seed conglomerates to protect their seeds against competitors. These provisions should be judged in the perspective of cut-throat competition to expand the market in a global scale. Strict provisions of Breeder's Right could not prevent the small seedsmen to be grabbed by the seed conglomerates through the process of mergers and acquisitions and thereby establishing control over the protected varieties of the rivals. Since in a developed country's perspective an individual farmer can least be identified as breeder, it hardly matters to the farmers in those countries. But in developing countries, like India, where major plant breeding has been carried on in individual farmer's field and corporate seedsmen are comparatively new entity, introduction of plant breeder's right will go against the interest of the former as their varieties are not protected and therefore vulnerable to be pirated by the latter. The criteria for a plant variety to be protected exclude indigenous varieties because even if they satisfy last three criteria but they are not new in the sense that they have already been exploited commercially. Therefore, the UPOV version of Plant Breeders' Right in potentially incapable in protecting farmers' right. The genetic diversity to qualify as a global public good, the farmers' right will have to be protected.

Table 1

SEED SUPPLY SCENARIO OF FOOD-GRAINS IN INDIA

DURING 1980-81 TO 1998-99 (In million quintals)

YEAR (1)	TOTAL DEMAND OF SEEDS (2)	DEMAND OF HYV SEEDS (3)	FRESH SUPPLY OF CERTIFIED HYV SEEDS (4)	SUPPLY OF FARMERS' MULTIMLIED HYV SEEDS (5)	SUPPLY OF INDIGENOUS SEEDS (6)
1980-81	56.32	19.16	2.50	16.66	37.15
1981-82	56.94	19.37	2.98	16.39	37.56
1982-83	56.49	19.22	4.21	15.01	37.27
1983-84	59.51	23.88	4.50	19.38	35.63
1984-85	57.66	24.04	4.85	19.11	33.61
1985-86	57.56	24.63	5.50	19.13	32.93
1986-87	57.45	24.99	5.58	19.41	32.46
1987-88	55.09	24.05	5.63	18.42	31.03
1988-89	58.50	26.71	5.68	21.03	31.78
1989-90	57.95	28.13	5.70	22.43	29.84
1990-91	58.94	28.91	5.71	23.20	30.03
1991-92	56.90	28.77	5.75	23.02	28.13
1992-93	57.95	29.08	6.03	23.05	28.86
1993-94	58.54	29.67	6.22	23.45	28.87
1994-95	59.29	31.74	6.58	25.15	27.55
1995-96	58.17	32.15	6.99	25.16	26.02
1996-97	59.57	33.99	7.00	26.99	25.58
1997-98	60.30	33.79	7.55	26.24	26.51
1998-99	61.66	34.50	8.30	26.20	27.15

Source: Arup Ratan Mukhopadhyay(2005), Seeds in India: Post-Independence Scenario, Ph.D. Thesis submitted to the D/o. Business Management, University of Calcutta.

Column (2) and (3) have been calculated from area under food-grains and area of food-grains under HYV seeds, published by the Ministry of Agriculture, Government of India (Vikas Singhal, Indian Agriculture 2003, Indian Economic Data Research Centre, new Delhi, 2003), multiplying the area by seed rate of different crops (N. Samanta, Seed Certification, Anirban Enterprise, Kolkata, 2003, p.223).

Column (4) published by the Ministry of agriculture, Government of India (Vikas Singhal, 2003),Column (5) = Column (3) - Column (4).

Column (6) = Column (2) - Column (3)

Table – 2.

Traditional and HYV Rice: Choice of Sample Farmers

Traditional Rice Varieties		HYV Rice Varieties	
Variety Name	**Frequency of response**	**Variety Name**	**Frequency of Response**
Dudhersar	**92**	**CR1017**	**28**
Gobindabhog	**22**	**Pratikha**	**21**
Patnai	**12**	**Pankaj**	**11**
Rupshal	**12**	**Ranjit**	**11**
Khejurchori	**11**	**Barsha**	**9**
Malabati	**10**	**BN20**	**7**
Olisent/ Narasinghajatta	**9**	**Niranjan**	**7**
Marichsal	**9**	**Super-Shyamali**	**7**
Balam	**8**	**Santoshi**	**6**
Niko	**7**	**Swarna masuri**	**5**
Chamarmani	**7**	**Swarnasaon**	**5**
Gheus	**6**	**Maharaj**	**3**
Basmati	**5**	**Masuri**	**3**
Lilabati	**5**	**Bangabandhu**	**2**

Valuki	**5**	**Dharitri**	**2**
Darsal	**4**	**JP72**	**2**
Sabita Patnai	**4**	**Jamuna**	**2**
Asfal	**3**	**Keralasundari**	**2**
Bahurupi	**3**	**Sabita**	**2**
Chinekamini	**3**	**Swarno**	**2**
Hiramati	**3**	**Anushree**	**1**
Kalabhat	**3**	**Ganga kaberi**	**1**
Master patnai	**3**	**N-Sankar**	**1**
Boyerbat	**2**	**Shyamali**	**1**
Hamai	**2**	**Sabita**	**1**
Kalomota	**2**		
Lal Dhan	**2**		
Paloi	**2**		
Gopalbhog	**1**		
Talmugur	**1**		
Kabirajashal	**1**		
Total	**259**	**Total**	**142**

Source: Study Number – 184. A STUDY ON INDIGENOUS RICE VARIETIES IN SUNDARBAN DELTA AND THEIR ROLE IN ENSURING LOCAL FOOD SECURITY IN THE FACE OF CLIMATE CHANGE THREATS

Santadas Ghosh and Kali Sankar Chattopadhyay (February 2017).Agro-Economic Research Centre Visva-Bharati University, Santiniketan, West Bengal, India.

Study sponsored by Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.

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How Relevant is the Gandhian Political Economy for Today's India?

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Abstract

M.K.Gandhi, the politician and philosopher came to India from South Africa to serve our Indian land. He was the first to warn the then Indian leaders ,policymakers and his followers in the late 1940s about the dangers of high inequality in income and wealth distribution prevalent between the rich and the poor in India. Gandhi's vision of non-violence, ahimsa and right action was based on the idea of the total spiritual interconnectedness and divinity of life as a whole. He was the also the first also to create three principles of sustainable development: Sarvodaya, Swadeshi and Satyagraha, aptly relevant for today's India. His idea of creation of economically self-sufficient local economy is now at the closest proximity with Atmanirbhar Bharat *which he tried to launch more than 76 years back. It is in this context we try to explore the relevance of Gandhian political economy for today's India*

Key Words: Lucknow concession, Pass laws, Platform capitalism, Sarvodaya , Satyagraha, Sustainable development

Jel Code: D63, F63, I131, P16, P4, Q01

If you cannot change yourself, how can you change the World?

M.K.Gandhi (1869-1948),

I. Introduction

Mohandas Karamchand Gandhi (1869-1948), known as *'Mahatma',* meaning 'great-souled' as people called him, was born in a *bania* family on 2 October 1869 at Porbandar, Western India and went to England in 1888 to study law. He returned to India in 1891, and after practicing law for some time he moved to South Africa in 1893, where he was a determined opponent of the 'pass laws' and other kinds of racial discrimination. There he organized '*Satyagraha'* (non-violent action, or 'passive resistance') in 1906, 1908 and in 1913, perhaps inspired by John Ruskin's book *Unto This Last* which cast a magic spell on Gandhi and brought about an instantaneous and practical transformation in his life. He was later to translate the book into Gujarati with the title *Sarvodaya* (The welfare for all) (

Kamath,2007), drawing from Ruskin a recognition of the overriding necessity of welfare for all and the value of manual labour. He realized that the oppressed were to be roused, the oppressors to be persuaded. This outlook made it possible for Gandhi to enter the dilapidated huts of the poor as no modern Indian leaders had done till then. He also realized that resistance to imperialism was possible as history points out to the facts of the Soviet Revolution in 1917 and the defence of Soviet Russia against Allied intervention (1919), together with the banner of independence of Turkey raised by Mustafa Kamal. It was the genius of Gandhi that enabled him to see in Khilafat the crucial factor in the situation. If the struggle for it was successful it could throw British imperialism off balance in world arena and thereby bringing Swaraj so much nearer; in India, it could arouse in the Muslim masses an enthusiasm for the National Movement that the Lucknow concession of December, 1916 on distribution of council seats had failed to elicit (Habib, 2018)

II.Gandhi's Philosophy For Nation Building

With a view to serving his country of birth, he returned to India from South Africa in 1914 and soon became a leading figure in the cause of Indian nationalism and development movements. In 1915 Gandhi established the Satyagraha Ashram at Ahmedabad, and in 1917 moved it to the Sabarmati River. On 30 January 1948 Gandhi was shot down on the way to his Prayer Meeting.

In the late 1940s, the term 'development' was not in vogue as it is today. Gandhi had, therefore, used the term 'progress' for development, more with respect to ethics and cosmic integrity. He said, 'by economic progress we mean material advancement without limit, and by real progress we mean moral progress, which again, is the same thing as progress of the permanent elements in us' *(The Collected Works of Mahatma Gandhi (WMG)*, Vol. 87: 249). He never made an academic contribution to 'development'. Instead, he pleaded for an organized effort to change the ruling paradigm and move towards a superhuman stage. The Gandhian idea of development is based on the foundational ethics of *ahimsa* (non-violence, which he interpreted as 'firmness in the truth'). Perhaps Gandhi's most important influence has been on the black civil rights movement in the USA led by Martin Luther King.

In the cosmic-moral organization, faith is the path of spirituality, and spirituality in its true sense is the motive and guiding force behind development. Gandhi suggested 'Seven Social Sins' to be avoided, if one strives to be a real man. Of course, these are ideals, but they are more relevant in the present era of desperation and age of confusion, and could easily be accepted.

According to Gandhi, the 'Seven Social Sins' are:

1. ***Consumption without conscience.*** The means and symbols of consumption are

the 3Ps, namely property, power and prestige. Without conscience or moral responsibility, consumption always turns to evil; in other words, eating food is consumption, but without conscience it leads to sickness. Consumerism is one of the basic root causes of social conflict. Consumerism is the go of the day of the many emerging market economies, whose painful consequences are known to us.

2. ***Knowledge without character.*** Knowledge is power, but without morality it is hypocrisy. With a lack of morality, knowledge becomes a heavy burden on humanity.

3. ***Wealth without labour.*** In the modern era, wealth is the highest symbol of projecting the level of personality and status. This promotes the tendency of the 'rich becoming richer and the poor becoming poorer'. Such rich people never realize their social responsibility; this leads to social crisis and propels the society on the verge of ruin.

4. ***Business without morality.*** According to the philosophy of welfare economics, the basis of economic success is morality. Gandhi said, 'Economics that hurt the moral well-being of an individual or a nation are immoral and, therefore, sinful' *(WMG,* vol. 13: 317, also *cf. WMG,* vol. 75: 158).

5. ***Religious duty without sacrifice.*** Compassion, service, sacrifice and altruism are the basic rules of *dharma* (righteous duty). Lacking the sense of sacrifice promotes individualism, egocentricity and selfishness. Serving the poor is service to God.

6. ***Science without human sense.*** Science has the power of both creation and destruction; its nature depends on the way in which it is used by mankind. Misconception of science as a tool and technique for the use of resources has promoted the philosophy of consumerism, which finally resulted in environmental disorder, pollution and loss of peaceful life. Science is the means, but the end is human kindness!

7. ***Politics without principles.*** Politics without principles is the cause of the global crisis and destruction of social harmony. Gandhi emphasized the need for spirituality as the first step of politics and governance.

Whenever the ethical code of a society is lost, civilization will grind to be an abrupt fall and end. In such a situation, a cultural tradition is unable to find a balance between the needs and expectations of society, and that is how it fails to illuminate a path of revolution. In this way, the road to progress and development comes to a dead–end. Gandhi proposed a philosophy of revival and peace which he called '*Sarvodaya* ('well-being for all'). Enhancing personal welfare(sva-) to the level of community well-being (*sarvo*) is the cultural code of *Sarvodaya* . History has proved that the alternative to war and conflict is *ahimsa* ('non-violence'), i.e. peaceful agitation, creating mass awareness of cultural unit (Singh, 2015).

There are two ideas inherent in the philosophy of *Sarvodaya.*

1. ***Democracy is a life style.*** Democracy is not only a way of governance; it is also a way of life. Gandhi warned that a process of dialogue and criticism must always be maintained between the public and ruling powers. The continuing trend towards loss of public awareness is a sign of the decline of democracy.

2. ***Machines have a cultural value.*** The use of *machines* (a product of science) also has a cultural value. The application of science, or its tool, the machine, depends on human intention. Science is like a machine, the effects of whose use depend upon the attitude and motives of the person who has control over it. The path on which science is presently advancing will lead to a great dissolution. Cultural values are imposed upon machines by human beings *(cf. WMG,* vol. 25: 251-2).

Gandhi's view of non-violence, *ahimsa,* vegetarianism and *karma* (right action) is based on the idea of the total spiritual interconnectedness and divinity of life as a whole. All natural phenomena are, therefore, divine, sacred and of equal value. As human beings, we have to take the main responsibilities towards nature through a moral-ethical-religious approach. His theory of *ahimsa* was not strict like a sectarian rule; he said: 'whoever believes in *ahimsa* will engage himself in occupations that involve the least possible violence'. In one of his strongest articles he wrote that non-violence is not passive or inactive. It does not permit running away from leaving dear ones unprotected. It is the summit of bravery and is not meant for cowards or those who are afraid to die. He said, "Non-violence is the law of our species as violence is the law of the brute. The spirit lies dormant in the brute and he knows no law but that of physical might. The dignity of man requires obedience to a higher law— to the strength of the spirit."

Committed to non-violence *(ahimsa)* and self-realization *(svachetna),* Gandhi wanted to solve India's problems from the perspective of individual conversion and with the ideology that 'every man has an equal right for the necessities of life even as birds and beasts'. According to him, the 'right thing' is a moral order *(dharma)* operated by right action *(karma).* Gandhi's emphasis upon self-realization and rules of conduct and virtues is essential for spiritual life and also for the maintenance of the social order. Gandhi warned politicians about the social and political evils of which they become part!

Gandhi said, 'every human being has a right to live and, therefore, to find the wherewithal to feed himself and where necessary to clothe and house himself' (*WMG,* vol. 38:197). He said, 'there's enough in the world to meet the needs of everyone but there's not enough to meet the greed of everyone'. If ever, he did not advocate macroeconomic policy. All villages should become self-sufficient. It must work from the bottom upwards and not the top down.

As we work in different walks of life, we should continue to be inspired by his words that we must 'recall the free of the poorest and the weakest man (and woman) whom you have seen and ask yourself if the step you contemplate is going to be of any use to him (and her)' (*WMG*, vol. 89: 125).

Gandhi practiced what he preached (Cook and Stevenson, 2018)). If he was concerned about the 'poorest of the poor' he adopted a life style which reflected his constituency. And if he preached 'cleanliness' and the uplifting of Harijans ('untouchables'), he himself undertook the scavengers' work, and emphasized the importance of inner and outer cleanliness. To follow Gandhi is difficult and yet millions did. He emphasized throughout that we must change ourselves before we can change others and that our real enemies are within.

The essence of natural cures is that we learn the principles of hygiene and sanitation and abide by those laws as well as the laws relating to proper nutrition. If rural reconstruction does not include rural sanitation, our villages will remain the dung-heaps that they are today.

Gandhi's twenty-one years of experience in South Africa transformed his views on life and human existence, which he again experimented with in India (Swan, 1985). He started to look at the world from a poverty-trapped peasant's perspective, rather than from a middle-class bourgeois perspective. This led him to the creation of three principles of sustainable development: *Sarvodaya, Swadeshi* (meaning rejection of western machinery, not 'reproducing Manchester in India') and *Satyagraha.* To Gandhi, ahimsa was the means, truth was the end. Ahimsa was the bedrock of Satyagraha, the "irreducible minimum" to which Satyagraha adhered, and the final measure of its value. The other very important feature of sustainable development which he propagated was the whole question of local economy where everybody in the area would be self-sufficient. They would be employed and could sustain themselves and their families with dignity and work.

For Gandhi the *swadeshi* spirit extended to all the elements composing the *desh* (community) and implied a love of not only the traditional way of life but also the natural environment and especially the people sharing it. Gandhi used the term *swaraj* to describe a society run in the *swadeshi* spirit. It meant self-rule or autonomy and implied not only formal independence but also cultural and moral autonomy.

The removal of untouchability, an end to Hindu-Muslim enmity, economic self-sufficiency, and making non-violence effective were fundamental elements of his vision. Gandhi offered a viable alternative for self-rule and self-government. He focused on the welfare of all - Sarvodaya and the method he followed was that of *satyagraha* (Pyarelal, 1986*)*.

Sarvodaya ('the uplifting of all') was a philosophical position that Gandhi maintained. Society must strive for the economic, social, spiritual and physical well-being of all, not just the majority. He favoured a holistic approach to well-being, and a total approach to the community, for him, the well-being of every individual was an important concern.

He advocated that the locus of power must be situated in the village or neighbourhood unit. He believed that there should be an equitable distribution of resources and those communities must become self-sustaining through reliance on local products instead of large-scale imports from outside. Gandhi was opposed to large-scale industrialization, and favoured small local industries that promote local self-sufficiency, which he called *Swadeshi.* In current terms, it means buy local, be proud of local, support local, uphold and live local. Economic equality should never mean possession of an equal amount of worldly goods by everyone. It does mean, however, that everyone should have a proper house, an adequate and balanced diet, and sufficient cloth(ing). It also means that the cruel inequality that obtains today will be removed by purely non-violent means.

Finally, Gandhi's best-known theory of *satyagraha*, 'truth force' or non-violent direct action, is actually a way of life, not just an absence of violence. It also entailed respect for all beings regardless of religious belief, caste, race or creed, and a devotion to the values of truth, love and responsibility. Mass awakening exemplified by the *satyagraha* movement, is 'the perfect example of how one could confront an unjust situation, through extremely superior power' (*WMG,* vol. 9: 118, and c*f.* Gandhi 1990: 21). The achievement of political and moral ends through *ahimsa is* what Gandhi called *satyagraha.* This notion of non-violent action is the crucial part of Gandhi's political theory. *Satyagraha,* in fact, is a theory of action. It calls for courage, strength of character and positive commitment to a righteous cause. In some circumstances, e.g., inhuman acts like molestation or killing, it might be better to choose violence than craven submission to injustice. Gandhi thought that 'total non-violence' might be feasible only when mankind has acquired superhuman qualities.

The spectres of global warming, lack of water through deforestation, and continued depletion of natural resources and diversity on Earth, are some of the results of 'unsustainable development' and economic growth. Should we not follow the path of Gandhi? He corrected himself over and over in his striving for moral-spiritual perfection while doing his best to reform existing institutions and social practices. He wrote in 1932, 'I do not accept defeat but hope, with God's grace, to melt the stoniest heart and, therefore, continually strive to perfect myself ' (*WMG,* vol. 50: 451).

We are slowly realizing that reducing poverty or moving towards sustainable development is not just an economic or a technical problem or one of acquiring greater financial inputs. All these are important but achieving these goals also needs an inner awakening,

an inner transformation of man — a path already paved by Gandhi. If we ignore Gandhi 'we ignore him at our own peril', Martin Luther King once said.

III.Gandhi as a visionary Political Thinker

At the time India got its independence from the British colonial power, Gandhi observed that there were two 'India's: one residing with the landlords who were rich but few in numbers and the others who were landless poor—kicked pooh-poohed and neglected— constituting a vast majority suffering from utter destitution and poverty and struggling hard to finds both ends meet— bereft of shelter, food, clothing and drinking water. Therefore, he warned his followers who were at the helm of affairs in the country that the1917 Russian type of Bolshevik revolution in the country are knocking at the door, if the new government fails to take up urgent economic measures to uplift the rural and urban poor and reduce the gulf of difference that was existing between the rich and the poor. He suggested various measures to achieve the goal.

The first measure is land reforms, that is, the distribution of surplus land to the landless poor. The abolition of the Zamindari system (which existed for some time even after independence during Nehru's regime), the abolition of privy purses, the land reforms that were introduced to reduce the size of the big land holdings, and the resultant surplus land distribution among the landless poor during the regime of Prime Minister Indira Gandhi— all these measures help to mitigate the grievances of the rural poor to some extent and indirectly helped to avert the dangerous trend which Gandhiji feared was developing in the beginning days of independent India.

The second measure that was suggested by Mahatma Gandhi is preventing the concentration of the country's wealth in a few hands, leading to the rise of business tycoons, which are the characteristic features of the capitalist economy. He suggested heavy taxation on the corporate sector and other private entrepreneurs, and the resultant income may be spent to uplift the conditions of the poor by providing them basic amenities like food security, health, housing, clothing, child care and nutrition, and education for their children. Therefore, Indian Constitution makers have taken every care to implement these suggestions made by Gandhi and have chosen a via media (which is democratic socialism) between the two kinds of philosophies that were in practice in the rest of the world at the time India got its independence (*Bobbili, 2019*).

IV. How Did Gandhi Shake the World to wake it UP?

Gandhiji once claimed that nonviolence was the greatest power with which humankind had been endowed. Recognition of the power of non-violence struggle has since gone well beyond the spiritual pacifists of the Gandhian tradition to encompass a wide range

of social scientists who have recognized how Polish dockworkers, Filipina nuns, Serbian students and millions of other ordinary people have done what strategic alliances, armed guerrillas, and intergovernmental organizations could not, including bringing down some of the most entrenched dictatorships on the planet **(***Zunes, Merriman, & Stephan, 2010*). The study of nonviolence struggle has become a part of the international studies curriculum only recently.

Gandhiji was significant in the transformation of the study of nonviolence from individual acts of civil disobedience as articulated by Henry David Thoreau, Leo Tolstoy and other 19th century writers— to strategic civil resistance in which large numbers could participate to force social, economic, and political changes.

Much has been written by and about Gandhi concerning his campaigns in South Africa and India as well as his ideas while Gandhi wrote only two books**,** the articles, talks, and speeches in his *Collected Works* total 90 volumes. Many collections of Gandhi's remarks and writing on different topics have been made; a comprehensive volume was edited by Prabhu and Rao (1967) and a useful anthology of large selections in historical sequence was edited by Fischer (1962).

From the point of view of political theory, perhaps the most important volume on Gandhian nonviolence since his death in 1948 was written by Bondurant (1958), who analyses case studies of three major campaigning: the 1918 textile workers' dispute in Ahmedabad; the 1919 resistance to the Rowlatt Act Bills; and the 1930-1931 Salt March. Gene Sharp in his monumental 3-volume work '*The Politics of Nonviolent Action (1973)* defines nonviolent action as 'a general technique of protest, resistance, and intervention without physical violence.' It is so powerful that many oppressed citizens find their freedom, knowing it fully well that their armed war against an opponent's robust army would be futile.

Gandhiji's tangible appeal for the contemporary world should not be underestimated; although he espoused visionary ideals, we should by no means treat him as an ivory- tower idealistic. For, as a man of action, he was one of the most successful hands-on political leaders of the 20th century who, through his unconventional approach, epitomized what has come to be known as out-of-the-box decision making.

As a leader of the greatest anti-colonial struggle in history, he emphasized that he merely represented the voice of the people: 'I have merely given expression to the thoughts that were dormant within the hearts of the Indian people.' He was disheartened by the submissive stance of many of the Indian leaders (Dharampal, 2021).

V. Gandhian Political Economy

Much of what we call Gandhian political economy begins with his book *Hind Swaraj* (Home Rule for India) written in Gujarati in 1910 and its visions and ideas. This text,

in the form of a dialogue between Gandhi as 'Editor' and a radical Indian nationalist as 'Reader', is an important statement of the set of ideas with which Gandhi began his work in India in 1915. Much of it was articulated by Gandhi himself in his speeches and writings; these have been collected in three volumes called *Economic and Industrial Life and Relations* (1957). Particularly, the classic book *Hind Swaraj* has an overwhelming position among Gandhi's writings. Till the end, Gandhi maintained the book reflected his positions accurately. In *Hind Swaraj*, Gandhi attacked the endless pursuit of material wants, so characteristic of modern civilization as Gandhi saw it. In *Hind Swaraj,* Gandhi interrogated the very idea of ' progress' in the context of the aftermath of the Industrial Revolution. This, and his focus on human 'needs' as distinct from human 'wants', would suggest that Gandhi had a built-in bias against modern capitalism. Rao (2021:128) comments that *Hind Swaraj* needs to be read as a high-level statement of concern about modern civilization, especially its epiphenomenon of imperialism and the consequent pauperism of many, including Gandhi's fellow- Indian citizens. Parel (2006) has argued that there is sufficient evidence to show that Gandhi was not simplistic, rigid or close minded in his approach to machines. Gandhi was a newspaper editor, also a printer who worked and operated with his own printing press, a wondrous machine in its own right. . In Hind swaraj he has argued against machines simply, among other reasons because they displaced human labour.

A disciple of Gandhi, Narayan (1970) wrote about the relevance of Gandhian economics. Somewhat of recent years, Gandhian political economics has been further refined by several scholars like Sethi (1979), Das (1979), Diwan and Lutz (1985).

In terms of larger ideas, Gandhian economics belongs to spiritualism (Tendulkar,1951-54). The fundamental distinction between Gandhian and Classical political economy of both the left and the right varieties lies in the underlying assumptions about human beings and human conducts and therefore its underpinnings. Huxley (1944), Illich and Lang (1973) and Schumacher (1973) Hick, Hemple et al. (1989) articulate its reasoning in philosophical terms.

Gandhian political economy is based on a construct of an idealized community, The ruling ideology in this idealized society is Satya (the truth);Ahmimsa (non-violence) and Satyagrah(truth and action (Adams and Dyson,2003).

VI. Five Basic Concepts of Gandhian Economics

Diwan (1982) has formulated five basic concepts of Gandhian economics, all of which are related, are of equal importance, and have spiritual underpinnings.

- *Swadeshi*: a necessary condition for ecological sustainability. Swadeshi means self-reliance.
- Bread labour: This means personal action in the *swadeshi context*, and generates

the distinction (among other things) "values-in use" and "values-in- exchange," as well as between "stranger- defined" and "self-defined-work.

- *Aprigraha* : This means willing surrender It implies a demand function with an increase in the level of minimum consumption with a general lowering of price level.
- *Trusteeship:* This is best described as *sauci,* meaning purity of character. It is laced with spirituality and requires personal integrity, honesty and sensitivity. Gandhi's life is a glaring example of such a personal character.
- *Non-exploitation and equality:* Equality and non-exploitation shift the price vector by lowering the prices of necessities and raising those of luxuries.

These concepts define two different types of affluence; one where a person is surrounded by material goods only, and the second where one is surrounded by people who care about other people. These distinctions between two affluences explain the divergence between economic growth and quality of life in industrialized countries. Gandhian principles implies " small is beautiful" instead of " economies of scale."

Though the emphasis here is on the local level, it relates to the global economy. The role of government in Gandhian economics is to maintain and develop effective institutions. Since the object is to strengthen communities, the government needs to be highly decentralized. The test of every policy is not profit, employment and growth, but instead how it strengthens family and community and, through them character and sensitivity.

VII.Conclusion

Full many a change the world has witnessed today after Gandhi's departure. Different countries have been endowed with different forms of capitalism such as state-guided capitalism, big firm capitalism and entrepreneurial capitalism, platform capitalism. Many of these changes have been profound in their impacts. On the positive side, the world as a whole has become a 'flat earth' due to technological developments. On the negative side, development as an ambition that goes beyond simply increasing the monetary income, has not realized in many cases. Although the past 75 odd years after Gandhi's death has seen enormous progress, huge and urgent challenges remain in tackling injustice, inequality, and enormous suffering: hundreds of millions of men and women still remains desperately poor in Africa and in pockets of Asia, Latin America and Caribbeans. Gender-based inequalities still persist. The rapid economic growth goes hand in hand with increasing resource use and pressure on the environment and creates uncertainty for social stability and growth sustainability. The biggest challenges that the world faces today are: climate change, conflict, be it Russia-Ukraine conflict (2014) or Israel-Hamas war (2023), fundamentalism, civil war here and elsewhere, the rise of terrorism and pandemics. Inequalities in income and wealth in all most all societies are receiving growing attention since

inequality between countries and within countries are growing. Almost more than 90 crore people live on less than $1.90 a day. The world's richest 20 per cent of the people account for three-quarters of global income and consume about 89 per cent of global resources, while the world's poorest 20 per cent consume well under the 2 per cent of global resources. The picture is altogether same in India. Had Gandhi been alive today, he would be afraid of this Satanic earth and feel deeply that his preaching of peace, tryst of egalitarian society and political ideology based on firm pillar has evaporated meanwhile from India as well as the earth as a whole. India in particular would be saved if the future agenda would be formulated with the policies based on Gandhian economy with the modern envelops in order to regenerate communities and ensure sustainability in this respect.

To conclude, it would seem appropriate to cite Albert Einstein's famous appreciation on Gandhi on his 70th birthday:

> A man of wisdom and humility, armed with resolve and inflexible consistency, who has devoted all his strength to the uplifting of his people and the betterment of their lot; a man who has confronted the brutality of Europe with the dignity of the simple human being and thus at all times risen superior. Generations to come, it may be, will scarce believe that such a one as this ever in flesh and blood walked upon earth (Calaprice 2011:124). This exemplary figure provides a kind of moral compass to help us navigate our way through life in order to realize a more humane and sustainable future for our planet earth.

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