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Publication of Artha Beekshan, the quarterly referred journal of Bangiya Arthaniti Parishad, that is, the Bengal Economic Association, is one of the most important academic activities of the Association. The present volume, **Volume 31, No.4** of the Journal, contains the papers contributed by scholars . We are thankful to the authors and members who have helped in one way or other in the preparation of this volume. Because of the difficulties and disruptions caused by the intervention of the Pandemic in between, we have been compelled to bring out the combined issue.

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

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Cost of treating tuberculosis in India: insights from a Nationally Representative Survey

Paramita Barman[1] and Arijita Dutta[2]

Abstract

Objectives: *Amidst the recent surge in COVID-19 infection, medical services dedicated towards tuberculosis (TB),a much older infectious disease, have taken a backseat. The economic burden of TB is exacerbated by dwindling household incomes due to reduced ability to work on the one hand and perpetual expenses on care seeking on the other. Besides, substantial dependence on the private sector despite provision of free diagnostic and treatment services by the national TB program in India further increases out-of-pocket expenditure on TB related healthcare. The National Strategic Plan (2017-25) of the Government of India, in line with the End TB Strategy of the WHO, targets to eliminate catastrophic costs for TB afflicted households in India by 2025. In this context, the current study attempts to estimate treatment costs and identify the determinants of catastrophic costs and hardship financing among TB patients in India seeking hospitalized care.*

Methods: *The study uses unit level data from the 75th round (health) of NSSO (2017-18). Besides simple tools for descriptive statistics, multivariate logistic regression analysis has been used. Given the non-normal nature of data on healthcare expenditure, non-parametric tests of hypothesis like Mann-Whitney test have been employed.*

Results: *19.34 per cent ofall TB patients seeking in-patient care faced catastrophic costsand 17.38 per cent had to resort to distress financing. Income class, choice of treatment destination and duration of hospital stay are significant determinants of catastrophic expenditure among TB patients. Across private and public health facilities, median share of net total cost of inpatient care in household consumption expenditure is the highest among poor patients followed by those belonging to middle income and rich income classes. Residence, religion, gender, household occupation, choice of health facility and number of days spent on inpatient careturn out to be significant correlates of distress financing among TB patients.*

Conclusions: *Despite the provision of free TB care by the national TB control program in India, households ran the risk of catastrophic costs while seeking hospitalized care*

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for TB. Financial protection schemes for TB patientsneed to be considered on a priority basis especially in the wake of the recent pandemic that has struck a severe blow to socioeconomically vulnerable communities, fuelling poverty and malnutrition further, both of which are major risk factors for TB.

Keywords: Tuberculosis, catastrophic costs, distress financing, private health facility, public health facility, National Tuberculosis Elimination Program, pandemic

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I. Introduction

As the recent COVID-19 pandemic rages through the Indian economy and health system, tuberculosis (TB), an age-old public health crisis, continues to plague India which happens to be the highest TB burden country in the world accounting for nearly a quarter of the annual global TB incidence (WHO, 2020). In 2018, India witnessed 2.69 million new cases and 4.4 lakh deaths due to TB (GOI, 2020). The reallocation of economic and political resources from TB to COVID management threatens to undo any recent progress in reducing the burden of TB disease worldwide and in India. As suggested by the Nikshay portal of the Government of India, there has been a drastic fall in TB notification rates following shut down of out-patient departments at hospitals and shortage of medical staff due to lack of transport and general fear of COVID infection (Aggarwal *et al*., 2022). To quote the Director-General of the WHO, "*The disruption to essential services for people with TB is just one tragic example of the ways the pandemic is disproportionately affecting some of the world's poorest people, who were already at higher risk for TB*" (WHO, 2021). Greater vulnerability of the poor and socially backward classes to TB disease with more unfavorable patient outcomes (Spence *et al*., 1993; Oxlade and Murray, 2012) makes enquiry into costs of illness relevant and crucial. Poverty is not only a cause but also an effect of the disease. Long term morbidity due to TB reduces patients' productive ability leading to loss of income. Costs borne while seeking healthcare further add to economic hardship (Daftary and Padayatchi, 2012; Whitehead *et al*., 2001).

Quite a few studies are testimony to the economic implications of a chronic illness like TB on patients and households. Evidence from patient costs across the national TB programs of Ghana, Vietnam and the Dominican Republic to assess direct and indirect costs of TB diagnosis and treatment for patients and households suggests that 5 to 37 per cent sold property while 17 to 47 per cent borrowed money to finance healthcare expenses. Costs of hospitalization and nutritional food items constituted the lion's share of direct treatment costs. Average patient costs nearly amounted to a person's annual income, suggesting that mere provision of free services is not enough (Mauch *et al*., 2013). Although free diagnostic and treatment services are delivered by the national TB control program in India through the available public health infrastructure, there is substantial dependence

on the private sector for TB related care seeking (Atre, 2016). The Revised National Tuberculosis Control Program (RNTCP) which has been operational in India for nearly two decades now, has recently been renamed as the National Tuberculosis Elimination Program (NTEP) in 2020. A study from Puducherry, India by Prasanna *et al*. (2018) revealed that 32 per cent of households experienced catastrophic costs due to TB care, the likelihood being significantly higher for patients with HIV co-infection and patients receiving hospitalized treatment. Mortgage of jewellary and borrowing money constituted the major strategies to cope with healthcare costs. Ananthakrishnan *et al*. (2012) in a study based on South India finds that estimated total costs from the onset of symptoms to completion of TB treatment under the DOTS program constituted around 4 per cent of annual family income. Costs were significantly higher among male and employed patients. The study however emphasizes that DOTS helps bring down out of pocket expenses to TB patients. Study by Yadav *et al*. (2019) based on NSSO 71st round health data estimates that in India around 26.7 per cent of hospitalized TB cases faced hardship financing even with free TB care. Education of head of household, income class, health facility type and number of hospital days significantly influenced hardship financing.

Since 2018, the government of India has implementedstrategies toreduce costs to patients with TB through direct benefit transfers (DBT) in keeping with its target of the National Strategic Plan for Tuberculosis Elimination (2017-25) of achieving zero catastrophic cost for TB affected families by 2025, well ahead of the global deadline of 2035. The Nikshay Poshan Yojana it is a scheme to provide Rs 500 per month during the course of treatment, for nutritional support through electronic transfer into the bankaccounts of patients registered under the NTEP.A one-time payment of Rs. 750 at the time of notification, to provide financial support as transport allowance for TB patients belonging to notified tribal areas, is another scheme (GOI, 2020). Nevertheless,findings from recent research underscore the importance of exploring the socioeconomic consequences of TB. Studies on the implications of healthcare expenditure due to TB in India, especially in the context of inpatient care, are few. This paper hopes to address the gap. Our objective in this study is *to explore different aspects of costs of hospitalized TB treatment borne by households in India and look intothe implications of such costs with regards to catastrophic expenditure and distress financing.*

II. Data and Methodology

II.1 Data

The study uses unit level data from the NSSO 75th (2017-18) health round. The NSSO is a nationally representative survey on social consumption on health (Schedule 25.0) and education (Schedule 25.2), conducted by the National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India. It provides quantitative

information on morbidity, socio-economic profile of ailments and their treatment and role of private and public facilities in healthcare provision, among others. Data was collected using stratified multistage sampling design. The 75th round was conducted between July 2017 and June 2018 spreading across 5,55,352 individuals from 1,13,823 households. 93,925 hospitalization cases (defined as an overnight stay in the hospital at any time of the year before the survey)were reported. In case of TB and a handful of other important diseases, classification of a reported condition as indeed a case of the disease was objectively based on a reported medical diagnosis thus ruling out cases of over-reporting, under-reporting and wrong disease classification.

Information on costs of hospitalization included both medical and non-medical expenses (direct or out-of-pocket costs). Medical expenses included doctors' fees, medicines and diagnostic tests including X-Rays, ECG, etc., bed charges and other categories like charges for attendant, physiotherapy, personal medical devices, oxygen, blood, etc. Non-medical expenses comprised transport expenses for the patient and other expenses including expenditure on food, lodging and accompaniment who escorted the patient. Any loss of household income due to hospitalization was recorded (indirect costs).

2.2 Methodology

The current study, besides exploring crucial cost components of inpatient treatment of TB, looks into the implications of such costs on households with respect to catastrophic expenditure and distress financing, and their determinants.

Apart from simple statistical tools, the specific econometric method that has been employed is Logistic Regression Analysis**.** Logistic regression is run to estimate the probability of success if the discrete dependent variable Y is binary in nature, i.e. assumes only two values, 0 and 1 (dummy dependent variable). It predicts the likelihood that Y is equal to 1 (rather than 0) given certain values of X. The logistic formulae are stated in terms of the probability that Y=1, which is referred to as $\hat{p}$.The probability that Y=0 is 1-$\hat{p}$

The logistic equation is: $$\ln [\hat{p}/ (1-\hat{p})] = B_0+B_1X$$

where $$\hat{p} = (e^{B_0+B_1X})/[1+((e^{B_0+B_1X})]$$

Expenditure data relating to episode(s) of hospitalization with TB have been treated with non-parametric tests of hypotheses like the Mann-Whitney test (non-parametric equivalent of two independent sample t test) because data is found to be non-normally distributed both in its original form and when transformed and put through Shapiro-Wilk test to check normality.

We have used the definition of theWHO for calculating the proportion of the sample experiencing catastrophic costs associated with TB: total costs (direct medical costs plus

direct non-medical costs plus indirect costs)exceeding 20 per cent of the household's annual consumption expenditure. To determine whether a hospitalization case due to TB qualifies for catastrophic costs, annual household expenditure has been considered because information on cost incurred as in-patient has been provided for the last 365 days prior to the survey. Cases where percentage share of net total cost in annual household consumption expenditure is less than 20 per cent, have been coded 0 and percentage shares greater than or equal to 20 have been coded 1. So **'catastrophic cost' has been posed as the binary dependent variable with outcomes 0 (no catastrophic cost incurred) and 1 (catastrophic cost incurred).**

NSSO questioned respondents on the sources of finance for meeting healthcare expenses on hospitalized treatment of TB. Sources were categorized as *'household income/ savings'*, *'borrowings'*, '*sale of physical assets', 'contribution from friends and relatives' and 'other sources'.* Distress financing is defined in situations where the household had to borrow or sell property or assets or accept contributions from friends and relatives to finance TB related healthcare spending. The option 'household income/savings' was coded 0 and the rest were clubbed and coded 1. So '**distress financing' has been posed as a binary dependent variable with outcomes 0 (no distress financing) and 1 (resorted to distress financing).**

Independent variables considered for regression are residence (rural/urban), religion (Hindu/non-Hindu), reservation (unreserved/ST/SC/OBC), age, level of education (uneducated/primary/secondary and above), gender (male/female), monthly per capita expenditure (MPCE) class (poor/middle income/rich), marital status (single/married), health insurance coverage (not covered/covered), type of household occupation (self-employed/ salaried/casual and others), type of health facility chosen for inpatient treatment (private/ public), treatment on medical advice prior to hospitalization (no/yes)and duration of stay in hospital.

III. Results

III.1 Socioeconomic characteristics of TB patients

Table 1: Socioeconomic characteristics of TB patientsseeking hospitalized care in India

Socioeconomic categories	% share (N)
Residence Rural	64.10 (391)
Urban	35.90 (219)
Religion Hindu	75.08 (458)
Non-Hindu	24.92 (152)
Reservation Unreserved	24.92 (152)
ST	18.85 (115)
SC	20.16 (123)
OBC	36.07 (220)
MPCE Class Poor	25.41 (155)
Middle income	49.84 (304)
Rich	24.75 (151)
Gender Male	61.15 (373)
Female	38.85 (237)
Health Insurance Not covered	80.49 (491)
Covered	19.51 (119)
Household occupation Self employment	48.69 (297)
Salaried	16.89 (103)
Casual and others	34.43 (210)
Total	100 (610)

Source: NSSO 75thround (health) data; N=no. of observations

The above table reveals that out of 610 hospitalization cases of TB, percentage share is higher for rural residents, among Hindus, OBC and unreserved categories, middle and poor income class, males, uninsured and those belonging to households with 'self-employment' and 'casual and other' type of occupation.

III.2 Nature of costs

The different components of cost for hospitalized treatment of TB were direct medical expenses like doctor fees, expenses on medicine and diagnostics, bed charges, other medical expenses like attendant charges, physiotherapy, personal medical appliances, blood, oxygen, etc. and direct non-medical expenses on travel, food, lodging, escort, etc.**Table 2** reports mean and median values of the different components of direct treatment costs for IPD cases across private and public facilities. It can be seen that across components, hospitalization costs incurred in private facility are more than their public facility counterparts.

Table 2: Facility wise out-of-pocket cost components (in Rupees) for inpatient treatment of TB in India

Cost components	Public facility	Private facility
Doctor fees	530*(0)#	4809 (2000)
Medicines	3356 (1500)	9427 (4000)
Diagnostic tests	1448 (500)	4075 (1850)
Bed charges	379 (0)	5087 (2500)
Other medical expenses	871 (250)	5298 (1000)
Transport	674 (250)	913 (500)
Food, lodging, escort, etc.	1436 (750)	2207 (1200)

Source: NSSO 75thround (health) data; *mean #median

Medicine and diagnostics are the two most crucial components of healthcare costs. It is revealed that among TB patients who availed of a government facility for hospitalized care and reported costs borne towards medicine and diagnostics, only 21.45 per cent received medicines free of cost while 25.39 per cent received free of charge diagnostic services. However, these patients were predominantly from rural areas, either uneducated or primary educated, belonged to poor and middle income categories and to households with self-employment or casual and other types of occupation.Despite availing of government health facilities, a good majority of patients had to incur positive costs towards medicine and diagnostics. Median expenditures on medicine and diagnostics for inpatient treatment of TB turn out to be Rs. 1500 and Rs. 500 respectively in a government facility.

Table 3: Median total cost of hospitalized treatment of TB net of reimbursement across socioeconomic categories in India

Socioeconomic categories	Net total cost
Residence Rural	6800
Urban	7300
Religion Hindu	7050
Non-Hindu	6525
Reservation Unreserved	6262
ST	6000
SC	6801
OBC	8625
MPCE Class Poor	6250
Middle income	7025
Rich	7140
Gender Male	6801
Female	6960
Health Insurance Not covered	7200
Covered	4800
Type of facility Private	19000
Public	3940

Source: NSSO 75th round (health) data; *mean #median

Table 3 above reveals that for inpatients with TB, median total costs net of reimbursement are higher for urban residence, Hindu religion, OBC category, rich income class, female gender, patients without health insurance coverage and those availing private healthcare services.

Median and mean values of net total hospitalization costs with TB are Rs.6920 and Rs 16622 respectively. Mann-Whitney test reveals that the costs are significantly higher for the uninsured and those availing care in private facilities. However, no significant difference is observed across residence, religion, reservation, gender, household occupation, education levels and economic class.

Median and mean values of loss in household income due to hospitalization (indirect costs) stand at Rs.900 and Rs.2100 respectively. It is found to be significantly higher for patients belonging to reserved category, male patients, patients with primary and lower level of education including the uneducated, patients belonging to poor and middle income classes and patients from households with irregular income (self-employment and casual and other types of employment). Findings to note are that opportunity cost of hospitalization is more for in-patients in public health facilities and for patients who sought pre-hospitalization treatment on medical advice.

3.3Catastrophic costs associated with TB

19.34 per cent of inpatient cases with TB incurred catastrophic costs. **Table4**shows the facility wise distribution of cases that incurred CHE. Percentage share of cases bearing CHE is much higher in the private sector (40.76 per cent) than in public (8.02 per cent).

Table 4: Facility wise percentage shares of CHE among TB inpatients in India

Type of facility for hospitalization with TB	CHE=0	CHE=1	Total
Private	**125 (59.24)***	**86 (40.76)**	**211 (100)**
Public	**367 (91.98)**	**32 (8.02)**	**399 (100)**
Total	**492 (80.66)**	**118 (19.34)**	**610 (100)**

Source: Calculation from NSSO 75th round (health) data; ( )* percentage shares

The poor and those belonging to self-employment and 'casual & others' employment categories accounted for higher shares of TB patients facing CHE. It is higher among rural residents, OBC category, males, those availing inpatient treatment from private facility and those seeking treatment on medical advice before hospitalization.

Table 5 summarizes the logistic regression results run for CHE incurred by IPD patients with TB. The likelihood of CHE significantly falls with middle and rich income categories and public facility chosen as treatment destination and increases with greater duration of stay in hospital.

Table 5: Logistic regression results for factors determining CHE for hospitalized TB patients in India (not incurred CHE=0, incurred CHE=1)

Explanatory variables	**OR**	**P value**	**95 % CI**
Residence Rural *(Ref)*			
Urban	0.91	0.760	0.51 – 1.62
Religion Hindu *(Ref)*			
Non-Hindu	0.95	0.866	0.51 – 1.76
Reservation Unreserved (*Ref)*			
ST	0.82	0.651	0.37 – 1.85
SC	0.75	0.420	0.33 – 1.58
OBC	0.76	0.409	0.40 – 1.45
Age	1.00	0.517	0.99 – 1.02
MPCE class Poor *(Ref)*			
Middle income	0.51	0.027**	0.29 – 0.93
Rich	0.25	0.001***	0.11 – 0.56
Gender Male *(Ref)*			
Female	0.71	0.194	0.42 – 1.19
Education level No education/Preschool *(Ref)*			
Primary	1.14	0.639	0.65 – 2.01
Secondary & Higher	0.74	0.429	0.35 – 1.56
Health scheme/expenditure support No (*Ref)*			
Yes	0.99	0.998	0.53 – 1.88
Marital status *Single (Ref)*			
Married	1.31	0.346	0.75– 2.29
Household occupation Self-employed *(Ref)*			
Salaried	0.69	0.343	0.33 – 1.47
Casual and others	1.01	0.959	0.59 – 1.73
Type of health facility Private *(Ref)*			

Public	0.07	0.000***	0.04 – 0.12
Whether treated on medical advice before hospitalization *(Ref no)*			
Yes	1.06	0.838	0.59 – 1.92
Duration of stay in hospital	1.05	0.000***	1.03 – 1.07
Total Sample	N=610		
LR Chi2 (18)	158.56, p=0.000		
Pseudo R2	0.2646		
Log likelihood	-220.34		

Source: NSSO 75th Round (Health) data; ***significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent

Table 6 demonstrates the median percentage shares of net total cost on hospitalization with TB in consumption expenditure of households in India by MPCE class across private and public health facilities.

Table 6: Facility wise median percentage shares of net total cost of hospitalization with TB in household consumption expenditure in India

Income class	**Public facility**	**Private facility**
Lower	6.31	23.98
Middle	3.95	16.70
High	1.79	11.35

Source: NSSO 75th Round (Health) data

The table above shows that across income classes, median shares of net total cost of hospitalized TB care in household consumption expenditure is consistently lower in public health facilities compared to their private counterparts. Also, across facilities, this share is the highest among poor patients followed by those belonging to middle income and rich income classes.

III.4 Distress financing among TB patients

17.38 per cent of patients hospitalized with TB had to resort to distress financing which comprised *borrowings, sale of physical assets, contributions from friends and relatives* and *other sources*. The poor, uneducated and those belonging to households with 'casual

and others' employment category accounted for higher shares of TB patients facing distress financing. The shares were also higher among males, urban residents and those who sought hospitalized treatment from private health facilities.

Table 7: Logistic regression results for determinants of distress financing among TB in-patients in India (no distress financing=0, distress financing=1)

Explanatory variables	OR	P value	95 % CI
Residence Rural *(Ref)*			
Urban	1.78	0.027**	1.07 - 2.98
Religion Hindu *(Ref)*			
Non-Hindu	1.62	0.076*	0.95 – 2.77
Reservation Unreserved (*Ref)*			
ST	0.72	0.434	0.32 – 1.63
SC	1.78	0.103	0.89 – 3.58
OBC	1.46	0.223	0.79 – 2.70
Age	0.99	0.166	0.98 – 1.00
MPCE class Poor *(Ref)*			
Middle income	0.70	0.210	0.40 – 1.22
Rich	0.65	0.233	0.33 – 1.31
Gender Male *(Ref)*			
Female	0.64	0.077*	0.39 - 1.05
Education level No education/ Preschool *(Ref)*			
Primary	0.71	0.197	0.42 - 1.19
Secondary & Higher	0.58	0.134	0.29 - 1.18
Health scheme/expenditure support No (*Ref)*			
Yes	1.27	0.438	0.70 - 2.30
Marital status Single (*Ref)*			
Married	0.93	0.780	0.56 - 1.55

Household occupation Self-employed *(Ref)*			
Salaried	0.74	0.426	0.35 - 1.56
Casual and others	1.90	0.010**	1.17 - 3.09
Type of facility Private *(Ref)*			
Public	0.39	0.000***	0.25 - 0.63
Whether received treatment on medical advice before hospitalisation No *(Ref)*			
Yes	0.84	0.497	0.50 - 1.40
Hospital stay	1.02	0.005**	1.00 - 1.03
Total Sample	610		
LR Chi2 (15)	59.66, p>chi2 = 0.000		
Pseudo R^2	0.1059		
Log likelihood	-251.88		

Source: NSSO 75thRound (Health) data; ***significant at 1 per cent, ** significant at 5 per cent, * significant at 10 per cent

The above results reveal that the likelihood of facing hardship financing is significantly higher for urban patients, non-Hindu patients, patients belonging to households with 'casual & other' types of employment and patients with longer stay in hospital. It falls with female gender and public facility chosen as treatment destination**(Table 7).**

IV. Discussion

Across components of cost incurred by TB patients receiving hospitalized care, charges are higher for private facility compared to public facility as expected. However, data reveals that despite TB diagnosis and treatment being a government sponsored program, patients incurred substantial costs on medicines and diagnostics even in public facilities. Percentage shares of TB patients receiving free medicine and diagnostic services among those who availed of a government facility are remarkably low. However, the national TB program seems to be well targeted since overwhelming shares of patients receiving free of cost medicine and diagnostics in public facilities belong to socioeconomically vulnerable and marginalized communities. 19.34 per cent of patients hospitalized with TB faced catastrophic cost. Income class emergesas a significant determinant ofcatastrophic expenses towards TB. The finding is similar to the conclusion by Kastor and Mohanty

(2018) that odds of incurring catastrophic costs were significantly lower among the rich and middle MPCE households than among the poor. In this context, median share of net total cost of hospitalization with TB in household consumption expenditure is also found to fall with higher income class across health facility type. 17.38 per cent of inpatient TB cases had to resort to distress financing. The share is less than what was estimated by Yadav et al. (2019) from the 71st round of NSSO data. Findings from that study concerning the impacts of type of health facility and number of hospital days on hardship financing have been reiterated by our current piece of research. Female gender has been found to work towards reducing the chances of distress financing.

The study however is not without limitations. Firstly, stigma associated with TB might have led to under-reporting of cases in NSSO. Secondly, information on providing DOTS treatment to TB patients under the national TB control program in public facilities and private facilities tied to the program through PPP initiative is lacking. Thirdly, NSSO does not provide details regarding types of diagnostic tests or medicines purchased during stay as in-patient. So the possibility that a part of these costs are borne towards related or other comorbid conditions that might have arisen in the hospitalization episode, cannot be assumed away. Despite limitations, the study provides useful insights for cost management through targeted intervention and effective engagement of the private sector that caters to a substantial proportion of TB patients in India.

V. Conclusion

Since the role of the private sector is predominant in the Indian healthcare delivery system, stronger liaison of the government with private stakeholders in the delivery of TB related care is called for to ensure proper surveillance of this public health malady, along with an improvement in the general quality of public health services. The shares of TB patients incurring catastrophic expenses and resorting to distress financing to cover healthcare costs are large despite the national TB program providing free of charge diagnostic and treatment services through the public health infrastructure. There is need to revisit the current direct benefit transfer schemes operational under the NTEP like the Nikshay Poshan Yojana and Transport Support for TB patients from Notified Tribal Areas. The "*one-size-fits-all*" approach of these schemes with uniform reimbursement policy overlooks the need to incorporate socioeconomic diversities of patient beneficiaries, particularly with regards to their income class.In view of the target of the National Strategic Plan of the Government of India of zero TB affected households with catastrophic costs, an upgradation of the ongoing schemes in view of the needs of the poor and marginalised groups is called for besides considering subsidization of TB related private health care services. These interventions assume critical importance in the wake of the recent COVID-19 pandemic that has fuelled major risk factors for TB like poverty and malnutrition.

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Production Structure and Dynamics of Income Distribution in Post-reform Indian Economy: An Empirical Analysis

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Abstract

In this paper, we have made an attempt to understand the status of the unorganised group of workers in relation to the so called organised group in India in a formal way through multiplier effect based on semi-closed input output model. In India, the unorganised group of wage earners exceeds the rest of the population, but the former enjoy very much disproportionately a small share of the national income being produced by participation of all groups of people. Resorting to semi closed input output model by endogenising the household sectors comprising of organised regular wage and salary earners, unorganized self employed and casual workers and surplus and profit earners, we observed that the organized group gains in income share significantly and unorganized group gains marginally at the cost of surplus earners over the period 2003-04-2015-16. It is interesting to note that the final demand composition and /or production structure of 2015-16 differ from those of 2003-04 in such a way that multipliers work for a redistribution of income in favour of wage earners. So, it seems that the govt. policy may be directed to reallocate final demand in an appropriate way for redistribution of income in favour of the unorganised workers.

JEL Classification-E12, E24

Key Words- Production Structure, Income Distribution, Augmented Input Output Matrices

I. Introduction

The Keynesian approach in developing the macro economic analysis of income and the path breaking contribution of Leontief incorporating the structure of production into economic analysis did not consider the question of accommodating the crucial issue of income distribution among different functional groups which attracted serious attention of classical economics like Ricardo and Marx. Keynes aggregates the economy to a point where the relevant sectors are reduced to only two : households and business . He then considered the circular interrelationship between income generation and consumption which was commonly known as multiplier and , of course, it was of great help in understanding the circular nature of the economic process. But Keynes did not show any interest to go into the problems of income distribution. It is Leontief, who incorporated a

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simple linear multi sector production structure into the frame of analysis of income distribution. It can not be denied that in the era of globalization, the production structure of less developed economics also is getting complex and the relationship of production structure with income distribution is becoming worthy of serious investigation.

In capitalist economies with a developed production system the established practice of allocation of labour and materials into different production sectors by private business decisions in response to demand and supply in a competitive market was taken for granted .But for backward semi capitalist developing economies involved in planning the production structure itself was of vital importance. Again, during the last couple of decades ,however, with increasing concern regarding welfare policies, the distribution problem has come into greater importance .In the developing economies, production structure still continues to be an extremely important aspect of the development process, but distribution aspect has also gained importance and can not be left unplanned . It has, therefore, become necessary to find ways and means of incorporating the structure of income distribution into the model as an integral part of the development and growth and an expanded input output model may be an important analytical tool for this purpose.

Static input output model disaggregates the production sector and serves two major purposes . First, through reflecting the degree of interdependence in the economy, it helps tremendously in identifying the key sectors and thereby in planning process, to adopt a development strategy consisting of the consistent product-mix. Second, it helps to determine the multiplier effect (within production itself) of any exogenous demand in any sector or group of sectors. But the standard static input output model is not capable to capture the so called Keynesian Multiplier (accommodating the chain effect of induced consumption) So, in the expanded input output framework one can consider household sector as endogenous and thereby project multiplier effect of induced consumption on income generation. So, the importance of sectoral multipliers lies in the fact that they are disaggregated in nature and can recognize the total impact on income according to which sector experiences the initial expenditure change.

Keeping the above fact in mind, in this paper, we have made an attempt to develop a model where the implication of this sectoral interaction process in income distribution can clearly be focused. In order to do this, we have resorted to an expanded input output model endogenising the income and consumption of household sectors and thereby project income distribution among household sectors endogenously. More specifically, the objectives of the present study are as follows :

First, to study the implication of liberalized production structure (after economic reform of 1991-92) for the dynamics of income distribution among organized wage earners, unorganized wage earners and capitalists over the period 2003-04-2007-08. The size of

the unorganized segment constituting the 'Casual Workers" and "Self employed group" is much larger compared to the size of the Organised group ,though in terms of income share the former one seems very much marginalized as revealed by information furnished by National Accounts Statistics (CSO) . So , it seems essential to look into the relationship between changing production structure and dynamics of income distribution among these social groups in particular.

Second, as currently domestic input output tables are being made available by CSO ,Govt of India ,it is now being possible to trace the income generation and distribution in a more correct way as imported inputs and thereby income being leaked out through imported input in the process is being taken care of in any exercise of impact assessment and as a result, necessary adjustments are possible.

II. Literature Survey

We find several studies on partially closed input-output model with endogenous consumption in the literature. Miyazawa (1976) incorporates the household sector into the economic system by moving the household consumption and labor input to the input-output intermediate delivery matrix. The household sector is linked to the production sector by the labor input coefficient and consumption coefficient defined in this model. But, Batey, Madden, and Weeks (1987, 1989), Cloutier (1994), Wakabayashi and Hewings (2007) and Miller and Blair(2009) pointed out some limitations in this model. First, the model assumes the constant consumption coefficient and ignores consumption patterns of different households. Ghosh(1981),) tries to alleviate this limitations by disaggregating the household sector into different groups according to their characteristics like workers, other employees and surplus earners. But, there is also another type of limitation in the model. The household consumption behavior captured by this model is not consistent with the consumption theory, because the household consumption is fully endogenized in this model, which implies that the current consumption is totally determined by the current income. However, according to the relative income hypothesis and the life cycle-permanent income hypothesis, the household consumption is also determined by many other factors such as past consumption level and future income. Using a specific consumption decomposition formula , Quanrun Chen and others (2009), develops a new method to incorporate the household sector into the input-output model which can reconcile the input-output analysis with the so called consumption theory.

As far as the Indian economy is concerned, Sengupta(1976, 1989) have looked into the issue quite competently and in depth. He derived the sectoral multipliers for Indian economy and linked the production structure with the dynamics of income distribution process. However, we feel that the study by Sengupta does suffer from certain limitations apart from the issue of not taking care of updating of data base. The calcula-

tion of domestic output for any vector of final demand in Sengupta's study has been done through projection by the Leontief inverse of the technical coefficient matrix(in the absence of any availability of domestic input coefficient matrix). Obviously, the above is erroneous to the extent that domestic input coefficients may differ from the corresponding technical coefficients. The novelty of our approach lies in the fact that we have used the domestic input output matrices for our projection of income multipliers especially for the Indian economy.

III. The Methodological Framework

Let us first present the static open input output model as proposed by Leontief where we find that total output from each industry equals total inter-industrial demand plus the final demand. So, we have the balance relations as follows:

$$Xi = \sum_{j=i}^{m} Xij + Di \quad \ldots\ldots\ldots(1)$$

where Xi = Output of the ith sector(in value terms), Di =Final Demand in the i^{th} sector (in value terms) and X_{ij} = input flow from i^{th} sector to j^{th} sector. Assuming a production function with fixed coefficients , we can write

$$X_{ij} = a_{ij}.X_j \quad \ldots\ldots\ldots\ldots\ldots(2)$$

where $a_{ij} = X_{ij}/X_j$

By substituting (2) in (1) , gross output or sales of sector i can be expressed as :

$$Xi = \sum_{j=i}^{m} aij.Xj + Di \quad \ldots\ldots\ldots....(3)$$

Therefore, $X = AX + D$ where $X= (X_i)$, $A = (a_{ij})$ and $D = (D_i)$

Or, $D = X – AX = IX – AX = (I – A)X$

Or, $X = (I – A)^{-1}D$……....(4)

In the equation (4) if D is prescribed from outside, the required gross output levels X's get determined.

As indicated earlier, if aij be the input coefficient reflecting the ith sector input absorbed by unit output of j th sector , Vkj be the income accrued (value added generated) to kth household sector in jth processing sector as a proportion of output of jth processing sector and Wk be the Income flow to kth household sector (all processing

sectors together) , then the expanded input output model endogenising the income and consumption of household sectors can be presented as follows-

$$\begin{pmatrix} a_{11}\ a_{12}.....a_{1n}\ c_{1k1}\ c_{1k2}....c_{1kn} \\ a_{21}\ a_{22}.....a_{2n}\ c_{2k1}\ c_{2k2}....c_{2kn} \\ ..... \\ a_{n1}\ a_{n2}.....a_{nn}\ c_{nk1}\ c_{nk2}..c_{nkn} \\ v_{1k1}v_{1k2}.....v_{1kn}\ 0\ 0....\ 0 \\ v_{2k1}v_{2k2}.....v_{2kn}\ 0\ 0....\ 0 \\ vn_{k1}vn_{k2}.....vn_{kn}\ 0\ 0\ ....\ 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ ..... \\ x_n \\ 0 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} F_{1*} \\ F_{2*} \\ ..... \\ F_{n*} \\ 0 \\ 0 \\ 0 \end{pmatrix} = \begin{pmatrix} x_1 \\ x_2 \\ ..... \\ x_n \\ w_1 \\ w_2 \\ w_k \end{pmatrix} \quad .....(5)$$

Here, Cik : Consumption of ith sector output by kth household sector as a proportion of kth household sector income , Xi : the output of the ith sector , Fi * : Final demand of the ith sector. The above equation may also be written as -

$A^*X + F^* = X^*$ ……(6), where A* = the expanded matrix (the income sub matrix and the consumption sub matrix being tagged with the production matrix) , F* = final demand vector (excluding household consumption). Solving for X, we get

$$(I-A^*)^{-1}F^* = \begin{pmatrix} X \\ W \end{pmatrix}$$

Where X : Output requirement vector (n processing sectors)

W : Incomes (value added) accrued to k household sectors

Now, we may consider following two cases-

Case-1: $(I-A)^{-1} F = X$ ……(7)

Here, Household sector has been treated as exogenous.

Case-2: $(I-A^*)^{-1}F^* =$ $\begin{pmatrix} X \\ W \end{pmatrix}$ ……..(8)

$(I-A^*)^{-1}F^* = \begin{pmatrix} X \\ W \end{pmatrix}$

Where Household sector is endogenised .

In case -1, the projected income to the kth household sector stimulated by the exogenous demand accommodates the additional income generated through the indirect output requirement ie the so called Leontief multiplier works in income generation .As household consumption is treated as exogenous, induced consumption multiplier does not have any scope to work for income generation .

In case - 2 , let α_{ij} be the(i,j)th element of $(I-A)^{-1}$ and $e_{jk} = \sum \alpha_{ij} v_{ki}$, $F = (F_i)$

ejk : Leontief open income Multiplier for kth household sector with respect to jth processing sector and $W_k = \sum ejk\ Fj$, then the projected income to kth household can be presented as follows-

$$\begin{pmatrix} W_1 \\ W_2 \\ W_k \end{pmatrix} = \begin{pmatrix} \sum e_{j1}F_j \\ \sum e_{j2}F_j \\ \sum e_{jk}F_j \end{pmatrix} \quad \text{……(9)}$$

Here, Private Consumption which is usually considered as a category of final demand is treated here as endogenous . So the expanded matrix including the household sector is used to project the output requirement stimulated by residual final demand .Along with outputs, incomes are also projected as the bottom elements of projected outputs. Here the important point to be noted is that now the projection is capable of accommodating the consequence of induced consumption multiplier also (Keynesian multiplier) along with the Leontief multiplier.

So, if we now take the difference of (7) and (8) we get income generation due to feed back of induced consumption . Pattern and magnitude of income generation are

expected to be affected when Leontief income multipliers through (I-A) inverse and the Keynesian (semiclosed)income multipliers through (I-A*) inverse are allowed to work . But in this exercise we are more concerned to look into the process how the distribution of income among the social classes are affected through the working of Leontief as well Keynesian multipliers and how this distribution pattern tends to vary when the structure of production in the economy tends to change over a range of periods . The economy getting substantially liberalized after 1991 ,production structure no doubt has been less rigid and more competitive too. The change in the production structure has been a continuous process (may be sometimes fast and sometimes slow) Now ,this pattern of change in the structure of production is captured and easily reflected in the I-O tables prepared at short time intervals by CSO. The elements of the rows of the (I-A*) inverse corresponding to household sectors represent the semiclosed multipliers . The elements of a row of the (I-A*) inverse corresponding to a specific household sector represent the semiclosed income multiplier incorporating the feedback effect of induced consumption.

IV. Data Base of the Study

In our study, we have used the input output tables for the years 2003-04, 2007-08 and 2015-16 only to capture the pattern of income distribution in the late liberalized phase of Indian economy. Though the input output tables for the years 2003-04 and 2007-08 are published by the Central Statistical Office(CSO) , the input output table for the year 2015-16 is published the Brookings India (M.R Saluja and others). We consider the period 2003-04-2015-16 keeping in mind the fact that during this period the liberalization has progressed sufficiently so as to render some perceptible impact on the economy.

Since 1993 import matrices are also being made available by CSO (except for the year 2007-08 and 2015-16). So, besides technical coefficient matrices, we are now having domestic flow matrices also . The import matrices for the year 2007-08 and 2015-16 have been projected from the import matrix of 2003-04 and is used in our study. The projection procedure has been shown in appendix.

So, it is now being possible to trace the impact of certain categories of final demand on the economy more correctly through domestic matrices . For our present income distribution study, we have aggregated all the 130 x 130 matrices and 131* 131 matrices of various years to 9 x 9 matrices as nine sector breakdown of the economy is compatible with the income earning (by different social groups) data set made available in National Accounts Statistics published annually by Central Statistical Organisation , Govt of India .

Now, as our present objective has been mainly to look into the process of working of the two sets of multipliers in shaping the dynamics of income distribution in India ,formation of an 12x12 expanded Matrix (of course different for different benchmark years)

comprising the 9 processing sectors and 3 household sectors had been one of the major tasks facing us . Forming the 3x12 income coefficient matrix was no problem as National Accounts Statistics published by CSO annually directly provide the required sets of information. But to obtain the 12x3 consumption coefficient Matrix (in respect of organized, unorganized and profit earners) for the 9 products we had to use various sources of information and make some adjustments also . In fact , we have followed the procedure as adopted by Selim and others (2009) to construct the consumption coefficients for the income groups based on average propensity to consume (see Raziye Selim and others 2009, ESRC Research Papers, 2009/01, Istanbul Technical University).

V. Results and Interpretation

As in our expanded matrices, Private Final Consumption Expenditure(PFCE) is not a part of final demand, we have focused on three other constituents of final demand –Govt. Final Consumption Expenditure(GFCE), Gross Fixed Capital Formation(GFCF) and Export as the generators of income and the shapers of income distribution also. The above three categories differ in respect of sectoral composition and so naturally the same one rupee of Govt. consumption has an impact on generation and distribution of income different from the one originating from one rupee of export or capital formation . Further, the same one rupee of export or govt. consumption or capital formation will have different impacts on income generation or distribution if production structure changes (reflected in the I-O tables) . So, it is now obvious that over the period 2003-04-2015-16 changing pattern of income distribution can be understood largely by the changing composition of final demand and also by the changes in the production structure (explained partly by technology change and partly by degree of openness of the economy).

Let us now discuss the results we obtained from our study. Table-1 shows the projected income distribution stimulated by various categories of Final Demand for the years 2003-04, 2007-08 and 2015-16.

Table-1: Projected income distribution stimulated by various categories of Final Demand.

	Percentage Income Shares Stimulated By								
	Govt. Consumption			Capital Formation			Export		
	2003-04	2007-08	2015-16	2003-04	2007-08	2015-16	2003-04	2007-08	2015-16

Self Employed and Casual Labours(Unorganised Workers)	9	10	12	19	17	15	10	12	15
Regular Wage and Salary Earners(Organised Workers)	30	35	42	21	22	24	22	26	31
Surplus/Profit Earners(capitalists)	61	55	46	60	61	68	68	62	54

When we look at the results related to income distribution for the years 2003-04, 2007-08 , and 2015-16 we consider first incomes induced by Govt. Consumption. We see that the organized workers income share amounts to 30 percent , 35 percent and 42 percent in 2003-04, 2007-08 and 2015-16 respectively . While the unorganized segment representing the vast majority of population (90 percent of population)obtain only as little as 9 percent in 2003-04 , 10 percent in 2007-08 and 12 percent in 2015-16 , surplus earners capture 61 percent in 2003-04 55 percent in 2007-08 and 46 percent in 2015-16. Over the years 2003-04- 2015-16, while the share of organized and unorganized sectors in national income has increased , capitalist's share in national income has decreased.

Let us now see the income distribution induced by Gross Fixed Capital Formation. Table-1 highlights that Capital Formation stimulates on an average more or less 22 percent income share for organized workers both in 2003-04 , 2007-08 and 2015-16. For the unorganized segment, it is 19 percent in 2003-04 ,17 percent in 2007-08 and 15 percent in 2015-16. As usual capitalists accrue the larger share in income generated by the capital formation(60 percent in 2003-04 , 61 percent in 2007-08 and 68 percent in 2015-16).

The significant jump in the unorganized segment's income share (as compared to Govt. consumption) seems to be the result of more favourable unorganized labour participation in the Construction sector , a sizable constituent of Gross Fixed Capital Formation . In the construction of buildings , highways and bridges etc. unorganized segment seems to be the main workforce. By size of employment, the construction sector employs relatively a much smaller number of workers in the organized category . Further , wage bargaining in unorganized fashion seems to be a little bit powerful in recent days as surplus labour available (the nature of work in this sector being relatively harder) for this sector is gradually declining. On the other hand, the reason for increased share of surplus earners in income generation due to capital formation seems due to the fact that this compo-

nent of final demand constitutes the subsectors like Electrical equipment , Non Electrical Equipment , Transport Equipment and these sectors being relatively less labour intensive compared to the sector Construction naturally more income share tends to go to Surplus earners than to workers (both Organised and Unorganised) .

Another component of final demand is exports and now we try to project the pattern of income distribution stimulated by exports. Table-1 shows that Export induces on an average 12 percent income share for unorganized workers in 2003-04 , 2007-08 and 2015-16. For the organized segment, it is 22 percent in 2003-04 , 26 percent in 2007-08 and 31 percent in 2015-16. As usual capitalists enjoy the larger share in income generated by the exports (68 percent in 2003-04 , 62 percent in 2007-08 and 54 percent in 2015-16).

We know that 'Community Services' is the principal component in Government consumption . It is observed from table-2 that the open and semi closed multipliers are highest for surplus earners followed by organized sector during our study years as mentioned above. While the open multiplier for Community Services for the Organised Group has increased from .5086 in 2003-04 to .5812 in 2015-16 , during the same period, the semi closed multiplier has increased from .7486 to .8907 . For the surplus earners, open multiplier has increased from .2899 in 2003-04 to ..4785 in 2015-16. The semi closed multiplier for this sector has also increased from 1.0436 in 2003-04 to 1.3812 in 2015-16. The increase of both the open and semiclosed multipliers for the unorganized sectors is insignificant. Therefore, the Surplus earners enjoy the highest income share followed by the organized workers and the unorganized group remained deprived.

Table-2: Multipliers for Community Services

	Self Employed and Casual labours (Unorganised Workers)			Regular Wage and Salary Earners(Organised Workers)			Surplus/ Profit Earners(capitalists		
	2003-04	2007-08	2015-16	2003-04	2007-08	2015-16	2003-04	2007-08	2015-16
Open Multipliers	.0680	.0896	.1165	.5086	.5431	.5812	.2899	.3736	.4785
Semi Closed Multipliers	.2162	.2441	.2734	.7486	.8171	.8907	1.0436	1.2010	1.3812

As far as the role of multipliers in shaping the income distribution consequent to capital formation is concerned, table-3 shows that the semi closed multipliers are highest

for surplus earners followed by organized sector for the years 2003-04 , 2007-08 and 2015-16. While Leontief Open Multiplier for construction sector for the Organised Group has increased from .1719 in 2003-04 to .2684 in 2015-16 , the semi closed multiplier has increased from .3688 to .5532 in 2003-04 and 2015-16 respectively. For the surplus earners, open multiplier has increased from .2905 to .4501 in 2003-04 and 2015-16 respectively. The semiclosed multiplier for this sector has also increased from .8717 in 2003-04 to 1.3225 in 2015-16. So, as usual, the surplus earners enjoy the highest income share followed by the organized workers leaving the self employed and casual workers in utter distress.

Table-3: Multipliers for Construction Sector

	Self Employed and Casual labours(Unorganised Workers)			Regular Wage and Salary Earners(Organised Workers)			Surplus/ Profit Earners(capitalists)		
	2003-04	2007-08	2015-16	2003-04	2007-08	2015-16	2003-04	2007-08	2015-16
Open Multipliers	.2129	.2259	.2395	.1719	.2150	.2684	.2905	.3630	.4501
Semi Closed Multipliers	.3203	.3592	.4025	.3688	.4533	.5532	.8717	1.0750	1.3225

We know that 'Manufacture' is the principal component in Export . It is observed from table-4 that the open and semi closed multipliers of manufacture are highest for surplus earners followed by organized sector in 2003-04 , 2007-08 and 2015-16. While the open multiplier for manufacture for the Organised Group has increased from .1305 in 2003-04 to .2520 in 2015-16 , during the same period, the semi closed multiplier has increased from .3171 to .4970 . For the surplus earners, though open multiplier has decreased slightly from .5205 in 2003-04 to .4938 in 2015-16 but the semi closed multiplier for this sector has increased from .9619 in 2003-04 to 1.2994 in 2015-16. The increase of both the open and semiclosed multipliers for the unorganized sectors is not worthy of mention. Hence, the Surplus earners enjoy the highest income share followed by the organized workers leaving behind the unorganized workers .

Table-4: Multipliers for Manufacturing Sector

	Self Employed and Casual labours(Unorganised Workers)			Regular Wage and Salary Earners(Organised Workers)			Surplus/ Profit Earners(capitalists)		
	2003-04	2007-08	2015-16	2003-04	2007-08	2015-16	2003-04	2007-08	2015-16
Open Multipliers	.0668	.0826	.1016	.1305	.1815	.2520	.5205	.5084	.4938
Semi Closed Multipliers	.1715	.1977	.2275	.3171	.3978	.4970	.9619	1.1200	1.2994

VI Conclusion and Policy Implication

In this paper, we have made an attempt to understand the status of the unorganised group of wage earners in relation to the so called organised group in India in a formal way through multiplier effect based on semi-closed input output model. The major findings of our study are as follows-

1. Population wise though the unorganised group far exceeds the rest of the population, but the former enjoy very much disproportionately a small share of the national income being produced by participation of all groups of people.
2. Though the pattern of income distribution in terms of percentage share in national basket among the income classes ie, organized, unorganized and capitalists remains more or less same for both the years 2003-04 and 2015-16, it is interesting to note that, as far as income share in national basket is concerned, the organized group gains significantly and unorganized group gains marginally at the cost of Surplus earners over the period 2003-04-2015-16. The final demand composition and /or production structure of 2007-08 differ from those of 2003-04 in such a way that multipliers work for a redistribution of income in favour of wage earners.

So, it seems that the govt. policy may be directed to reallocate final demand in an appropriate way for redistribution of income in favour of the unorganised workers. At the same time, it should be remembered that subject to institutional constraint and unlimited supply of surplus labour, very little can be expected in terms of possibility of significant improvement in the income share status of the unorganised income group as they have almost zero bargaining power. Still, the policy makers of our country may try to improve the status of 'workers' by reallocation of final demand in such a way that can achieve some redistribution of income in favour of the workers in general and unorganized workers in particular.

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Appendix :

Import Matrix Projection Technique (In case of non-availability of Import Matrix) :

As indicated in the paper, the import matrices for the years 1989-90, 1993-94 , 1998-99 and 2003-04 have been collected (not published or circulated) from C.S.O 's desk informally. For the other years - 2007-08, 2013-14 and 2015-16 the import matrices are projected from other available import matrices following an appropriate methodology to be discussed here. The import matrices for the years 2007-08, 2013-14 and 2015-16 have been projected from the import matrix of 2003-04 considering it as a base import matrix.

Let, the import matrix of the year T_1 is available but we do not have the import matrix of a subsequent year T_2. We assume that total intermediate import for T_1 is distributed among the sectors of year T_2 in such a way that the pattern of distribution of sectoral import for year T_2 originated from a sector and destined to different sector assumed unchanged as in T_1 .

Let IMi^{T1} and TMi^{T1} be the sectoral intermediate import and sectoral total import(includes final demand import) for the year T_1 . For T_2 , we have sectoral total import ie, TMi^{T2} . First, we like to find out sectoral intermediate import for T_2 ie, IMi^{T2} . In order to do this, we find the ratio of sectoral intermediate import to sectoral total import for T_1 ie, $m_i = IMi^{T1} / TMi^{T1}$. Then, $TMi^{T2} * m_i$ simply provide us the sectoral intermediate import, ie, IMi^{T2} for the year T_2 .

Now we inflate the total intermediate import of T_1 and the rate of over all inflation is given by $I = \sum IMi^{T2} / \sum IMi^{T1}$.

We calculate the share of intermediate import for each sector in total intermediate import for T_1 and T_2 which is given by $pi = IMi^{T1} / \sum I Mi^{T1}$ and $qi = IMi^{T2} / \sum IMi^{T2}$

We now estimate an adjustment factor for each sector i which is given by, $ri = qi / pi * I$

Finally, the sectoral adjustment factor is multiplied by respective row of import matrix of T_1 to get the import matrix of T_2 . In other words, We get,

$M_{11} * r_1 \quad M_{12} * r_1 \ldots\ldots\ldots\ldots\ldots\ldots M_{1n} * r_1$

……

$M_{m1} * r_n \quad M_{m2} * r_n \ldots\ldots\ldots\ldots\ldots\ldots M_{mn} . r_n$

This is our projected import matrix for the year T_2 (projected from the import matrix of the year T_1).

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Unsustainable use of Surface Water in View of India's Shrinking Water Resources

Debolina Saha[1] and Debanjan Singh[2]

Abstract:

The available fresh water resources in India are shrinking due to several quantitative and qualitative factors which include exploitative extractions due to infrastructure inadequacies, insufficient funds, weak government regulations and policies, widespread pollution, contamination and decay of surface water bodies and groundwater resources, etc. The gap between availability and utilization of water resources is getting widen day-by-day. This study highlights the trends of surface water use for the last two decades in India. Further, the study explores state-wise and regional efficacy of surface water use, and determines empirically the factors affecting the total outflow of surface water for better management of water resources in future, with special emphasis on agricultural sector. The study comes to the conclusion that efficient management and awareness can reduce the unsustainable use of surface water resources, and surmount water resources scarcity and conflict in near future as predicted for India.

Keywords: Surface water, Water scarcity, Water resource management.

JEL Classification Codes: Q1, Q25, Q28, Q56, C1.

1. Introduction

The major sources of surface water in India are rivers, lakes, ponds, and tanks, with about 10,360 rivers and their tributaries longer than 1.6 km each and mean annual flow in all the river basins estimated to be 1,869 cubic km. However, due to topographical, hydrological and other constraints, only about 690 cubic km or 32 percent of the available surface water can be utilized (data of 2015-16, Ministry of Water Resources, GoI). Water flow in a river depends on size of its catchment area or river basin and rainfall within its catchment area. There are various sources of irrigation adopted in the country and out of 49 percent of India's gross cropped area that is irrigated; canal water irrigates 25 percent (Gulati *et al.* 2019). Canal water used to be the main source until early 1970s, but decreased gradually with the overall inefficiencies existing in the surface irrigation system. As per the existing technology, India's Ultimate Irrigation Potential (UIP) is 139.9 mil-

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lion hectares of which 54 percent is from surface water, but interestingly 64 percent of irrigated area is now irrigated by ground water (Gulati *et al.* 2019).

Agricultural sector is guilty of using irrigation water very inefficiently. As per the annual report of Central Water Commission (2014-15), the levels of efficiency are 30 percent for surface water. In the early phases of development of canal irrigation system, government constructed major and medium ones. In India, the Accelerated Irrigation Benefits Programme (AIBP) was launched during 1996-97 as a Central Assistance (CA) programme to accelerate the execution of large projects and handle the old ones which were getting delayed for financial crunch of the state governments. So major, medium, and in the later stage, even minor irrigation projects were under the control of AIBP. Though AIBP took part in extension, renovation and modernization of the irrigation projects to facilitate agricultural production, but it faced ballooning costs (Comptroller and Audit General of India, 2018). The main challenge was to tackle the ever increasing gap between irrigation potential created (IPC) by the system agencies and engineers, and actually utilized (IPU) by the farmers. Therefore, the ballooning cost was unable to meet the rising aspirations and on-demand supply of water for intensive and diversified agriculture. In spite of the massive public investments, compound annual growth rate (CAGR) of canal systems which grew at 7.29 percent up to 1974-75, shrank to negative and now stands at meager 0.52 percent for the period up to 2014-15 (Gulati *et al.* 2019).

Importance of the efficient use of water resources

There are three main reasons for which efficient use of water in India seems crucial. The first one being the large dependency of rural population on the use of ground and surface water since Indian agriculture is vulnerable to monsoon shocks. Monsoon rains are vital in agriculture, which accounts for 14.4 percent of the national economy and around 50 percent of the employment (Gulati *et al.* 2019). It is estimated that the share of agricultural output in National GDP reduces by 0.35 percent with every 1 percent fall in monsoon rains (long-period average) in India. Not only the total rainfall, but its proper distribution, and rainfall deficiency, especially drought-like situation are also responsible for total crop production and availability of food grains in the market.

Secondly, due to rapid growth of population in the past few decades, domestic demand for water has increased and would further put a huge strain on the already stressed water resources in India. Further, the increase in industrial production due to the increasing demand and subsequent misuse of the water resources has led the economy to huge water pollution.

Thirdly, Gulati *et al*. (2019) predict that water demand in India might exceed all sources of supply by 2050, in view of the fact that India's per capita water availability has already been decreased from 5178 cubic meter to 1544 cubic meter since 1951. The report

clearly indicates that India is moving fast from being water stressed country to water scarce country. Many of the Indian river basins like the Indus, Sabarmati, Pennar and Krishna have little opportunity for further development. Thus, the need for developing and managing water resources has great significance in the Indian context.

Since several old and new programmes have not been able to satisfactorily address the issues of canal irrigation system, so the public irrigation systems continue to struggle with poor management, crumbling infrastructure and shrinking command areas. Linking of Canals that is building storage reservoirs on rivers and connecting them to other parts of the country can reduce the regional imbalances and provide with additional irrigation, domestic and industrial water supply and hydropower generation.

II. Specific objectives of the study

A very few empirical studies have been done so far in the Indian context on surface water utilization with special emphasis on agricultural sector. Spatial variation in water supply and demand across river basins of India was studied by Amarasinghe *et al.* (2004). Further, India's water supply and demand from 2025-2050 with respect to the business-as-usual scenario and issues were also studied by Amarasinghe *et al.* (2008). Since the largest use of water is in agriculture and livestock together, around 85 percent of the total (Vaidyanathan, 2006), so efficiency in surface water use is a prime concern to combat with scarcity of water resources. The most produced crops in India such as rice, wheat and sugarcane consume a huge amount of water. Therefore, sustainable use of water for irrigation in Indian agriculture was studied by Rao (2002). Later on, the status of water use in agriculture, challenges and possible options for action in India were studied by Dhawan (2017). Sharma *et al.* (2018) carried out a water productivity mapping of major Indian crops. However, literature on the efficiency of surface water use in Indian agriculture, state-wise and at regional level, is scarce. More precise study to show the accountability of surface water use in agriculture, empirically, in view of upcoming fresh water scarcity and disputes, is of a burgeoning need. Therefore, the present study has two main objectives which are as follows:

1. to examine the efficiency of surface water use in Indian agriculture across states and regions for the last two decades, and
2. to determine the factors affecting the total surface water outflow for better management of water resources in future, with special emphasis on agricultural sector.

III. Methodology

The study uses secondary data for analysis, the sources of which are listed below.

- Water resources - Central Ground Water Board, Ministry of Jal Shakti, Department of Water Resources, River Development & Ganga Rejuvenation, GoI; National

Water Information Centre, GoI; Central Water Commission, Ministry of Jal Shakti, Department of Water Resources, River Development & Ganga Rejuvenation, GoI.

- Agricultural land area - Ministry of Agriculture and Farmers welfare, GoI.
- Agricultural production - Ministry of Agriculture and Farmer's Welfare, GoI.
- Temperature and rainfall - Annual summary 2017, National Climate Centre, Climate Service Division, India; India Meteorological Department, Ministry of Earth Sciences, GoI.
- State-wise rural population - Office of the Register General and Census Commissioner, Ministry of Home Affairs, GoI.

In the study, the entire economy is divided into five regions – north, south, east, west and central. The data have been collected in five data points – 2004, 2009, 2011, 2013 and 2017 as per availability of the data. Efficiency of surface water use is calculated state-wise and at regional level. Pictorial representation has been made to show the trend of surface water use for different regions in India. Regression analysis is done to determine the factors affecting the total surface water outflow in India. Descriptive statistics is used to explain the variables used in the study. Some statistical tests have been performed to validate the regression model.

IV. Results and Discussion

In this section, at first the efficacy of surface water use in food grains production is studied, and then the factors influencing the total surface water outflow are studied.

Efficacy of surface water use in food grains production

The efficacy of surface water use in food grains production is calculated in terms of net change of surface water flow (subtracting total change in outflow of surface water from total change in inflow, in BCM) for per unit of food grains production (in million tons) for the states over the five time points in India. Then average values of surface water use in food grains production over the assessment period for all the states have been calculated and presented in Table 1. Ranking of the states (from highest to lowest) has also been done according to their level of efficacy of surface water use. The states possessing higher average values represents higher level of efficacy and vice versa.

Table 1: State-wise analysis of the efficacy of surface water use for food grains production

Rank	State	Year					Average
		2004	2009	2011	2013	2017	
14	Andhra Pradesh	-1.023	-0.291	-1.122	0.188	1.798	-0.090
19	Arunachal Pradesh	-0.749	0.032	0.055	-0.754	-0.027	-0.288
18	Assam	-0.917	0.084	-0.819	-0.160	0.443	-0.273
16	Bihar	-0.774	-0.445	0.249	0.141	-0.170	-0.199
6	Chattisgarh	-0.453	0.758	0.448	-0.504	0.384	0.126
24	Goa	-3.082	0.000	0.000	0.073	-0.649	-0.731
26	Gujarat	-1.272	-1.282	-2.470	-0.974	-2.773	-1.754
23	Haryana	-0.691	-0.254	-0.922	-0.045	-0.255	-0.433
25	Himachal Pradesh	-1.705	-3.627	-0.576	0.942	1.108	-0.771
2	Jammu & Kashmir	5.537	-1.141	-1.197	0.348	-1.476	0.414
13	Jharkhand	-0.636	-0.580	0.421	0.270	0.131	-0.078
3	Karnataka	0.492	0.540	-0.671	1.041	0.211	0.322
1	Kerala	1.654	2.406	-6.205	10.519	2.634	2.201
4	Madhya Pradesh	-0.167	0.552	0.585	0.591	-0.367	0.238
7	Maharastra	0.317	-0.761	-0.655	1.133	0.190	0.044
21	Manipur	-2.478	0.000	0.000	0.000	0.000	-0.495
15	Meghalaya	0.177	0.585	-0.120	-0.968	-0.248	-0.114
11	Mizoram	0.000	0.000	0.000	0.000	0.000	0.000
9	Nagaland	0.000	0.367	-0.070	-0.272	0.018	0.008
5	Odisha	-0.410	-0.125	-1.164	0.211	0.392	0.219

10	Punjab	-0.058	-0.166	0.218	0.132	-0.154	0.005
18	Rajasthan	0.710	-0.532	0.720	-0.562	-1.560	-0.244
11	Sikkim	0.000	0.000	0.000	0.000	0.000	0.000
8	Tamil Nadu	-0.616	0.149	0.706	-0.530	0.383	0.018
22	Tripura	0.125	-0.432	-0.342	-1.431	-0.374	-0.490
20	Uttar Pradesh	-0.625	-0.424	-0.240	0.152	-0.341	-0.295
27	Uttarakhand	-5.939	-0.757	-1.495	0.455	-1.733	-1.893
12	West Bengal	-0.062	-0.842	0.345	0.293	0.056	-0.042

Source: Done by authors

Note: In Mizoram and Sikkim, the average change in surface water use is negligible.

Table 1 lights on the facts that average net change of surface water is more negative in the states like Gujarat and Uttarakhand for producing food grains, and thus show inefficiency in surface water consumption in comparison to other states. In Delhi, no agricultural activities are undertaken. So surface water use is zero for food grains production. In Kerala, efficiency in surface water use is found highest for the food grains production. The availability of surface water depends upon several topological, geological and climatic factors. So in vast countries like India, with having varied physical characteristics of watershed and climate, it is comprehensible for encompassing discrepancies in efficacy of surface water use.

The regional efficacy of surface water use for the five time points are presented in Table 2 for food grains production.

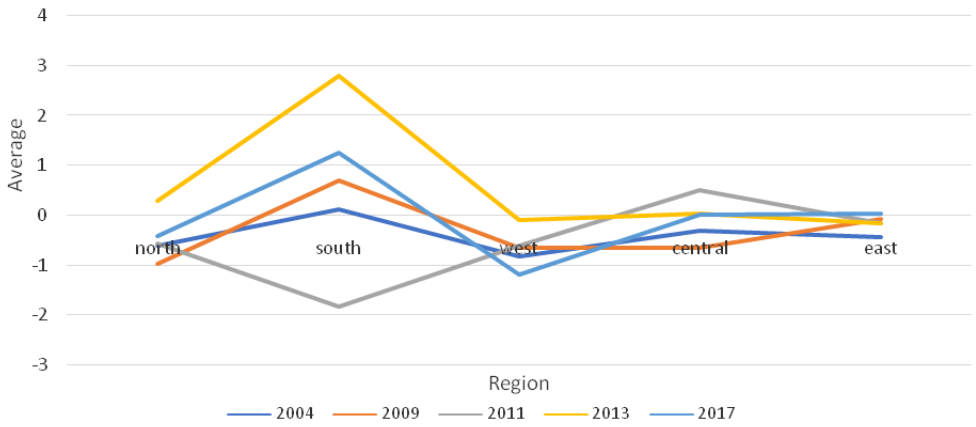
Table 2: Regional analysis of the efficacy of surface water use for food grains production

Sl. No.	Region	State	Year				
			2004	2009	2011	2013	2017
1	North	Jammu & Kashmir, Punjab, Haryana, Himachal Pradesh, Uttar Pradesh, Uttarakhand, Bihar	-0.607	-0.970	-0.560	0.290	-0.420
2	South	Andhra Pradesh, Tamil Nadu, Kerala, Karnataka	0.120	0.700	-1.820	2.800	1.250
3	West	Rajasthan, Gujarat, Goa, Maharashtra	-0.830	-0.640	-0.600	-0.080	-1.190
4	Central	Chhattisgarh, Madhya Pradesh	-0.310	0.650	0.510	0.040	0.008
5	East	Odisha, Jharkhand, Bengal, Sikkim, Tripura, Nagaland, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram	-0.450	-0.082	-0.150	-0.250	0.035

Source: Done by authors

Regional trends of the efficacy of surface water use are presented in Figure 1.

Figure 1: Regional trends of the efficacy of surface water use



Source: Done by authors

Figure 1 demonstrates that in 2004, the performance of southern region was good in terms of the efficacy of surface water use in food grains production compared to the other regions. In 2009 also southern region was the highest performer. However, in 2011, central region took the lead. Furthermore, in 2013 and 2017, again the southern region performed well in comparison to the other regions, though its performance was worst in 2011. The eastern and a few northern states of India mostly use surface water in agriculture for the existence of several perennial rivers and their tributaries. In the southern region, usually the rivers get dry in summer in the absence of adequate and timely rainfall due to ever increasing pollution level and climate change. But, as per the report of Central Ground Water Board, 2014, during 2009-2011, annual rainfall in southern region was normal. No deficiency in rainfall was perceived in most of the states there, and therefore, the region used a huge amount of the surface water inflow at that period. Generally, southern region depends upon ground water for agricultural use. Being the total surface water outflow low in the southern region for per unit of food grains production, efficacy of its use remains high, though this region harnesses ground water in an unsustainable manner. Report of the Central Ground Water Board, 2019 (on National Compilation on Dynamic Ground Water Resources of India, 2017) also marked the states like Punjab, Haryana, Rajasthan Uttarakhand, and some parts of Madhya Pradesh, Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, Kerala as over exploited or sometimes critical in ground water use.

In view of the second objective, factors affecting of surface water use have been determined through a regression analysis for better management of water resources in future. The regression analysis is done for the 29 states after mining the data for the

year 2017. The independent variables are agricultural land area, average rainfall, average temperature, agricultural production, rural population, total inflow of surface water, total ground water use, and efficacy of ground water use in food grains production of each state. The descriptive statistics of the independent variables used in the regression analysis is presented in Table 3.

Table 3: Descriptions of the Explanatory Variables

Variable	Description	Mean	Standard Deviation
Agricultural Land Area	Agricultural land area is measured in '000 hectare.	2398.276	3464.125
Average Rainfall	Average rainfall is measured in millimeter.	1438.23	999.1308
Average Temperature	Average temperature in summer and average temperature in winter have been taken into account, and then grand average is calculated. The measurement unit is Celsius.	24.0169	7.266344
Agricultural Production	Agricultural production is measured in '000 tons.	27196.07	47580.97
Rural Population	Rural population is in '000 number.	196.0345	137.718
Total Inflow of Surface Water	Increase in the total inflow of surface water. Measured in billion cubic metre (BCM).	1.030345	4.667124
Total Ground Water Use	Use of ground water in agriculture and for industrial and domestic purposes. Measured in billion cubic metre (BCM).	8.569759	11.19772
Efficacy of Ground Water Use in Food Grains Production	Ground water use (in BCM) for per unit of foodgrains production (in million tons)	.6280345	.604

Source: Done by authors

The dependent variable in the regression analysis is the total outflow of surface water (in BCM), the mean of which is 2.92. The estimated regression result is presented in Table 4.

Table 4: Estimated regression result

Variables	Coefficient	VIF
Constant	7.180572 (5.718517)	-
Agricultural Land Area	.0036945 (.0015211)***	6.19
Average Rainfall	.0005749 (.0009712)	1.52
Average Temperature	-.2353541 (.2209343)	1.27
Agricultural Production	-.0000718 (.0000864)	5.25
Rural Population	-.0431915 (.027027)	3.29
Total Inflow of Surface Water	.6863208 (.0890905)***	1.04
Total Ground Water Use	-.2393809 (.2140352)	6.06
Efficacy of Ground Water Use in Food Grains Production	5.521561 (4.481002)	2.33
Number of observations = 29 F(8, 20) = 54.77 Prob > F = 0.0000 R-squared = 0.5955 Root MSE = 7.4415 Mean VIF 3.37		
(Figures in parenthesis indicate standard error) ***denotes significance at 1 percent level		

Source: Done by authors

In the model, robust estimator has been used to tackle the problem of heteroscedasticity, since the assumption of constant variance is crucial to keep the OLS (ordinary least square) estimator BLUE (Best Linear Unbiased estimator). The R^2 value for this cross-section data is 0.5955. R^2 measures the goodness-of-fit for linear regression models.

The model shows that 59 percent of the variation in the data of outcome variable is due to the variations in the data of independent variables collectively. The value of F-statistic is 54.77 and the P-value associated with it is 0. 000. The probability value of less than 0.01 ($P < 0.01$) indicates that in overall the regression result statistically significantly predicts the outcome variable.

In the model, all the coefficients of the independent variables have expected signs. The results show that surface water use increases with the increase in agricultural land area, average rainfall, total inflow of surface water and efficacy of ground water use; and decreases with the increase in average temperature, agricultural production, rural population and total volume of ground water use. It is expected that with the increase in agricultural land area, the demand for surface water will increase to water the field. Adequate rainfall helps in raising total surface water inflow, and therefore, the total outflow of surface water increases. Further, with the increase in efficacy of ground water use, the use of surface water increases to tackle the problem of lowering of water table below the permissible levels. Conversely, increase in average temperature evaporates surface water fast, and reduces the total outflow of surface water. Increase in rural population forces more people to join as agricultural labourer, and to raise agricultural production. Therefore, intensive, and multiple cropping demand more surface water to water the field. Though the augmented efficacy of ground water use in food grains production boosts the total outflow of surface water, but the unsustainable increase in the volume of ground water use (either in agriculture or in industrial and domestic uses), reduces the need of surface water use. The estimation results show that total inflow of surface water and agricultural land area are statistically significant at 1 percent level. In addition, the Variance Inflation Factor (VIF) of the independent variables in the model has been estimated and the mean VIF is found as 3.37 (within the critical value of 10), which indicates that the model does not suffer from any severe multicollinearity problem; the independent variables are not highly correlated with one or more of the other independent variables.

V.Conclusions

The study analyzes the efficacy of the states and regions in terms of surface water use to deal with upcoming fresh water scarcity as predicted for India. The study examines the regional trends of surface water use for the last two decades as well, which is rare in the Indian context Further, the key factors responsible for the total outflow of surface water determined from the regression analysis have serious policy implications.

The study shows that the efficacy of surface water use in agriculture varies significantly across states and regions of the country. Therefore, the water use efficiency must be improved and more rigorous studies are to be done for serious policy implementation in view of shrinking water resources in India. Since total inflow of surface water highly

depends upon geology, slope, climate, precipitation, saturation, soil type, vegetation, etc; so mostly it is beyond our control to increase the quantity. Qualitative control in over use, misuse or polluting water, especially in agricultural fields may help combating the predicted water scarcity. Proper management and awareness can only reduce the unsustainable use of surface water resources, and surmount water resources conflict in near future as predicted for India

Though the study has serious policy suggestions, but the study could be extended for state-wise and regional efficacy analyses of ground water use. Incorporation of water use in industrial and domestic purposes in India, alike the agricultural sector might also enrich the study. Further, expansion of time horizon and inclusion of more determinants of surface water use might help validating the study results.

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Appendices

Appendix 1:

State-wise total inflow of surface water (in BCM)

Sl. No.	State	Year				
		2004	2009	2011	2013	2017
1	Andhra Pradesh	0.04	0.02	0.02	0.02	0.14
2	Arunachal Pradesh	0.00	0.00	0.00	0.00	0.00
3	Assam	0.00	0.00	0.00	0.00	0.00
4	Bihar	0.00	0.00	0.00	0.00	0.00
5	Chattisgarh	3.12	0.61	0.51	4.79	25.16
6	Delhi	0.00	0.00	0.00	0.00	0.00
7	Goa	0.00	0.00	0.00	0.00	0.00
8	Gujarat	0.03	0.01	0.03	0.00	0.04
9	Haryana	0.00	0.00	0.00	0.00	0.00
10	Himachal Pradesh	0.00	0.00	0.00	0.00	0.00
11	Jammu & Kashmir	0.00	0.00	0.00	0.00	0.00
12	Jharkhand	0.19	0.16	0.55	0.44	0.36
13	Karnataka	072	0.39	0.78	0.78	0.28
14	Kerala	0.28	0.08	0.38	0.49	0.15
15	Madhya Pradesh	0.12	0.02	0.06	0.29	0.05
16	Maharastra	1.15	0.59	1.58	6.57	1.04
17	Manipur	0.00	0.00	0.00	0.00	0.00
18	Meghalaya	0.00	0.00	0.00	0.00	0.00
19	Mizoram	0.00	0.00	0.00	0.00	0.00
20	Nagaland	0.00	0.00	0.00	0.00	0.00
21	Orissa	3.27	1.39	4.24	4.51	2.51
22	Punjab	0.00	0.00	0.00	0.00	0.00
23	Rajasthan	0.00	0.00	0.00	0.00	0.00
24	Sikkim	0.00	0.00	0.00	0.00	0.00
25	Tamil Nadu	0.83	0.46	0.91	0.77	0.15

26	Tripura	0.00	0.00	0.00	0.00	0.00
27	Uttar Pradesh	0.00	0.00	0.00	0.00	0.00
28	Uttarakhand	0.00	0.00	0.00	0.00	0.00
29	West Bengal	0.00	0.00	0.00	0.00	0.00

Data Source: National Water Information Centre, Government of India

Appendix 2:

State-wise total outflow of surface water (in BCM)

Sl. No.	State	Year				
		2004	2009	2011	2013	2017
1	Andhra Pradesh	13.75	4.48	20.64	-3.69	-21.73
2	Arunachal Pradesh	0.17	-0.01	-0.02	0.29	0.01
3	Assam	3.32	-0.38	3.82	0.82	-2.45
4	Bihar	5.97	4.52	-3.50	-1.82	2.91
5	Chattisgarh	5.40	-3.11	-2.57	8.62	22.87
6	Delhi	0.60	0.18	0.18	-0.06	-2.24
7	Goa	0.48	0.00	0.00	-0.01	0.07
8	Gujarat	6.72	7.40	21.95	8.95	21.30
9	Haryana	9.06	3.91	16.56	0.77	4.14
10	Himachal Pradesh	2.75	3.69	0.87	-1.44	-1.65
11	Jammu & Kashmir	-8.30	1.50	1.90	-0.62	2.32
12	Jharkhand	1.66	1.41	-1.21	0.72	-0.43
13	Karnataka	-4.45	-5.53	8.90	-11.93	-2.21
14	Kerala	-0.83	-1.39	3.93	-4.90	-1.23
15	Madhya Pradesh	2.48	-8.83	-11.88	-13.29	12.35
16	Maharastra	-2.20	10.17	9.80	-9.12	-1.49
17	Manipur	1.11	0.00	0.00	0.00	0.00
18	Meghalaya	-0.04	-0.14	0.03	0.31	0.09

19	Mizoram	0.00	0.00	0.00	0.00	0.00
20	Nagaland	0.00	-0.13	0.04	0.17	-0.01
21	Orissa	6.10	2.34	11.71	2.74	-0.30
22	Punjab	1.50	4.49	-6.21	-3.90	4.89
23	Rajasthan	-8.63	6.58	14.03	10.06	31.15
24	Sikkim	0.00	0.00	0.00	0.00	0.00
25	Tamil Nadu	4.64	-0.66	-6.26	5.43	-3.96
26	Tripura	-0.07	0.28	0.25	1.04	0.32
27	Uttar Pradesh	23.67	18.35	12.10	-7.64	17.55
28	Uttarakhand	10.46	1.36	2.77	-0.81	3.30
29	West Bengal	1.01	13.27	-5.52	-5.02	-0.95

Data Source: National Water Information Centre, Government of India

Appendix 3:

State-wise food grains production (in 1000 tones)

Sl. No.	State	Year				
		2004	2009	2011	2013	2017
1	Andhra Pradesh	13396.0	15295.0	18363.1	19665.1	12159.8
2	Arunachal Pradesh	226.9	308.9	362.5	384.6	359.1
3	Assam	3618.2	4481.2	4663.3	5096.8	5525.9
4	Bihar	7704.4	10150.6	14047.2	12905.8	17036.9
5	Chattisgarh	5023.0	4902.8	6870.5	7595.6	5958.7
6	Delhi	0.0	0.0	0.0	0.0	0.0
7	Goa	155.7	109.9	130.2	135.5	107.8
8	Gujarat	5257.5	5761.0	8874.3	9179.6	7664.7
9	Haryana	13109.0	15357.0	17958.7	16974.1	16191.8
10	Himachal Pradesh	1612.3	1017.2	1510.3	1528.4	1488.3
11	Jammu & Kashmir	1499.0	1314.2	1586.3	1777.9	1571.1

12	Jharkhand	2311.1	2152.2	4175.3	4285.7	6001.3
13	Karnataka	10495.0	10955.0	12095.1	12208.9	11791.2
14	Kerala	670.9	610.8	572.1	512.4	523.8
15	Madhya Pradesh	14104.8	16016.4	20394.8	22978.0	33450.4
16	Maharastra	10540.7	12586.3	12544.0	13846.2	13246.7
17	Manipur	447.8	338.9	669.1	490.6	706.5
18	Meghalaya	225.2	239.2	249.1	320.0	361.8
19	Mizoram	124.6	62.3	68.0	72.8	74.2
20	Nagaland	403.5	354.2	566.5	624.6	552.3
21	Orissa	6889.7	7552.9	6412.3	8359.4	7151.3
22	Punjab	25670.7	26950.1	28389.1	29480.4	31691.9
23	Rajasthan	12150.8	12350.1	19469.7	17899.6	19957.0
24	Sikkim	103.9	117.3	103.2	102.4	93.9
25	Tamil Nadu	6175.8	7511.4	10151.8	8783.2	10713.6
26	Tripura	556.4	647.9	729.9	726.7	855.3
27	Uttar Pradesh	37836.3	43195.3	50283.6	50027.5	51369.9
28	Uttarakhand	1761.0	1796.0	1852.0	1776.5	1903.2
29	West Bengal	16055.4	15741.5	15985.7	17078.9	16877.5

Data Source: Ministry of Agriculture & Farmers Welfare, Government of India

Role Of Education In Agricultural Practices And Marketing Management: Prospect Of West Bengal

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Abstract

The study examines contribution of education and extension services in sustainable agricultural practices and marketing management in the context of sustainable growth and development of Indian horticulture. Disaggregated (unit level) NSSO data are used to analyse the role of education and training to enhance income of farmers of West Bengal agriculture. Mincer earning function is used to assess the contribution of different levels of general education in income of agricultural community. Income of the members of the agricultural households (mainly from farming) is considered dependent variable and the independent variables are: years of schooling, work experience, gender, training, migration status (dummy variable), and a spatial dummy variable. The study has found that diversification of Indian agriculture towards horticulture is important for sustainable use of agricultural resources and to enhance farm income. Education and extension services are very crucial inputs for development of modern horticulture. Education and training to farmers plays an important role in modern agricultural practices and sustainable management of agri-business. Education planning and manpower planning should be integrated with economic planning to achieve sustainable economic development and management practices in agriculture. The study also suggests some strategies/policies for increasing employment and sustainable income of Indian farming community.

JEL Classification: Q15, Q16, O13, I26

KEY WORDS: Agricultural Resources, Sustainable Practices, Returns to Education, Horticulture.

I. Introduction

Increasing demand for horticultural products is an opportunity to revitalise agricultural growth and augment income of the farmers through diversification of agriculture towards horticultural crops in India **(Birthal et al, 2008**). Horticulture-led growth has considerable potential to create employment opportunities for small and marginal farmers to enhance their income from farming. There is also a huge scope of employment

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generation in the non-farm sectors like transport, retail and wholesale trading, storage and processing industries, packaging and exports etc., particularly for the vast number of unorganised and low skill labourers in India. Due to strong backward and forward linkages of horticulture sector to non-farm sectors, rational use of agricultural resources and sustainable management of both inputs and outputs of horticulture is very crucial for transforming agricultural growth to sustainable economic development. A very complex and diversified production -distribution - consumption links of agri-products tainable management of the system of agricultural production and marketing. Education is one of the most important instruments for sustainable use of natural and human resources in agriculture. It empowers farmers to change the way they think, innovate and work for sustainable agriculture. Education helps people to develop knowledge, skills, values and behaviour which are indispensable for sustainable development. UNESCO aims to improve access to quality education for sustainable development at all levels and in all social contexts. Education and agricultural extension services can play a significant role in the management of human resources, technology and natural resources involved in the system of agriculture towards sustainable future and environment. In this context, the present study is an attempt to assess contribution of education to employment and earnings from agriculture with particular focus on Indian horticulture production and marketing systems.

The rest of the paper is organised as follows: Section II specifies the major objectives of the study. Section III reviews some literature of the subject and highlights some important issues in Indian agriculture. Section IV deals with data and methodology. Section V analyses empirical results and findings of the study. Conclusions and policy prescriptions are given in the last Section VI.

II. Objectives of the Study

The major objectives of the study are as follows:

1. To examine role of education and agricultural extension services in sustainable agricultural practices in West Bengal with special reference to Indian horticulture.
2. To estimate returns to education on earnings of the persons belong to agricultural households in West Bengal.
3. To suggest some policies for sustainable management of agricultural resources and sustainable agricultural growth for sustainable future.

III. Literature reviews and Some issues

The major changes that are taking place in Indian agriculture are: (i) shrinking resource base due to inappropriate and unscientific use of land and water, (ii) changes in demand and consumption pattern in favour of fruits, vegetables, meat, fish, eggs and dairy

products, (iii) there is a decreasing trend in per capita cereal consumption, (iv) there is a shift of farming systems from food grains to non-food grains cultivation which needed different types of support systems like training, extension services, problem-solving consultancy, marketing advice etc., (v) public investments in agriculture is declining in real terms, and (vi) country's policy of economic openness results new opportunities as well as new threats to agriculture. Particularly, Indian agriculture faces a big challenge under economic globalisation and liberalization (Sulaiman & Van den Ban, 2000).

Education is one of the most important instruments for sustainable management of agricultural resources for sustainable agricultural growth and development. It is increasingly realized that knowledge is an important input for efficient farming. In the present era of globalisation, agriculture is becoming an increasingly recognised as knowledge and information-driven enterprise. Education in general and agricultural research and extension education in particular are not only important to increase agricultural production, productivity and profitability but also very crucial for improvement of social and economic life of vast rural people associated with the farming system. Agricultural extension education and advisory services are a vital element of the array of market and non-market entities and agents that provide critical flows of information that can improve farmers' and other rural peoples' welfare (Anderson, 2007). But it is very unfortunate that the existing knowledge and information about how to use optimal combination of inputs, know-how, land management methods, and how to process, and market agricultural commodities remain inaccessible to a vast number of marginal and small farmers in India (Babu & Joshi, 2014). This is a matter of grave concern to the policy makers.

NSSO survey results (2003) regarding situations of agricultural households showed that 60 per cent of the farmer-households did not access any information on modern technologies in India. In a study it is found that: (i) one-third of the farmers obtained extension services from progressive farmers and input dealers, (ii) about 29.3 per cent farmers used radio, television and newspapers, (iii) the contribution of public sector extension system is about 10 per cent, and (iv) only 0.6 per cent of the farmers was accessed private and NGO extension services. The proximity (33.7%), assured quality (21.1%), sole option (20.6%), and timely availability (13.7%) were the main reasons for the choice of such information (Babu *et al*., 2012). In another study it is also found that the service delivery by public-sector extension workers was lowest for small farmers (4.8%) compared to large farmers (12.4%) (Adhiguru *et al*., 2009). Particularly, with the development of new technologies our agricultural extension system faces important challenges in the areas of relevance, accessibility, accountability, efficiency and sustainability.

Several studies have been made to establish the relation between the income and education both in India as well as outside India. As far as India is concerned, there are some studies which are based on NSSO data (Duraisamy 2002; Dutta 2006; Kingdon

and Theopold 2008; Madheswaran and Attewell 2007). Studies suggest returns to education are higher for lower levels of education (e.g., primary) and decline with the level of education. This is due to the low cost of primary education relative to other levels of education and considerable productivity differentials between primary graduates and illiterate persons. But in this study an attempt has been made to show the impact of education among the rural people and to substantiate the role of education as well as agricultural training for the improvement of the productivity and earnings among the people engaged in agricultural activities in West Bengal.

The role of education is considered to be important for earning higher income level. But the impact of education is not the same among the agricultural and the non-agricultural sector. So when it comes to education the important thing which is important to understand is that whether it is increasing the earnings for all the sectors or it is paying attention to some specific sector. If education does not increase the earnings of the agricultural workers then investment in education is not viable for the people who are engaged in the agricultural sector. On the other hand, if it is increasing the level of earnings then what level of education is contributing the most is important question. Moreover, not only education but useful and effective training in agricultural practice as well as the management of the sustainability of the same is also very important.

IV. Data and Methodology

The study is based on secondary data collected from different government sources like the National Horticultural Board, National Sample Survey Organisation, Government of India and Bureau of Applied Economics and Statistics, Govt. of West Bengal. To assess the impact of education on income of rural agricultural households in West Bengal we have considered unit level data extracted from the 70th round of NSS on Situation Assessment Survey (SAS) of Agricultural Households, 2013.

We have considered the people engaged in agricultural activities residing in the districts of Darjeeling, Jalpaiguri, Koochbihar, Uttar Dinajpur, Dakshin Dinajpur, Maldaha, Murshidabad, Birbhum, Barddhaman, Nadia, North 24 Pargana, Hugli, Purba Midnapore, Paschim Midnapore, Bankura, Puruliya and Howrah. The target group of the study is basically the rural people engaged in agricultural activities of West Bengal.

For estimation of the returns to education we have taken two groups where the first group consists of the people who worked in household enterprise (self-employed: own account worker, employer, worked as helper in household enterprise (unpaid family worker), worked as regular salaried/ wage employee, worked as casual wage labour: in public works other than MGNREGA works, in MGNREGA works and the people who worked in other types of work. Since the study is based on the rural people of the districts of West Bengal as a result the study is basically of the agrarian people. The sample size

for the first group includes 1609 persons. The second group of the sample includes the people who are regular wage or salaried people only. This is a homogeneous group consisting of people with agricultural background. The sample size is small with a number of observations equal to 477.

For the estimation of rate of returns to education on earnings from the agriculture we have used the earnings function method (Psacharopoulos 1981, 1994). As the elaborate method requires entire information regarding age-earnings as well as cost of education profiles by educational level, the elaborate method (Becker, 1964) is not used. This study estimates returns to education based on the earnings function method, which is also known as human capital earnings function or 'Mincerian' method of the people engaged in agricultural activities. An interesting aspect of Mincer's model is that the time spent during schooling is a key determinant of the earnings. The basic 'Mincerian' earnings function (Mincer, 1974) is given as:

$$\ln Y_{ij} = \beta_0 + \beta S_{ji} + \mu_1 E_i + \mu_2 E^2_i + u_i$$

The dependent variable used in the analysis of the study is log of income and the independent variable incorporating the human capital variable can be extended by levels of education of the rural people where dummy variables are used for different levels of education using standard Mincerian earnings function named after Jacob Mincer.

Model Specification:

$$\ln Y_{ij} = \beta_0 + \sum \beta_{ji} S_{ji} + \mu_1 E_i + \mu_2 E^2_i + u_{i,}$$

S_{ji}= ith individual completing jth level of education, E= Potential Expererience in the labour market, E^2_i =Squared term of potential experience of the labour market where potential experience is defined by the difference between age and years of schooling less 6 i.e the age at which a person gets enrolled in school.

This model is purely a model of heterogeneous model of returns to education (Stearns, 2000) since the level of earnings is different for different level of education and education is not treated as continuous variable rather discrete. So, with the growth of level of education the benefit of education also goes up.

However, we also want to check the impact of some demographic factors as well as social characteristics and the impact of migratory trend for those who have spent at least 15 days continuously outside their native land, locational effect reflected by region (dummy variable) and finally impact of agricultural training on the level of income. So, the equation becomes

$$\ln Y_{ij} = \beta_0 + \sum \beta_{ji} S_{ji} + \mu_1 E_i + \mu_2 E^2_i + \mu_3 G_i + \mu_4 T_i + \mu_5 M_i + \mu_6 R_i + u_{i,}$$

G_i= Gender male or female, T_i= Trained or Untrained, M_i= Migrating outside the native land

R_i= Region whether Gangetic West Bengal or Non-Gangetic West Bengal (including terai and Jungle Mahal economy).

The equation shows that the log of income depends on the educational level of individuals, experience, squared experience, Gender, Training obtained, Staying pattern of the individual and finally the Region.

In this context, it is important to understand the geographical diversity of West Bengal since we are concentrating on the rural people and mostly on the households who are engaged in agricultural activities. So, the topography of the area under study is important. As a result a dummy variable is incorporated which is denoted by R_i and it takes the value 1 for the districts which belong to gangetic West Bengal and takes the value 0 for the districts which are under terai, dooars and jungle mahal more precisely non-gangetic part of West Bengal. The gangetic part of West Bengal is fertile and the productivity of agricultural crops is more compared with the non-gangetic part of the state. So the coefficient of R_i represents the differential effect due to location.

Similarly, the co-efficient of gender represents the differential effect of being male or female, the co-efficient of training represents the differential effect of being trained and finally the co-efficient of the variable M_i represents the differential effect of staying outside the native land for more than 15 days.

In the next segment a comparative analysis is done regarding the mean earnings of the people of the representative districts. Also, there is availability of data regarding the individuals training in agricultural activities and motivation towards migration. An attempt has also been made to capture the relationship between training in agricultural activities and motivation towards migration and their impact on income. The table (Table A) below describes the nature of the variables used for regression.

Table1: A Description of Variables

Variable	**Description**	**Base Category**
	Dependent Variable	
Log wage	Natural log of wage in Rs to estimate the earnings function.	None
	Explanatory (Independent)variables	

Human Capital Variables		
Educational Level	An individual belongs to one of the following educational level: illiterate and literate below Primary, Primary, Secondary, Higher Secondary and Graduate & Post Graduate. It is assumed that an individual spends 0, 4, 6 , 2, 3 and 2 additional years respectively in these educational levels. (5 Dummies: Primary, Secondary, Higher Secondary, Graduate & Post Graduate)	Illiterate and literate below primary (S_{ji}=0)
Experience (E)	Potential experience (Proxy for actual labour market experience) in years is defined as age minus years of schooling minus 6	None
Experience^2 (E^2)	Square of experience	None
Demographic Variables		
Gender	Sex of Individual (Male or Female) Dummy Variable	Female (G_i =0)
Regional	Place of Residence: Gangetic West Bengal Versus Non-Gangetic West Bengal (Terai, Dooars and Jungle Mahal Economy), Dummy Variable.	Non-Gangetic West Bengal (=0)
Training	Agricultural training taken by individuals versus untrained, Dummy Variable	Untrained (T_i =0)
Stayed outside	Stayed outside for at least 15 days, Dummy Variable	Stayed inside (M_i =0)

Semi logarithmic regression equation is used to estimate annual average compound growth rate of the relevant variables in the study.

V. Results & Discussions

Horticulture is a subset of agriculture sector which covers wide varieties of crops from vegetables, fruits, and flowers to spices, honey and different plantation, aromatics and medicinal crops and plants. It is a rapidly growing sector in the country. The National Horticulture Mission scheme has been launched in 2005-06 for the holistic growth and development of horticulture sector. The area under horticulture crops in India has increased from 18.5 million hectare in 2005-06 to 24.9 million hectare in 2016-17 with a

growth rate of 2.9 per cent per year and the corresponding horticulture production has increased at the rate of 6.7 per cent per year; from 166.9 million MT to 300.6 million MT during the same period. The growth rates of exports of fresh vegetables, fresh fruits and floriculture in value terms are significantly high of 9.03%, 15.31% and 5.64% respectively as compare to the overall growth of India's agri-exports (2.37%) during 2011-12 to 2017-18.

It is proud of us that India has secured 1st position in the production of Okra, Banana, Mango, Mangosteen, Guava and Papaya among the countries in 2014 Therefore, it is a bright side from the production point of view. But, if we examine data on land productivity of vegetables and fruits, it can be said that the Indian horticulture productivity is quite low in compared with that of the other countries (Figure 1). India's vegetables productivity is found to be 14.87 tonnes per hectare while the said productivity in USA is 33.30 tonnes per hectare. In China it is also quite high of 24.04 tonnes per hectare as compared to India. Thus, there is great potentiality to improve productivity of Indian horticulture. So, the prospect of Indian agriculture lies in the improvement in yield rates of different crops. Education, training, agricultural extension services etc. are the crucial inputs for growth and development of modern agriculture in India.

Table below shows the growth rates of traditional principal crops and horticulture crops (vegetables and fruits). It reveals that the growth rates of traditional crops are estimated to be less compared with the horticultural crops during 1961 to 2016. Secondly, among the horticultural crops, if we compare the pre- and the post- reform periods, the rate of growth of horticultural crops is observe to be greater in the post-reform period than in pre-reform period which implies prospects of horticulture sector in India.

Table 2: Growth rates of Area and Production of different crops in India, 1961-2016.

	AACG	AACG	AACG
Growth of Area & production	1961-1990	1991-2016	1961-2016
Crops	Pre-reform	Post-reform	Total
Paddy area	0.63	0.06	0.41
Paddy production	2.67	1.43	2.31
Wheat area	2.50	0.93	1.47
Wheat production	6.22	2.03	4.06
Fruits area	1.85	4.01	2.91
Fruits production	2.55	4.57	3.65

Vegetables area	2.05	2.61	1.79
Vegetables production	3.47	3.88	3.43

Note: a=Area in 000 hectare and p=Production in 000 tonnes. AACG = annual average compound growth rate (%).Source: FAO Data base.

Therefore, the major concern is to find out the factors which are responsible for the development of the people engaged in the agricultural economy in India. Diversification of agriculture in favour of horticulture has great potentiality to proper use and management of agricultural resources. The management of human and physical sources and effective optimisation techniques and policies might increase the productivity. In the present context of knowledge-driven agriculture, the impact of education is therefore needed to be carefully analysed.

West Bengal in Indian Horticulture

Vegetables occupy a prime place in West Bengal horticulture. The area under vegetables is about 76 per cent of total area of horticulture in West Bengal followed by fruits area (13 per cent), and flowers (2 per cent) in triennium crop year ending of 2016-17. Others horticulture plantations and crops share about 9 per cent of total horticulture area. In India, the shares of vegetables, fruits, and flowers in total area under horticulture are 41 per cent, 26 percent and 1 percent respectively in 2016-17. Area and production of vegetables, fruits and flowers in West Bengal vis-a-vis India during last six years are depicted in Table 5.2. Total area under horticulture in West Bengal increases from 1720.2 thousand hectare in 2011-12 to 1838.2 thousand hectare in 2016-17; total production increases from 27029 thousand tonnes to 30008.2 thousand tonnes. The annual average compound growth of area and production of total horticulture crops in West Bengal is estimated as 1.43 per cent for area and 1.28 per cent for production during the last six years. The corresponding horticulture growth rates of area and production are 1.14 per cent and 2.84 per cent respectively in India.

Recently, West Bengal has achieved an impressive growth in area and production of fruits. The area under fruits in West Bengal increases monotonically from 216.6 thousand hectare in 2011-12 to 253.0 thousand hectares in 2016-17 with a growth rate of 3.38 per cent per year during 2011-12 to 2016-17, while in all India level there is a negative growth of area under fruits (-2.06 per cent per year) during the same period of time. Among the leading states in respect of fruits, the position of West Bengal is 12th rank in area, 9th rank in production, and 9th rank in land productivity of fruits in 2016-17. Top-3 fruits producing states are Andhra Pradesh, Maharashtra, and Uttar Pradesh.

West Bengal has occupied first position consistently among Indian states in terms of area under vegetables till 2015-16. In 2016-17, West Bengal ranks second next to Uttar Pradesh in terms of both area and production of vegetables. In terms of land productivity of vegetables, the performance of West Bengal is not satisfactory; ranks 10th among the states. High productivity of vegetables states are Tamil Nadu, Andhra Pradesh, Jammu & Kashmir, and Himachal Pradesh. Vegetables production in West Bengal increases from 23.4 million tonnes in 2011-12 to 25.5 million tonnes in 2016-17. The corresponding figures for India are 156.3 million tonnes in 2011-12 and 178.2 million tonnes in 2016-17. West Bengal has contributed a significant share in all India vegetables; on an average, it shares 15% of production and 14% of area of all India vegetables (Table 5.4). Recent growth rates of area (0.88%) and production (0.67%) of vegetables in West Bengal are found to be lower than that of all India growth of area (2.74%) and production (2.37%) of vegetables during 2011-12 to (Table 5.3).

Table3: Percentage share of West Bengal in All India Horticulture Area and Production

		West Bengal's Contribution (%) in All India						AACG
Crops		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	**(%)**
Fruits	A	3.23	3.16	3.10	3.74	3.96	3.97	**5.55**
	P	4.00	3.90	3.27	3.83	3.90	3.86	**-0.07**
Vegetables	A	14.81	14.64	14.69	14.54	13.77	13.55	**-1.81**
	P	14.98	15.70	14.15	15.55	13.50	14.32	**-1.66**
Flowers	A	9.43	10.49	9.74	10.19	9.23	8.50	**-2.42**
Loose	P	3.87	3.77	3.79	4.11	4.20	4.19	**2.35**
Cut*	P	33.36	33.14	26.76	30.57	37.35	29.09	**4.61**
Total Horticulture	**A**	7.40	7.35	7.35	7.65	7.51	7.40	**0.28**
	P	10.51	10.86	9.62	10.82	9.52	9.98	**-1.51**

Note & Source: Same as Table 1.

West Bengal is one of the leading flower producing states in India. It ranks top position in production of cut flowers; more than 30% share is contributed by West Bengal in India. In terms of production of loose flower West Bengal occupies 3rd position after Tamil Nadu and Karnataka. In terms of area under flowers, West Bengal rank is 5th highest

(contributed 8.5% of total area under flower in India) in 2016-17 and other leading states are Jammu & Kashmir, Karnataka, Tamil Nadu, and Kerala.

Table 4:Productivity (MT/Ha.) of horticulture crops in West Bengal & India

Crops	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	
West Bengal	**West Bengal**						**AACG**
Fruits	14.1	14.4	13.0	14.5	14.1	14.2	0.22
Vegetables	17.6	18.9	16.7	19.0	16.4	18.4	-0.21
Flowers (Loose+Cut)			8.5	8.5	10.4	10.5	8.53
Total Horticulture	15.7	16.8	15.0	17.0	14.8	16.3	-0.15
India	**India**						
Fruits	11.4	11.6	12.3	14.2	14.3	14.6	5.85
Vegetables	17.4	17.6	17.3	17.8	16.7	17.4	-0.36
Flowers (Loose+Cut)			9.0	8.6	7.9	7.8	-5.06
Total Horticulture	11.1	11.3	11.5	12.0	11.7	12.1	1.67
Productivity Index= (Yield in West Bengal/ Yield in India)*100							
Fruits	123.7	124.1	105.7	102.1	98.6	97.3	
Vegetables	101.1	107.4	96.5	106.7	98.2	105.7	
Flowers (Loose+Cut)			94.4	98.8	131.6	134.6	
Total Horticulture	141.4	148.7	130.4	141.7	126.5	134.7	

Source: NHB, GOI.

Table 4 depicts land productivity differentials in horticultural crops in West Bengal in relation to all India average productivity. It is observed that land productivity of total horticulture in West Bengal is higher than the National average productivity during 2011-12 to 2016-17; value of productivity index for West Bengal is being greater than 100 in

each year. But there are year-wise fluctuations in land productivity both in West Bengal as well as in India. As a whole productivity of horticultural crops decreases in West Bengal during 2011-12 to 2016-17; in India it is increasing. Land productivity of fruits and flowers increases and productivity of vegetables decreases in West Bengal. In all India level, fruits productivity increases but productivity of vegetables and flowers decreases during the same period of time.

V.2 Education & Earnings

V.2.1: Analysis of Descriptive Statistics

An analysis of aggregated NSSO data (Table 5.6) reveals that average monthly income and consumption expenditure per agricultural households are Rs. 6426 and Rs.6223 respectively in India during the latest agricultural survey year of 2012-13. The said figures for West Bengal are found to be lower than the national average. In West Bengal, average monthly income and consumption are estimated as Rs. 3980 and Rs 5888 per agricultural households respectively. Table 5.7 depicts Net attendance ratio for different levels of education by sex in rural West Bengal vis-a vis rural India. It reveals that performance of West Bengal in terms of extent of education (net enrolment ratio and female education) in rural areas is above the national average. Thus, it is very difficult to draw any conclusion regarding the relationship between education and earnings in rural areas based on aggregated data.

Regarding agricultural extension services to farmers it is observed that about 50.6 per cent of the agricultural households accessed technical advices in the field of agriculture from any agencies/ sources in West Bengal, while at the all India level, it is 40.6 per cent of the cultivating households during the period of July, 2012- December, 2012 (Table 5.8). In West Bengal, the major sources accessed by the agricultural households for access to modern technology and technical advices are Progressive farmers (26.4%), Private Commercial agents (21.3%), and Radio/ TV/newspaper/ internet (20.4%). Only 3 per cent of them reported that they have accessed technical advice from extension agent in West Bengal which is below the national average figure of 6.2 per cent. The contribution of Krishivigyan Kendra in this respect is only1.5 per cent in West Bengal and 2.7 per cent in India. Private Commercial agents play important role in this regard in West Bengal as compare to all India level. However, farmers' access to modern technology and technical advices in the field of agriculture is a very important aspect for sustainable management of farming practices which positively affects the preferences and practices of the farming community towards better output and income from agricultural activities. As per NSS report more than 90 per cent agricultural households found such technical advices useful in India.

Table 5: Per 1000 distribution of agricultural households having accessed technical advice by source

(during July, 2012- December, 2012)

Source	West Bengal	Al India
Extension agent	30	62
Krishivigyankendra	15	27
Agricultural university/college	4	12
Private commercial agents (including drilling contractor)	213	74
Progressive farmer	264	200
Radio/tv/newspaper/internet	204	196
Veterinary department	59	80
NGO	6	12
Any agent	**506**	**406**

Source: NSS Report No.573: Some Aspects of Farming in India, 2012-13

We have used NSSO unit (individual) level data to examine the relationship between education and earnings from farming in West Bengal. We have estimated returns to education in rural areas. The Figure 7 shows the estimated average earnings of the rural people engaged in agricultural activities. It varies greatly across districts in West Bengal. It can be said that the income of the agrarian people in these regions differ considerably. The districts which fall under gangetic part are Maldaha, Murshidabad, Nadia, Birbhum, Hooghly, Bardhaman, Howrah, North 24 Pargana and South 24 Pargana. These districts are adjacent to the river Bhagirathi flowing toward the Bay of Bengal. The districts which are less productive and suffer from low productivity of agriculture are: Purulia, Bankura and Paschim Midnapore (belong to Jungle Mahal), Dakshin Dinajpur, Darjeeling, Koochbihar and Jalpaiguri (belong to terai and dooars). The districts with lower productivity have mean earnings below the state average level of income and those with higher average earnings have higher productivity.

Table 6: Mean and standard deviation (SD) of the variables used for regression analysis

Variables Used	Mean and(S.D) (for Total Rural Workers) N= 1609	Mean and (S.D) (for Regular Rural Workers) N=477
Earnings	20997.1 (29992.29)	43502.58 (46223.41)
Years of Schooling	6.13 (5.14)	9.42 (5.33)
Primary	0.28 (0.45)	0.16 (0.37)
Secondary	0.27 (0.44)	0.28 (0.45)
Higher Secondary	0.06 (0.23)	0.13 (0.34)
Graduate	0.07 (0.26)	0.21 (0.41)
Post Graduate	0.02 (0.14)	0.06 (0.24)
Stayed outside	0.12 (0.32)	0.54 (0.22)
Trained	0.02 (0.15)	0.02 (0.16)
Spatial	0.66 (0.47)	0.71 (0.45)
Gender	0.84 (0.36)	0.77 (0.41)
Experience	24.25 (14.22)	22.11 (12.81)
Experience Square	790.53 (805.54)	653.05 (630.42)
Age	36.39 (12.65)	37.54 (11.41)

Calculated on the basis of the unit level NSSO data (2012-13)

It is observed from the analysis of descriptive statistics shown in Table 5.9 that the mean earning is higher (more than double) for those who are regularly employed in comparison with the total rural workers. The average years of schooling is less for the total workers (6.13 years) in comparison with the regular rural workers (9.42 years). The human capital variables used in the model for both the categories interestingly shows that the mean values for the total workers decrease with level of education but the mean values of the regular workers rise with level of education in comparison with the total workers. About 28% people of the total worker are primary educated whereas about 16% people of the regular workers are primary educated. If we consider the Secondary education, 27% people are educated in the total worker category whereas out of the regular workers 28% people fall in this category. Moreover, for the educational level of Higher Secondary education, only 6% are in the total workers category but 13 % fall in the regular workers.

Similar pattern is observed for Graduate and Post Graduate category. Out of the total workers 7% are Graduate and 2 % are Post Graduate whereas in the regular workers category 21 % are Graduate and 6% are Post Graduate. So, it can be said that the regular workers have higher propensity to invest in education and as a result increase the probability of being employed round the year even in the unorganised sector like agricultural economy in West Bengal. The mean value of the persons in the total workers category who have migratory trend is less than the regular worker category but the proportion of people taking training related to agriculture is same for both the categories. More regular workers reside in the gangetic West Bengal than the total workers. The mean value of experience is less for the regular workers in comparison with the total workers but the mean age is less for the total workers in comparison with the regular workers.

V.2.2 Analysis of regression results.

The table 5.8 shows the OLS estimates of the regression equation mentioned above. The OLS estimation shows that the value of R^2 is higher for the people who were regular wage employed. The first sample consists of the explained variables such as level of schoolings like primary education, secondary education, higher secondary education, graduate, post graduate all are positive and statistically significant at 1% level of significance for almost all the level of education both in the overall rural people category and the people who were regular wage employed. The difference is that for the later the estimate is robust because it consists of a homogenous group. Moreover, the estimates of the variables like experience and squared experience also show the desired sign. A positive sign on experience implies that income goes up with years of experience which is the proposition that skill increases dexterity and thereby productivity. Moreover, the squared experience negative implies that there is monotony in the same work and thereby productivity goes down. In both the samples the desired signs are observed and are statistically significant. It is observed that the earnings reach maximum when the experience is 31 years. The gender dummy captures the wage differential between male and female which also shows the desired sign i.e male workers are paid more than the female workers.

Table 7: Ordinary least Square Estimates of the Regression equation

	All Workers	**Regular Workers**
	R^2=0.25	**R^2=0.34**
	N=1609	**N=477**
Dependent Variable:- Log Income	**F=(11,1597)=49.19**	**F=(11,465)=22.12**
Explanatory Variables	**Co-efficient**	**Co-efficient**
	(p-value)	**(p-value)**

Primary	0.105	0.36
	(-0.100)	(-0.010)
Secondary	0.391	0.88
	(0.000)	(0.000)
Higher Secondary	1.11	1.33
	(0.000)	(0.000)
Graduate	1.53	1.63
	(0.000)	(0.000)
Post Graduate	2.01	2.01
	(0.000)	(0.000)
Experience	0.05	0.05
	(0.000)	(-0.004)
Experience^2	-0.0008	-0.0008
	(0.000)	(-0.029)
Gender	0.33	0.33
	(0.000)	(-0.001)
Trained	-0.15	0.27
	(-0.320)	(-0.270)
Stayed outside Native land	0.14	0.16
	(-0.050)	(-0.030)
Regional	0.13	0.18
	(0.000)	(-0.040)
_Cons	8.06	7.758
	(0.000)	(0.000)

Calculation is Based on NSSO data 2012-13

In both the samples the results are statistically significant. The dummy variable capturing the effect of obtaining training is negative insignificant indicating that formal training is not sufficient to increase the earnings of the individual. Also, the dummy variable stay-

ing outside captures the indirect effect of increasing wages. The indirect effect of staying outside the native land for more than 15 days creates the opportunity for gaining some quality in earning more. However, the direct impacts of basic skills should not be underestimated. Under certain circumstances, just being able to calculate, read and write provides opportunities for the performance of a more lucrative work. However, if the young generation starts to move towards city or migrate towards other areas then the earnings tend to increase which is observed for those who have stayed outside their villages for more than 15 days or like that implying that these labour force has alternative usage to increase the overall productivity of the economy rather than remaining idly in the rural areas. Thus, regression results summarise the following observations:

1. The overall model is significant as the "F" pertaining to each category is significant. The value of R^2 is 0.25 for the total workers and it is 0.34 for the regular workers.
2. The human capital variables are positive and highly significant indicating a direct relationship between education and earnings for both the total workers in the rural area and the regular workers in the rural area. Moreover, as the level of education goes up, the magnitude of the co-efficient also goes up for both the categories though the impact of education on earnings increases with level of education more for the regular workers category.
3. The variable gender is positive and significant indicating that the income of the male workers is upward biased for both the category of workers with same magnitude.
4. The variable for training is not significant for both the category of workers. In case of total workers, the co-efficient is negative. However, for the regular workers it is positive but insignificant. So, the training of the agricultural workers is not up to the mark.
5. The variable representing migratory trend from rural area is positive and highly significant for both the category of workers but the impact of migration increases income for the regular workers more compared to the total workers. In fact, those who get employment opportunity more have a propensity to stay outside the native land in compared to those who are occasional employment.
6. The most important variable is the regional variable in the context of agriculture in West Bengal and it is positive and highly significant for both the category of workers. However, the magnitude for the regular workers residing in gangetic West Bengal is higher in comparison with the total workers.

7. The income of the people belong to rural workers is maximised when the experience is 31 years. This can be calculated by using the formula $-(\mu_1/2\mu_2)$ following the study by Agarwal (2011).

The Table 8 shows the differential effect of the dummy variables used in the model. According to Halvorsen and Raymond (1980) for the interpretation of dummy variables in a semi-logarithmic equation, the differential effect is captured, since the dependent variable is in the logarithmic form, the coefficient of dummy variable is adjusted by $\{e^{(\text{co-efficient})} - 1\}$. The estimates shown in the table 5.11 suggest that a person (belong to the group total rural worker category) who is primary educated earns 11.07 % more than the illiterate people for the same category. Similarly, with the increase in level of education a person belonging to secondary education earns 47.84 % more than primary educated and so on. A male worker earns 39.09 % more than a female worker. If a worker is staying outside then he is earning 15.02 % more than the person living in the native land. Finally, a person living in the Gangetic West Bengal is getting 13.88 % more than the people living in non-Gangetic West Bengal. The same comparison can be done for the regular workers also. The same trend is observed for the regular workers also but the only difference is that they earn more than the total workers category.

Table 8. Differential effect of dummy variables in Semi logarithmic regression equation

Level of Education	Total Rural Workers	Regular Rural Workers
Primary	0.11	0.43
Secondary	0.47	1.41
Higher Secondary	2.03	2.78
Graduate	3.61	4.10
Post Graduate	6.46	6.46
Sex	0.39	0.39
Trained	-0.13	0.30
Stayed outside Native land	0.15	0.17
Regional	0.13	0.19

Calculated on the basis of the estimates of the OLS estimation

V.3.3 Marginal Returns to Education

From the OLS estimation mentioned above we will see the private returns to education which is the per year returns to education from individual point of view for investing one more year in education can be calculated by the following formulae Psacharapolous (1994): $r_2 = (\beta_2 - \beta_1)/\Delta n2$ is the marginal rate of returns to education per year. Here β_2 is the estimate of the co-efficient of 2nd level of education β_1 is the estimate of the co-efficient of the 1st level of education and $\Delta n2$ is the additional year of schooling for completing level 2. Finally, r_2 is the private returns to education for 2nd level of education. Thus, the marginal returns to education can be calculated using the above formulae for each level of education. The table below shows that the private returns to education has increased from primary education to secondary education and from secondary education to higher secondary education in an increasing rate for both the all rural workers (taken together) and for the regular rural workers. But thereafter, the marginal return to education for graduate level has fallen and finally it has increased for post graduate level. The interesting thing is that it has happened for both the type of workers. The only difference is that the returns are higher in lower level of education for the workers who are regular workers as compared with the all rural workers. The returns to higher secondary onwards the returns have drastically fallen for the regular workers in comparison with the all rural workers. The estimates are upward biased for the people in the overall category and even lower for the regular wage salaried people since they get work on regular basis their urge of studying more gets down as they have to forego the present earnings and there is uncertainty regarding job in the future in the rural area. This also leads to higher drop out ratio for higher education in rural West Bengal.

The marginal returns to education per year of education are higher for regular salaried workers in comparison with all workers for primary and secondary level only. Thereafter with the increase in level of education from Higher Secondary to Post Graduate it is less for the regular workers in rural West Bengal. The possible reason behind this might be those who are regular workers find it difficult to continue education as well as work. Alternatively, it is also true that since the all workers are heterogeneous, outcome changes with level of education. Therefore, as far as policy prescription is concerned, on the job training as done in the organised sectors does not cope up with the same yield in the unorganised sector. So the impact of training on farm income of the people engaged in agriculture is insignificant in rural West Bengal. Moreover, it is observed that only 2.3 % of the regular workers and 2.7 % of the total workers have taken training. Therefore, more and more people have to be trained in the agricultural sector so that with proper training they come under an umbrella of equity.

VI Conclusions and Policy prescriptions

Diversification of agriculture towards horticulture is important for sustainable use and management practices of agricultural resources in India. India has occupied 2nd position in the production of world horticulture. In production of some horticultural crops like banana, mango, papaya and Okra the position of Indian horticulture is the highest in the world. Indian horticulture has great potentiality to absorb labour force and to enhance income from farming. Compared to the production of traditional principal crops (paddy-wheat), the production of horticulture crops has been growing faster annually. Moreover, the rate of growth of horticultural products has been accelerated in the post reform era. The contribution of West Bengal horticulture in all India level is very significant. The rate of growth of production is highest for fruits in comparison with the vegetables and flowers in West Bengal. So, diversification of crops in favour of horticultural crops is required in India and for West Bengal; more emphasis should be given towards the production as well as marketing of fruits, vegetables and flowers to ensure management sustainability and profitability of Indian agriculture. Education, training and extension services are the crucial inputs of modern agriculture. Role of education in agricultural sector has significantly positive impact in West Bengal. The study reveals that education has positive impact on the level of earnings from agriculture for both the categories of workers i.e., the total workers and the regular workers. The level of education along with the other explanatory variables explains the Mincerian model more precisely for the homogenous group of workers who are regular. There is wage disparity in favour of male workers as compared with the female workers. So, policies should be taken to empower the female workers for sustainability in agrarian economy. Training in agricultural activities shows desired sign for the homogeneous group i.e., training increases the farm income though it is statistically insignificant. There is regional disparity in the income of agricultural households in West Bengal may be due to diversified agro-climatic conditions and differences on farming practices across districts. People who have migratory trend earn more than others. An adoption of appropriate labour management practices in Indian agriculture is also required. Therefore, as a whole it can be concluded that education and training plays an important role in modern agricultural practices and sustainable management of agri-business. Education planning and manpower planning should be integrated with economic planning to achieve sustainable economic development and management practices in agriculture. The following suggestions are important for increasing employment and sustainable income of Indian farming community.

1. There is an urgent need of educational reforms to change the system of education and training in favour of work conditions and increase productivity.
2. Farmers accessibility to Government Agricultural extension services should be improved for sustainable management and farming practices in India.

3. Farm and non-farm employment opportunities should be created through diversification of agriculture in favour of horticultural crops and marketing management of horticultural products.
4. Emphasis should be given on efficient use of agricultural resources, particularly on land and water.
5. A system should be developed to improve agricultural labour management information for manpower planning and sustainable agricultural development.

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