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Focus

Ensuring Clean Water Accessibility and Mitigating Water Induced Disasters—Contributing Towards Sustainable Development Goals

R. B. SINGH

India has occupied 4 per cent of fresh water resources, 2.4 per cent of total geographical areas and 17 per cent population in the world. This imbalance further results into crisis in securing water to its rapidly growing population. Situation of water resource degradation is complex in India. There are huge potential of water resources, which are facing the challenges in the form of conflicts arising out of poverty, population growth and careless application of technology together with water induced disasters. Development activities should be implemented but not at the cost of degradation of the water. Water environment sustainability should be achieved through afforestation for the soil moisture, restore the natural water storage sites like wetlands, lakes and ponds, etc., linking rivers of water surplus and water deficit areas within states, selection and growing of the crop according the availability of water in the area, installation of more and more treatment plant for recycling of waste water and proper mechanism for the treatment of disposable industrial waste and wastewater reuse. This paper aims at identifying critical issues, challenges and innovative solution in order to contribute to the UN Sustainable Development Goal 6, that is, Clean Water and Sanitation.

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Introduction

The Sustainable Development Goals (SDGs) address water security through Goal 6 which aims to ensure water and sanitation for all. India has in its possession 14 major, 55 minor and 700 small rivers which are considered as the backbone of the Indian economy, serving potable water, electricity and livelihoods to millions of people. But pollution and improper utilization of river water has resulted into water crisis in India. One-third of India's districts are affected by severe drought, affecting some 330 million people in 256 districts in 10 states. One thousand villages in eight districts of Gujarat are suffering from acute drinking water crisis. In India, despite considerable progress, a large number of people are found without having access to drinking water estimated at 75.78 million (Table 1). By 2050, there will be 50 per cent gap between water demand and supply. The World Health Organization estimates that around 97 million of India's population suffers due to lack of access to safe water today, second only to China. On the basis of available facts, the World Bank estimates

Table 1: Access to Safe Drinking Water and Improved Sanitation in Emerging Economics (per cent)

Country	Drinking Water	Sanitation
India	89	28
Brazil	91	77
China	88	65
Mexico	95	81
South Africa	93	59

that 21 per cent of communicable diseases in India are water-borne diseases.

In many states, farmers have killed themselves due to drought and debt since January 2015. In Gujarat, about 1,000 villages in eight districts are suffering from acute shortages of drinking water. Latur in Marathwada region of Maharashtra is worst affected by severe drought condition. The districts of Bundelkhand region across Madhya Pradesh and Uttar Pradesh are affected with the third consequent drought in a row, resulting into 50 per cent of its water resources being dried up. Four major reservoirs in Hyderabad city have dried up. Shimla, Himachal Pradesh, is facing a problem of contaminated drinking water supply which has resulted into jaundice outbreak. Cities like Pune, Maharashtra, are relying on water tankers to meet the increasing demand of water. Industrial shutdowns have been recorded due to acute shortage of water in many areas of country.

Drinking Water: Availability and Accessibility

Drinking water is intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption. It has characteristics like odourless, tasteless, colourless, absence of impurities (e.g., microorganism, hardness), pollution free, balance oxygen and balance dissolved salts. About 80 per cent of fresh surface water and 60 per cent of ground water has been used by the agriculture sector. More than 8 per cent of fresh water and 10 per cent of the ground water is used by industrial sectors. Water demands of both sectors are projected to attain heights in coming future. The third major demand of water after agriculture and industry is for domestic purposes in cities and villages, which has shown a sharp increase but the supply has not grown at the same rate. Most lakes are contaminated and rivers are polluted due to sewerage in Indian cities. Ground water extraction is higher than the recharge rate due to irrational pumping of ground water. Urban water bodies are also degraded due to the continuous growth of the aquatic weeds results from disposal of industrial waste and domestic waste.

Uncertainty and erratic behaviour of the monsoon further intensifies the easy availability of fresh water. The total estimated quantity of utilizable groundwater resource is around 433 BCM where 90 per cent of rural and more than 50 per cent of urban water supply are met from groundwater. Around 21 million of groundwater extraction structures with estimated 221 BCM of withdrawal pose a direct threat to the availability of groundwater and its quality. The major problem comes with unchecked withdrawal of ground water for agricultural practices where it is needed to have a sustainable solution in securing ground water resource for its multipurpose usage. India's average annual precipitation is around 4,000 BCM with average annual utilizable water of 1,123 BCM meeting the requirement of 690 BCM from surface and 433 BCM from ground water (BCM = billion cubic metre is assessed as the average annual utilizable water). Our nation's present total water use is 634 BCM, out of which 83 per cent is used for irrigation. This is projected to grow to 813 BCM by year 2010 and 1,093 BCM by 2025. At present ground water draft is 230.6 BCM out of which 213 BCM is used for irrigation and 18 BCM for domestic and industrial uses. By 2025 demand for domestic and industrial uses is projected to rise by 29 BCM from the current level of 18 BCM (Table 2, Figure 1).

Water security can be achieved by the adoption and implementation of important steps at ground level (Figure 2).

Mitigating Water-induced Disaster—Key to Sustainability

Table 2: Water Characteristics in India

Annual Rainfall	**1,208 mm**
Major River Basin	12
Medium River Basin	46
Annual Average Precipitation	4,000 BCM
Average Precipitation during Monsoon (June–September)	3,000 BCM
Estimated Utilizable Surface Water Resources	690 BCM
Total Utilizable Groundwater Resources	433 BCM
Per Capita Water Availability	1,720.29 BCM

Source: Khurana et al., 2015.

India is becoming increasingly vulnerable to natural disasters. Nearly three million people worldwide may have been killed in past 20 years due to natural disasters. Ninety per cent of the natural disasters and 95 per cent of the total disaster related deaths worldwide occur in developing countries in which India has the second largest share. Of the total geographical area, 85 per cent of India's land is prone to various kinds of disasters. Around 68 per cent of cultivable area is prone to drought and 8.5 per cent of

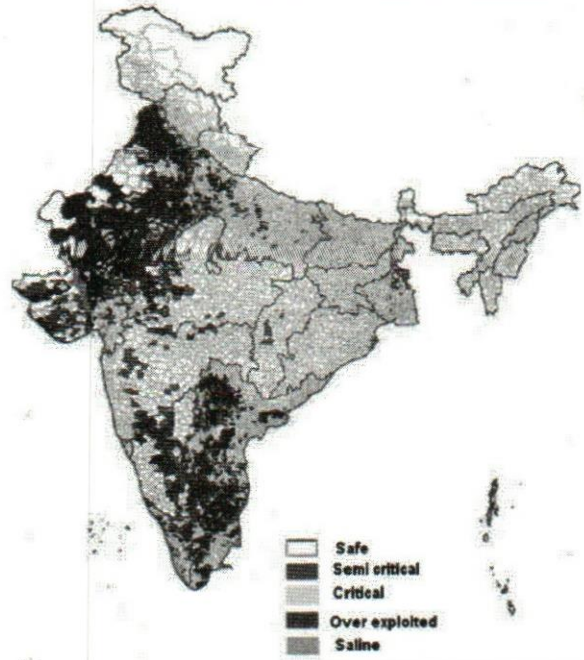

Figure 1 : Ground Water Development Index

Source: Planning Commission (India) (2007).

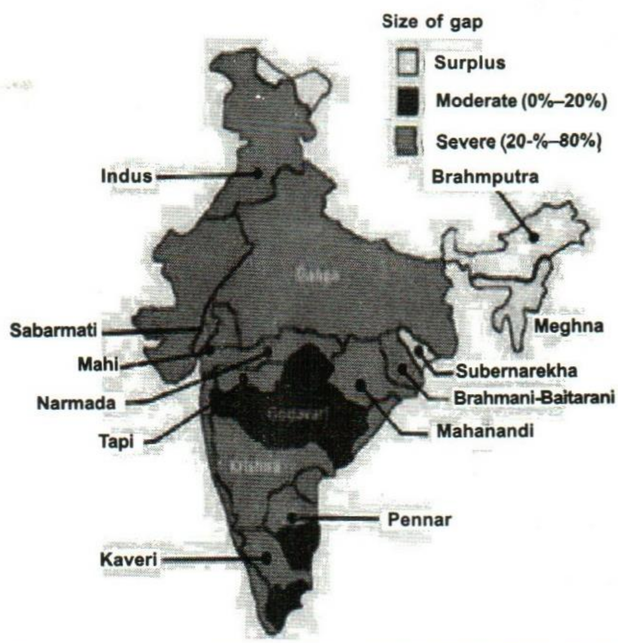

Figure 2: Gap between Existing Supply and Projected Demand in 2030 Based on 2030 Water Resource Group Percent of 2030 Demand

Source: Addams et al. (2009: 55).

Table 3: Drinking Water Supply Programme and Policies at a Glance

Year	Events
1949	The Environment Hygiene Committee (1949) (Bhor Committee) recommended the provision of safe water supply to cover 90 per cent of India's population in a timeframe of 40 years.
1950	The Constitution of India specifies water as a state subject.
1969	National Rural Drinking Water Programme was launched with technical support from UNICEF.
1986	The National Drinking Water Mission (NDWM) launched to accelerate the process of coverage of the country with drinking water.
1987	First National Water Policy drafted by the Ministry of Water Resources giving first priority to drinking water supply.
1994	The 73rd Constitution Amendment makes provision for assigning the responsibility of providing drinking water to the Panchayati Raj Institutions.
1999	Formation of separate Department of Drinking Water Supply in the Ministry of Rural Development, Government of India.
2005	The Government of India launches the Bharat Nirman Programme, with emphasis on providing drinking water within a period of five years.
2011	Department of Drinking Water and Sanitation upgraded as Department of Drinking Water and Sanitation.
2012	Twelfth Five Year Plan focusing on piped water supply with 55 lpcd, earmarking of 5 per cent funds for coverage of quality.
2013	Launching of special programme to address the rural water supply and sanitation issues of four low-income states with the collaboration of World Bank.
2014	Innovation of new technology in rural drinking water.

Source: Ministry of Drinking Water and Sanitation, Annual Report, 2014–15.

land is vulnerable to cyclones,that is, 570 kms out of 7,516 km of coastline. Millions of people are rendered homeless almost every year due to floods and about 15 per cent of area is prone to landslides. This gets complicated due to the dense clusters of population, lack of awareness and prevalent poverty. In present time the magnitude of disasters are increasing due to changes in climate. As recent floods in India caused large scale loss of human life and damage to properties through direct and indirect impacts, it is high time to give foremost importance of preventive measures. In India, despite considerable progress, a large number of people are found without having access to drinking water estimated at 75.78 million (Table 1).

Climate Change Impact through Glacial Shrinking Induced Floods

The Himalaya is considered to be highly sensitive to climate change, and is one of the youngest mountain ranges on earth. It is characterized by a high-energy environment due to high relief, steep slopes, complex geological structures with active tectonic process and continued seismic activities and weak folded structure. Climate variability in this region is a very prominent phenomenon due to its topography and monsoon together with increasing population pressure, overgrazing, deforestation, road construction, dam construction and agriculture/horticulture in high slope regions. The mountain regions are prone to multiple hazards, viz., landslides, flash floods, etc.

India's 1.2 per cent of land is vulnerable to floods. Floods in the Indo-Gangetic–Brahmaputra plains are an annual feature, on an average a few hundred lives are lost every year. The warming in past decades has been found to be progressively higher at the higher elevations and the warming in this region is having profound impacts on the glacial melting. It has been observed that, in the high mountains (4,500 to 5,500 m) the frequency and occurrence of Glacial Lake Outburst (GLOF) events has been increasing in the second half of the 20th century. There is an urgent need to monitor high altitude glaciated regions like Sikkim and Himachal Pradesh to understand the natural processes and to reduce the magnitude of flood hazards in downstream. Awareness of glacial lake outburst floods in the Himalayan region is derived from the memories of local people and from incidentally documented evidence. There are more than eight thousand glacial lakes in the greater Himalaya and about two hundred lakes are potentially dangerous. Most of the glacial lakes in the Himalayan region are known to have formed within the last 5 decades, and increased numbers of GLOF events have been reported in this region. On an average, in every 3 to 10 years one GLOF event was recorded in the Himalayan region. These GLOF events have resulted in the loss of many lives, as well as the destruction of houses, bridges, fields, forests, roads and livelihoods.

In recent times, the problems have accentuated due to increased tourism, urbanization and climate change. The recent flood furies at Leh (2010), Uttarakhand (2013) and Jammu and Kashmir (2014) have showed the significant vulnerability of Himalaya. The nature and mechanism of all the three events was different due to varying geographical factors but all three caused huge loss of life and property. Both the Leh and Kedarnath floods were induced by cloud burst, but the spatial impact varied. The impact varies between flat land topography and high hill region. Leh being a flat land the impact was confined to local areas only but in the case of Kedarnath, due to ridge and valley topography the impact was carried to downstream area that caused massive devastation.

The number of occurrence and the trend of these cloud burst event have been continuously increasing. In 1908 one cloud burst was reported. After a span of 62 years, another cloud burst occurred in July 1970 at Uttarakhand. Since 1990s, 17 cloudbursts have happened to cause massive damage to lives and properties of which at least 11 cloudbursts occurred only in the three hilly states of Uttarakhand, Himachal Pradesh and Jammu and Kashmir. In fact, now this phenomenon seems to be highly frequent: 11 out of the 17 cloud bursts occurred only during 2010–2013. One can say that the increase in frequency of such incidences is because of changing climate.

In recent Jammu and Kashmir flood, the event was not triggered by a cloud burst. But it was due to the intense rainfall for more than 450 mm in 3 days (Annual average rainfall of Jammu and Kashmir is 100 mm). The huge amount of rainwater was beyond the Jhelum's catchment capacity added by chocking of drainage system due to extensive soil erosion during the event. The soil erosion increases due to bareness of surfaces caused by human activities. As per the past records Jammu region has experienced such huge rainfall in 1903, 1908, 1926, 1942 and 1988, whereas in the Kashmir valley such intensity rainfall was observed in 1903, 1911, 1917, 1928 and 1992.

Above experiences compel us to think that at last we have to cope with the disasters.

Drought Vulnerability in Arid and Semi-Arid Regions

The drylands of India cover more than 60 per cent of geographical area extending from western arid region, central semi-arid tracts of Rajasthan, Rann of Kutch in Gujarat to leeward side of Western Ghats in western Maharashtra and Karnataka. The drylands of India are frequently affected by drought. Every year hectares of agriculture land is damaged by variability of rainfall. In some instances like in 2009 there occurred a flood in Barmer causing widespread damage due to lack of preparedness. The vulnerability of dry regions to climate change is continuously increasing due to decreasing rainfall and increasing temperatures causing decrease in moisture content and thereby increasing the aridity. In Rajasthan, during 1951–2010 the temperature has shown a great variability with an average rise of about 0.168°C for winter season, 0.240°C in summer season and 0.304°C in autumn season. In summer and monsoon season, more prominent rise in temperature is observed after 1990, respectively. The problem of desertification is also increasing and new areas are being engulfed by shifting sand dunes. It has been observed through various studies that the climatic belts have shifted eastwards by about 100 km. Use of water expensive crops in water stress areas and lack of management skills in storage facilities of water at local, household, village, district, regional and country level adds human dimensions to drought. The water conservation techniques in the drylands of India are the best management practices to be undertaken along with agriculture practices.

Water Pollution and Improvement of Water Quality

Ecological degradation and faulty policies make water scarce and less accessible in India. Increasing deforestation and degradation of environment has further deteriorated the situation. Poor water quality is the byproduct of insufficient and delayed investment in urban water-treatment facilities. Water in most rivers of India is largely unfit for drinking and in many stretches not even fit for bathing. Irrational use of the water, faulty agricultural activities (excess use of fertilizer) and over extraction of the ground water are the outcomes of lack of proper rule and regulations. Lack of water treatment plants for reuse and recycling of waste water, encroachment of the water bodies and no proper pipe distribution for each household, no proper price mechanism for industrial and commercial use of water and lack of awareness about new water saving technologies are common issues leading to wastage of precious water resource in India.

The River Yamuna outnumbers any other river in the number of industries located on its bank. Around 720 mld of untreated water enters in the river as the waste residual product (National river conservation Directorate, New Delhi). About 2,000 million litres of sewage is pumped into the river from Delhi every day. According to CPCB, 70 per cent of the pollution is due to untreated water. Other factors responsible are industrial sources, agricultural runoff, garbage, etc. The pollution levels can be through improvement measures in water quality, including

1) The sewage treatment plants should be built at the mouth of major drains.
2) To deal with non-point pollution, the construction of low cost toilets and crematoriums.
3) The minimum flow required in the river should be maintained.
4) Reservoirs should be built to store water.
5) Optimum application of fertilizers.
6) Factories still operating on the banks of the rivers must be relocated.
7) The treated effluents, both domestic and industrial, have to be used for irrigation.
8) Special areas where ashes and garlands can be processed with respect without affecting the sanctity of the river.
9) Idols to be immersed in the river water during festivals should be made of traditional clay rather than baked clay.
10) Construction of any form along the river bed should not be encouraged.

National Rural Drinking Water Programme–Government Initiatives

The National Rural Drinking Water Programme and Accelerated Urban Water Supply Programme aim to provide universal and equitable access to safe and affordable drinking water for all by 2030.

Swachh Bharat Abhiyan (2014), aims to ensure access to sanitation facilities and safe and adequate water supply to every person by 2019. There are in total 140 major lakes in India, which are facing problems of contamination due to domestic sewage, agricultural run-off, discharge of industrial effluent and over fishing. Water security has emerged as India's greatest challenge with higher production in agriculture, population growth, industry and energy. Inter-state dispute in sharing river water is the biggest burden in utilizing river water in a judicious manner. The NRDWP aimed at providing adequate and safe drinking water to the rural population of the country. The NRDWP is a component of Bharat Nirman, which focuses in creation of rural infrastructure. Rural drinking water is one of the six components of Bharat Nirman.

1. Swachh Bharat Mission (Gramin)

a) Swachh Bharat Kosh

The Swachh Bharat Kosh has been set up by Ministry of Finance to facilitate the voluntary contribution from corporate sectors as part of Corporate Social Responsibility as well as from individuals in response to achieve the Swachh Bharat by 2 October 2019. The trust areas include:

1) Financing the construction of community/individuals toilets in rural and urban areas, toilets in Government Schools, Anganwadi Centres.
2) Renovation and repair of dysfunctional toilets.
3) Construction activity for water supply to the existing toilets.
4) Training and skill development to facilitate the maintenance of constructed toilets and any other initiatives for improving sanitation and cleanliness in rural and urban areas including Solid and Liquid Waste Management .

b) Ganga Action Plan (GAP)

The GAP includes the following steps:

1) Ministry of Drinking Water and Sanitation has prepared Action Plan to make all Gram Panchayats along the banks of River Ganga and Open Defecation Free.
2) Total 1,657 Gram Panchayats have been identified along the banks of River Ganga.
3) It has been decided to take-up these Gram Panchayats on priority basis under Swachh Bharat Mission.

Interlinking of Rivers for Integrated Management of Floods and Droughts

It will provide irrigation facilities to 35 Mha area (surface water 25 Mha and ground water 10 Mha) over and above 139 Mha. The benefits of linking of river may have multiple benefits such as

1) Flood control benefits due to construction of storage dams. This can reduce flood peaks by about 20 to 30 per cent.
2) Drought mitigation in 25 lakh ha area in the states of West Bengal, Bihar, Uttar Pradesh, Haryana, Rajasthan, Jharkhand, M.P., Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu.
3) Hydro-power generation of 34,000 MW. Against 84,000 MW of hydro-power potential only about 22,000 MW has been developed so far.
4) Environment will be greatly enriched by maintaining better flows in the rivers throughout the year, providing vegetation and greenery to semi-arid and parched lands.

Social and Economic Measures for Water Accessibility and Water Security

The government should ensure the water accessibility based principles of equity such as equitable access, availability and distribution of water for all, create awareness about water conservation methods and techniques, create responsible citizen to conserve the environment and promote investment in water conservation area, technologies and methods. The programme provides credit for the techniques and scientific advised for water conservation and water recycling, water conservation on different industrial and commercial institution, adopting micro irrigation techniques, for example, drop irrigation and sprinkle irrigation techniques.

Water security aims at reducing dependency on erratic and uncertain monsoon by construction of water storages so that water shortage could meet at immediate basis. Proper implementation of drip and sprinkle irrigation should be insured in order to reduce wastage of water could minimize in agricultural practices, for example, in Israel. The agricultural products which consume more water, i.e., soybean, paddy, rice need not to use for exporting purposes as exporting these product will create water scarcity. Maximum water pollution is resulted from the power plant industries, which has not been addressed properly and not even mentioned in the policy framing. There should be regulation in utilizing underground water by farmers with certain limitation.

Multiple Innovative Solutions for Sustainable Water Management

In order to promote sustainable water management solutions, the local governments and communities should incorporate and practice rainwater harvesting and artificial recharge of groundwater, desalination of river and inland water, awareness generation among the masses through water campaign. Industrial solution for the water treatment plant, water use efficiency in agriculture sector where use of drip and sprinkle irrigation could be a solution. There should be regulatory norms in utilizing ground water resources. The water solutions should be practiced at multiple levels. It should be practised using the following principles:

- Water charging mechanism for different users
- Rooftop water harvesting
- Water train (to remote dry areas for emergency measures)
- Reduce total water consumption
- Water banks
- Desalination of seawater, brackish water or treated water
- Artificial recharge of underground water
- Addressing evaporation loss and percolation loss
- Mitigating water-induced disasters
- Identifying water security indicators

Conclusion

Water has to be conserved using the concept of 5 Rs (Reduce, Reuse, Recycle, Recharge, Restore). The other measures include water storage capacity and facilities in each household, village, district, city and region, mandatory rainwater harvesting system in each house's roof or community based rainwater harvesting system in poor area. Good water governance is the key to solving problems of employment, economy, export, equity and environment. The development of modern data-gathering techniques and space assisted decision support system will contribute for achieving water resource sustainability. There is an urgent need to develop partnership between government, private and civic sectors. Improving water governance would ensure conflict resolution and supply of water to every people/farm, remove poverty, and provide green cover over degraded areas. Traditionally India is considered as a leader of water management and may show the ways to other developing countries for preserving rivers through integrated approach. There is an immediate need for the effective coordination between the key institutions for formulating the policies and implementing them at ground level to combat with the complexities of water-related challenges. Following are some of the key institutions:

- Central Water Commission, GOI
- Ministry of Water Resources, River Development, and Ganga Rejuvenation, GOI
- Central Ground Water Board, GOI
- Ministry of Drinking Water and Sanitation, GOI
- National Water Development Agency, Ministry of Water Resource
- Water Resource Information System (WRIS) WebGIS, ISRO, GOI.

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If conservation of natural resources goes wrong, nothing else will go right.

—M. S. Swaminathan

Focus

Safe and Pure Drinking Water: An Alternate View Point

BRIJESH C. PUROHIT

Besides water supply, there are serious concerns regarding the safety and availability of drinking water. Even the quality of drinking water in India is also a major concern. Water quality is affected by both point and non-point sources of pollution. There are various methods adopted to purify water. A major concern raised in this paper is about reverse osmosis-based technology presumably being marketed aggressively. This technology has been criticized for its harmful effects which relate to demineralization of water. Using different evidences we have explored arguments both in favour and against this technology. However, evidence based on current status of Indian data remains inconclusive.

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Introduction

At present, per capita water availability in India is less than 1,700 cubic metres and thus the country is considered a water-stressed nation. Water stress is considered to occur when per capita water supply drops below 1,700 m^3/year and then frequently disruptive water shortages occur. Besides water supply, there are serious concerns regarding the safety and availability of drinking water. Even the quality of drinking water in India is also a major concern. Water quality is affected by both point and non-point sources of pollution. These include sewage discharge, discharge from industries, run-off from agricultural fields and urban run-off. Water quality is also affected by floods and droughts and can also arise from lack of awareness and education among users. The need for user involvement in maintaining water quality and looking at other aspects like hygiene, environment sanitation, storage and disposal are critical elements to maintain the quality of water resource.

India holds 17.5 per cent of the world's population yet it only contains 4 per cent of the world's fresh water resources, which are declining in terms of both supply and quality. Although drinking water was once considered safe in India, yet, today providing nearly 1.2 billion inhabitants with access to safe drinking water is an increasingly difficult challenge. Approximately 66 million Indians use water sources containing excess fluoride and another 10 million have excess arsenic in their groundwater. Other factors, like septic effluent percolation to the water table, are also a source of water contamination causing health problems. As shown in Table 1, many Indian states have been affected by various water-borne health problems.

It is estimated that the annual impact of water-borne disease in this country affects 37.7 million persons annually. There is a loss of 73 million working days and the death of 1.5 million children from diarrhoea alone

Table 1: States Affected by Various Water Quality Problems

Parameter	Maximum permissible level	Health impact	Affected states
Fluoride	1.5 mg/l	Immediate symptoms include digestive disorders, skin diseases, dental fluorosis.	Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal.
		Fluoride in larger quantities (20–80 mg/day) taken over a period of 10–20 years results in crippling and skeletal fluorosis which is evere bone damage.	
Arsenic	0.05 mg/l	Immediate symptoms of acute poisoning typically include vomiting,oesophageal and abdominal pain and bloody 'rice water' diarrhoea.	Assam, Bihar, Chattisgarh, Jharkhand, Tripura, West Bengal.
		Long-term exposure to arsenic causes cancer of the skin, lungs, urinary bladder and kidney. There can also be skin changes such as lesions, pigmentation changes and thickening (hyperkeratosis).	
Iron	1 mg/l	A dose of 1,500mg/l has a poisoning effect on a child as it can damage blood tissues, digestive disorders, skin diseases and dental problems.	Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jharkhand, Jammu and Kashmir, Karnataka, Kerala, Manipur, Meghalaya, Mizoram, Madhya Pradesh, Maharashtra, Nagaland, Odisha, Punjab, Rajasthan, Sikkim, Tripura, Tamil Nadu, Uttar Pradesh, West Bengal, Andaman & Nicobar Islands, Puducherry.
Nitrate	100mg/l	Causes Methamoglobinemia (Blue Baby disease) where the skin of infants becomes blue due to decrease efficiency of haemoglobin to combine with oxygen. It may also increase risk of cancer.	Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh.
Salinity	2,000 mg/l	Objectionable taste to water.	Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Kerala, Madhya Pradesh, Maharashtra.
		May affect osmotic flow and movement of fluids.	Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal, Puducherry.
Heavy Metals	Cadmium–0.01 mg/l	Damage to nervous system, kidney, and other metabolic disruptions.	Gujarat, Andhra Pradesh, Delhi, Haryana, Kerala.
	Zinc–15 mg/l Mercury 0.001 mg/l		
Persistent	None	High blood pressure.	Delhi, Himachal Pradesh.
Organic Pollutants		Hormonal dysfunction and growth retardation.	Jharkhand, West Bengal.
Pesticides	Absent	Weakened immunity.	
		Abnormal multiplication of cells leading to tumor formation. They contain chlorides that cause reproductive and endocrinal damage.	

(Shanumganandan, 1999). Water-related diseases put an economic burden and the economic loss includes cost of treatment and wage loss during sickness. Loss of working days in turn affects national productivity. The measurement of health impact from the availability of water supply and sanitation (WSS) facilities has been attempted by considering either the incidence of diseases or infant mortality rate as dependent variable. There have been a various reviews which cover a large number of studies. For instance, one review of 144 studies by Esrey et al. (1985) relating to water-sanitation indicated that WSS led to reduction in morbidity ranging from 4–78 per cent from different diseases like ascariasis, diarrhoea, drancunculiasis, hookworm infection, scistosomiasis and trachoma; there are also studies which concluded that improved WSS facilities are not efficacious in improving health status and not particularly cost-effective (Walsh and Warren, 1979). Another notable review of 67 studies from 28 countries found that WSS investments can reduce diarrhoea morbidity and mortality rates by a median of 22 per cent and 21 per cent, respectively (Esrey et al., 1985). It should be also noted that the results of such studies were also influenced by the methodologies adopted, inadequate health indicators and lack of control for confounding variables including selective primary health care and other health facilities (Blum and Feachem, 1983). There have been also case-control studies in some countries. Such types of studies were conducted in countries like Lesotho (Daniels et al., 1990), Malawi (Young and Briscoe, 1988) and Philippines (Baltazar et al., 1988). These studies have pointed out a reduction owing to WSS investments between 20–24 per cent in the incidence of diarrhoea. Likewise study by Guilkey and Riphahn (1998), for instance, using a longitudinal data from metropolitan Cebu-Philippines from 1983 to 1986 for child mortality up to two years indicated that child mortality varies significantly between birth weight and nutritional status. Another study relating to Bangladesh and Philippines analysing such impact along with socioeconomic factors on child health found no significant effect between water supply and source of drinking water, sanitation and child health (Lee, Rosenzweig and Pitt, 1997). In the Malaysian context also using stratified partial likelihood estimation, similar conclusions were drawn (Ridder and Tunali, 1999). By contrast, WHO (2000) using a primary survey and logit regression model indeed indicated a negative relationship between arsenicosis and household income. A survey in Argentina during the period of 1990–1999 found that the privatization of water services is associated with 33 per cent reduction in the mortality rate, which amounts to a 5.3 per cent reduction of the baseline rate (Galiani et al., 2005).

Studies in the Indian context have indicated a significant impact of water-borne diseases on child mortality. According to one study, for instance, nearly 105 million children under five years die each year due to water-borne diseases which amounts to a loss of 200 million man-hours a day every year (or Rs 36,000–366 billion crores) (Shanmuganandan, 1999). A survey study of three villages of Tamil Nadu, namely, Gudimallur, Devathanam and Vannivedu, for instance, found water contamination leading to an increase in water-related diseases (Sankar, 2001). Another study in rural Andhra Pradesh indicated that up to 15 million people are using water obtained from unsafe sources which may have identifiable health effects (Hughes et al., 2001). A primary survey for the period 1993–94 found that the overall prevalence of diarrhoea is 10.1 with an average of 0.33 days of illness and mean expenditure of 0.74 rupees per episode of diarrhoea (Jalan and Ravallion, 2003). Using factoral analysis, another study found significant impact of water and sanitation facilities in rural and urban sectors on Infant Mortality Rate (IMR), Crude Death Rate (CDR) and incidence of different diseases (Purohit and Siddiqui, 2004). In rural areas of Uttarakhand with a primary survey of 1,530 households in 2004–2005, Murugesan, Dayal and Chugh(2008) indicated that latrine availability affected episodes of diarrhoea negatively, and the availability of water, education, poverty and the Swajal programme had a positive effect on latrine availability and use. In Dahod district of Gujarat it was noted that toilets significantly reduced not only the cost of medical treatments but also the loss of wages induced by sanitation-related diseases (Agoramoorthy and Hsu, 2009). A study in Chromepet and Pallavaram township of Tamil Nadu using primary data indicated that drinking water quality and sanitation significantly affect the health of households (Srinivasulu and Haripriya, 2004). Another study, by contrast, in the districts of Murshidabad and Bankura in West Bengal, indicated that by providing only toilets in individual houses, the disease burden may not reduce substantially. It should also be accompanied with improvements in drainage condition, general sanitation, personal hygiene and food sanitation to minimize the disease burden among the villagers (Sulabh Int. Serv. Org, 2007). From the above review of studies we hypothesize that there is a link between health status and WSS which works directly through its impact via transmission or incidence of water-borne diseases.

To overcome this burden of water-borne diseases as well as other health related problems, both the central and state governments spend a lot of resources on treatment of the sick and providing other supportive services (Purohit, 2014). At the same time to support such efforts, the quality of drinking water supplied in India is governed by the Bureau of Indian Standards (BIS) which has developed norms to standardize monitoring of chemical and microbiological constituents in drinking water. These guidelines specify the acceptable levels of chemical and microbiological constituents in drinking water and provide information on the implications of drinking water in which these contaminants exceed their guideline value.

Purification Methods for Safe Drinking Water

Due to the drinking water contamination issues, many Indian consumers are using point-of-use (POU) water purifiers to treat their water. There are currently many POU treatment devices available using various technologies including: Ultraviolet (UV) Technology, Ultra Filtration (UF), Nano Filtration (NF), Reverse Osmosis (RO), Iodine or Chlorine or Bromine or Nano silver as disinfectant, Ion exchange for softening and finally boiling the water. Multi-technology devices are being widely used in India. In general, POU units will contain both sediment and activated carbon filters combined with a disinfection technology such as UV, UF or RO. Furthermore, in some cases a combination of disinfection technologies are used such as RO and UV.

The selection of an appropriate technology is largely a matter of publicity and users acceptance. Use of modern technologies such as RO and ozonation are effective in the treatment of water but their feasibility in a rural setting may be difficult owing to capital expenditure and manpower in operating and maintaining such systems.

Factually, in RO, water runs through a permeable membrane to take away the impurities and unwanted contaminants, the output being purified water. Many of these pollutants are toxic and, thus, not suitable in drinking water. Besides RO, there are many filtration methods available today, but there are advantages and disadvantages in using them. However, RO has many relative advantages which have made it a popular method. Some of the major benefits include removal of bacteria and pathogens. The latter, for instance, include Giardia and Cryptosporidium which are harmful bacteria that can cause diseases. Consumption of water contaminated with Giardia may lead to fatigue, diarrhoea, excessive gas, bloating, loss of interest in food and weight loss. In case of Cryptosporidiosis, affected gastrointestinal system may be a consequence. Further, RO water in general may have better taste and smell and thus may not have chlorine smell. Harmful substances like chlorine, asbestos, mercury and lead are some of the toxins that can be found in tap water but removed in RO.

However, the demerits of RO technology are less known due to the aggressive marketing of RO purifiers. For instance, many RO systems come with carbon pre-filters. This although helps to filter chlorine and Volatile Organic Chemicals (VOCs) which are smaller than water molecules but may not be completely reliable. Another major disadvantage is its externality of wastage of considerable amount of water. In the process of filtration in general RO units require 3 to 10 gallons of untreated water to make a single gallon of purified water, which is wasteful and expensive.

Another major drawback is the maintenance involving a scheduled replacement of its filters to avoid the fouling of the membranes and retain the optimal performance. The pre-filters, which protect and extend the life of the membrane, must be changed annually, while the RO membrane (thin film composite-TFC) should be replaced every two to three years. Also, it must be noted that RO water purifiersare bestsuited to treat hard water but are not so effective for micro-organism.

A major disadvantage of RO technology is its particular feature of the removal of essential minerals such as iron, magnesium, calcium and sodium which are essential to the human body and which may cause mineral deficiency in the body. With the removal of natural minerals, water taste is affected. Despite this, industry analysts indicate that over half a million households in the country purchase water purifiers every year. At Rs 1,500 crore, the market is growing at 15–20 per cent a year. Thus, with advertisements sparkling, pure water has never looked so alluring.

New Health Concerns and Pure Water

As a matter of fact, WHO has been updating quality parameters for drinking water and setting guidelines for the same. Maximum acceptable concentrations of inorganic and organic substances and microorganisms have been established internationally and in many countries to assure the safety of drinking water (GOI, 1975; WHO, 1993, 1996, 1997).

A number of risks mentioned by the WHO studies using demineralized water for different countries include gastrointestinal problems, bone density issues, joint conditions and cardiovascular disease. The evidence indicates that consuming demineralized water (such as from RO techniques) can create serious side effects. Such water when used for cooking is known to cause substantial losses of all essential elements from food (vegetables, meat, cereals). These losses may reach up to 60 per cent for magnesium and calcium or even more for some other microelements (e.g., copper 66 per cent, manganese 70 per cent and cobalt 86 per cent). By contrast, with the use of hard water for cooking, the loss of these elements is much lower, and in some cases, even higher calcium content was reported in food as a result of cooking. The use of low-mineral water for cooking and processing food may lead to a marked deficiency in total intake of some essential elements. The current diet of many people usually does not provide all necessary elements in sufficient quantities and, therefore, any factor that results in the loss of essential elements and nutrients during the processing and preparation of food could be detrimental for them (Kozisek, 2004; Haring and Van Delft, 1981; WHO, 1979).

Some of the studies suggest that the intake of soft water, that is, water low in calcium, may be associated with higher risk of fracture in children, certain neurodegenerative diseases, preterm birth and low weight at birth and some types of cancer. Besides an increased risk of sudden death, the intake of water low in magnesium seems to be associated with a higher risk of motor neuronal disease, pregnancy disorders (so-called preeclampsia) and some types of cancer (Durlach, 1988).

An extreme of soft or hard water is neither good for health nor acceptable by people, primarily on grounds of taste. The amount of TDS and hardness has effect on taste of water. Water with low TDS is flat and insipid while with high TDS (>2,000 mg/L) become objectionable and unpalatable.The palatability with TDS level up to 600 mg/L is considered good (Kozisek, 2004). An Expert Consensus Meeting Group Report on potential health consequences of long-term consumption of demineralized, remineralized and altered mineral content drinking water has reinforced the hypothesis that consumption of hard water is associated with a somewhat lowered risk of cardiovascular disease with magnesium being the more likely contributor of that benefit (WHO, 2005). Thus, there is a real concern whether one should use the so-called purified water from POU technologies or should we be content with the newly found belief in old patterns of water consumption using indigenous methods?

Positive Effects of Treated Water

It should be noted that these disadvantages of POU technology particularly RO technique should not lead us to conclude only negatively. In fact using NSSO data 69th round (GoI, 2013), empirically we find that there is indeed a positive impact of treated water in avoiding some of the water-borne diseases. We utilized regression analysis which gave the impact coefficients to indicate the importance of *a* prioi causal factors on the incidence of a particular disease which is denoted by number of cases of the disease (or number of deaths due to a disease) taken as the dependent variable. The 28 Indian states for which data for our analysis have been used include Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. We used this analysis for four major diseases which are associated with WSS and continue to prevail in most of the states. These include acute diarrhoea, viral hepatitis, enteric fever and malaria. Among the explanatory variables we included sets of variables representing drinking water facilities and sanitation amenities. Thus, in our regressions main explanatory variables were, namely, improved source of drinking water, households treating drinking water by any method during 2012, sufficient drinking water, households without latrine facility, households having exclusive use of latrine and households having access to improved source of latrine throughout the year. All these variables were used for rural urban areas separately. The results of our analysis are presented in the following Tables 2 and 3.

As presented in Table 2, the water variable, namely, water treated by any method by households is significant both in male and female deaths by acute diarrhoea. The value of coefficient is higher for water treated in urban areas which varies between -1.043 (for total cases) compared to -1.10 (for males and females separately). Water treated in rural areas has also a statistically significant coefficient the value of which varies between -0.55 (for total case) to -0.575 (for male cases). These coefficients are relating to double log specification and thus denote elasticity of disease incidence with respect to improved water facilities.

Table 2: Regression Results: Dependent Variable: Acute Diarrhoea Deaths

Dependent Variable: Acute Diarrhoea Deaths						
Total Cases	Male Cases (D)	Male Cases (D)	Female Cases (D)	Female Cases (D)	Total Cases (D)	Total Cases (D)
Explanatory Variable\Statistic						
Intercept	5.57	9.23	5.23	9.01	5.89	9.36
	(-3.23)	(-2.35)	(-3.34)	(-2.5)	(-3.4)	(-2.35)
Water treated Rural	-0.575		-0.57		-0.55	
	(-1.98)		(-2.12)		(-1.86)	
Water treated Urban		-1.10		-1.10		-1.043
		(-1.79)		(-1.96)		(-1.67)
R_2	0.104	0.081	0.126	0.105	0.09	0.067
F Statistic and DF	3.9 and 24	3.22 n24	4.48 n25	3.83 n25	3.48 n24	2.79 n24

Source: Estimated

Table 3: Regression Results: Dependent Variable: Enteric Fever Cases

Total Cases Enteric Fever	Male Cases	Male Cases	Male Cases	Male Cases
Intercept	-17.61 (-3.72)	-34.39 (-3.14)	63.33 (-3.41)	19.91 (-8.74)
Water treated (Rural)				-.708 (-3.13)
Water treated (Urban)			-1.514 (-3.03)	
Exclusive latrine facility (Rural)	-1.365 (-3.72)			
Exclusive latrine facility (Urban)		-3.85 (-2.28)		
Improved sanitation facility (Rural)				-1.042 (-2.79)
Improved sanitation facility (Urban)			-6.50 (-2.25)	
R_2	0.32	0.13	0.44	0.4660
F Statistic and DF	13.8n26	5.21n26	11.94n26	12.78n 28

Source: Estimated.

Table 4: All-India Rural (by different methods of treatment)

Principal source of drinking water	Method of treatment of drinking water							
	Proportion of hhs treatment drinking water	Electronic purification	Boiling	Chemical treatment with alum	Chemical treatment with bleach/ chlorine tablet	Filtration with water filter	Filtration with cloth	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bottled water	61	42	81	0	40	670	88	79
Piped water into dwelling	538	72	183	16	20	103	539	68
Piped water to yard/plot	542	25	125	12	36	72	669	59
Public tap/ stand	347	7	189	4	11	63	682	45
Pipe tube well/borehole	180	47	80	7	16	192	586	71
Protected well	600	7	272	35	77	113	442	54
Unprotected well	588	9	377	7	49	53	441	64
Protected spring	313	50	751	0	13	162	23	0
Unprotected spring	283	0	576	0	2	80	318	23
Rainwater collection	971	3	146	251	0	8	367	225
Tank/ pond	692	0	317	16	0	71	541	55
Other surface water	637	1	152	52	34	39	692	29
Others	606	29	131	17	24	11	675	113
N.R.	191	0	116	0	0	0	243	0
All (incl. N.R.)	323	30	182	12	28	108	576	63

Source: NSSO, GoI (2013).

Table 5: All-India Urban (by different methods of treatment)

Principal source of drinking water (per 1,000)	Method of treatment of drinking water							
	Proportion of (per 1,000) hhs treatment drinking water	Electronic purifi-cation	Boiling	Chemical treatment with alum	Chemical treatment with bleach/ chlorine tablet	Filtration with water filter	Filtration with cloth	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bottled water	132	216	490	0	13	173	70	38
Piped water into dwelling	711	351	181	8	11	182	235	32
Piped water to yard/plot	608	152	216	14	17	174	377	51
Public tap/stand pipe	387	17	269	8	8	110	523	66
Tube well/ borehole	355	321	92	5	12	215	293	62
Protected well	771	111	405	12	47	249	132	44
Unprotected well	782	59	679	4	27	66	129	36
Protected spring	552	232	322	0	0	336	92	18
Unprotected spring	447	0	746	0	0	232	22	0
Rainwater collection	987	13	29	510	0	15	413	20
Tank/pond	926	2	209	112	0	14	648	15
Other surface water	695	0	672	68	186	5	69	0
Others	486	62	167	30	2	113	564	62
N.R.	925	757	67	0	0	101	0	0
All (incl. N.R.)	544	248	209	10	13	173	303	44

Source: NSSO, GoI (2013).

Table 6: All-India (Rural + Urban)

Principal source of drinking water	Method of treatment of drinking water							
	Proportion of hhs treatment drinking water	Electronic purifi-cation	Boiling	Chemical treatment with alum	Chemical treatment with bleach/ chlorine tablet	Filtration with water filter	Filtration with cloth	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bottled water	103	174	391	0	20	293	75	48
Piped water into dwelling	662	286	181	10	13	164	306	40
Piped water to yard/plot	574	90	172	13	26	124	519	55
Public tap/stand pipe	359	10	214	5	10	77	632	51
Tube well/borehole	207	118	83	7	15	198	510	69
Protected well	627	27	298	30	71	139	383	52
Unprotected well	608	15	417	7	46	55	400	60
Protected spring	319	59	731	0	12	171	26	1
Unprotected spring	287	0	583	0	2	87	306	22
Rainwater collection	973	4	134	278	0	9	372	203
Tank/ pond	705	0	308	24	0	66	549	52
Other surface water	638	1	159	52	37	39	683	29
Others	545	44	147	23	14	58	624	90
N.R.	215	44	113	0	0	6	229	0
All (incl. N.R.)	393	125	194	11	21	137	457	55

It indicates that precautionary measures prior to using water for drinking purposes are helping in reducing the incidence of acute diarrhoea. The results for enteric fever cases significant only for males depict the negative impact of water treated and improved sanitation facilities both in rural and urban areas. The coefficient for water treated and improved sanitation for rural areas is -0.708 and -1.042 and the respective values for urban areas remain as -1.514 and -6.50. Thus a more prominent impact of water sanitation variables for enteric fever is observed for urban areas (Table 3). Thus, overall our results indicate that water sanitation facilities have helped to provide preventive inputs to reduce the incidence of two of the diseases, namely, acute diarrhoea and enteric fever.

One limitation of these results is the fact that here treated water includes any of the methods which include electronic purification (i.e., RO method), boiling, chemical treatment with either alum, bleach or chloride tablets, filtration with water filter or cloth and others (Table 4). However, if we look at the percentage of electronic filtrations among these methods, we find that among 1,000 users only 30 users in rural areas, 248 user in urban areas and 125 user (in all areas)(according to NSSO data; Tables 4 to 6) have made use of this method. Thus, in order to conclude about negative or only positive impact of RO method alone we need to have more controlled experimental studies or separate primary surveys. At the moment concretely we can conclude only disease preventive positive benefit of any kind of treated water and thus cannot advocate whether to use or not to use RO method of purification.

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Nothing is softer or more flexible than water, yet nothing can resist it.

–Lao Tzu

Focus

Economics of Water:Understanding India's Water Balance in a Globalized Economy

KRISHNA RAJ

This article deals with economic conception of water as economic good as well as natural capital for equitable and efficient management of water under the globalized economy. Understanding of water as an economic good ensures devising various new market instruments which help allocation of water efficiently and equitably among competing sectors of the economy. The recent international attempts to include Natural Capital in the Integrated Economic and Environmental Accounting or Green GDP consider the role of total economic value of water to economic growth. The growing scarcity of water, already reflected in market prices, limits future economic growth of India, unless the government takes policy measure of supply-side (water enhancement) management through catchment area conservation and demand-side (efficient) management by reducing the demand for water in the cities. The study of New York and Bangalore in the context of climate change led water scarcity helps in understanding the status of urban water management by the respective water utilities. Water scarcity, water use inefficiency and inequity in water distribution have already resulted in prevalence of water poverty all over India. In this context, this paper favours that the production and consumption behaviours of industry and consumers should be on the path of sustainable development practices.

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Introduction

1. Water as an Economic Good

In future, economies falling and rising not based on speculative stock prices but on real water prices similar to ancient civilizations falling and rising on the banks of rivers. But economists hardly consider the economic scarcity of water succinctly reflecting their view 'to know the price of everything and the value of nothing' even though Adam Smith explained 'Diamond-Water Paradox'. He states that 'nothing is more useful than water; but it will purchase scarce anything; scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value-in-use; but a very great quantity of other goods may frequently be had in exchange for it' (Adam Smith, 1776). This implies that nothing is more useful than water but still it is relatively underpriced or cheap where market fails to reflect the value of water. Adam Smith assumed that water is abundant whereas diamond is scarce; of course, he was right given the time of writing his treatise 'Wealth of Nations' in 1776. Still, economics literature in 21st century lacks in considering water as one among the factors of production except land, labour, capital and organization assuming that water is available freely and in plenty and it is embedded with the property right or ownership of land. Even today, economic research abundantly takes into account productivity of land, labour, capital, organization for estimating the economic efficiency of industrial or agricultural output squarely ignoring the contribution of water to total production and productivity. The Productivity Commission of Australia recognizes water (TERM-Water) as a key factor input for irrigation sector and marketable asset among cultivators. Virtual water trade in the form of water embedded in the products of grains, timber, meats, fruits, flowers and so on is gaining importance of understanding the economic importance of water. The main issue surrounding water is that if water is recognized as economic, environmental, social and cultural good, it allows understanding of the importance of water from various needs (consumptive and non-consumptive) and also easy to assess and compare its varied benefits (direct and indirect). However, International Conference on Water and the Environment, held in Dublin in 1992 (ICWE,1992) generally agreed the principle that water should be recognized and traded like economic good. The market and price mechanism governs the water towards its efficient allocation, distribution, efficient use and equitable distribution among competitive uses of the economy. Understanding of water as economic good will ensure devising various new market instruments to ensure water is allocated efficiently and equitably. Further, economics will play an important role in understanding the scarcity and availability of water for short-, medium- and long-term benefits of society. This will also help in understanding dynamic characteristic of water whether short-run economic priorities of water policy spoil sustainable allocation of water in the long run. It is a difficult task to value water due to varied benefits and to monitor given its availability and condition which varies across space and time, stock and flows. The difficulty of valuation of water is also imposed by its fugitive, bulky and non-substitutable character. This allows us to think that water possesses a combination of attributes that makes it different from other resources and products. Water acts as environmental good by serving ecosystem as input, as natural resource acts as both product and by-product (polluted water). It shows that some services of water are valued (benefits) and dis-services (costs) are not. This calls for rational judgement by the policymakers to treat whether water is free good (public) or private good (economic), and whether water is renewable (abundant) or non-renewable (scarce)/conditionally renewable resource. Water is considered as a free good (river water) when there is no opportunity cost involved in production. The properties of non-rivalry in consumption and non-excludability make water as public good. However, water becomes an economic good when it is scarce and it involves opportunity cost (time and resource) for its extraction or/and production. The physical supply cost and scarcity value make water as economic good but it depends on location, timing, quality and uncertainty or variability. Further, characteristics or attributes associated with water also influence to treat as economic or free good where quality variation results in variation of quantity demanded. There is willingness to pay for better quality and reliable water supply. However, many complexities exist to treat water as an economic commodity to its nature but it helps in understanding the economic value of water in a globalized economy. As Ward and Michelsen (2002) state,'in a market system, economic values of water, defined by its price, serve as a guide to allocate water among alternative uses, potentially directing water and its complementary resources into uses in which they yield the greatest total economic return'.

Table 1: Methods for Assessing the Economic Benefits of Water Use

For an aquifer or a catchment	For a region, a system of region or a nation
1) Cost-benefit analysis	1) Input–output and embodied water analysis
2) Water value-flow analysis	2) Computable general equilibrium models
3) Water balance accounting	3) Spatial price equilibrium models

Source: Adopted from David F. Batten (2007).

Various economic methods are applied by the economists to assess total benefits of water for a river catchment area or a region, state and country (Table 2). The quantity of water demanded by an economy considering various types of demands from producers and consumers of goods and services from agriculture, industry, service, domestic sector apart from water required for natural environment and the actual water supply in the catchment area will help assessing water-balance. Further, the net benefits and costs form an alternate water use reflects the relative prices, i.e., the price elasticity of demand for water. To estimate the demand for or price of water Stated Preference Methods (Non-market valuation) like Contingent Valuation Methods are increasingly applied over revealed preference methods to measure the consumer or producer willingness to pay which clearly reflect the shape of demand curve for a given period. The recycling and reuse of waste water or storm helps return flows of water as well as the value of the same water, the water value-flow approach considers the benefits derived from efficient of use of waste and storm water. Water balance accounting method estimates the water use, depletion and productivity of water in a water basin. The input–output approach uses water as an input like labour to calculate water multipliers (factor inputs) among different sectors of the economy. Water use intensities to produce different products in agriculture, industry, service and domestic sectors will be assessed based on the amount of water embodied in dollars' worth of products. This technique will also help in understanding the virtual water trade the amount of water used to produce the product which are internationally traded (import and export). A computable general equilibrium (CGE) model is also used to estimate how changes in water use or flow affect the behaviours of economic actors including industries, households, governments, investors, importers and exporters where consumers try to maximize their utility and producers prefer profit maximization. Above a few methods are used to assess the economic importance of water.

2. Water as Capital

Further, present economic growth models account the relative economic contribution of man-made capital and human capital to overall increase in Gross Domestic Product (GDP) and rarely recognize the natural capital including water. Thus, the stock of natural capital has decreased over time due to its underpricing or missing markets. The recent international attempts to include Natural Capital in the Integrated Economic and Environmental Accounting or Green GDP take into account the role of total economic value of water to economic growth. The widening gap in water supply and water demand for various economic needs calls for adoption of Green GDP approach and realizing sustainable development. The term'sustainability' needs to be understood both from strong sustainability and weak sustainability views. Is improvement in infrastructure and knowledge appropriate and adequate substitute for environmental or water losses? These concerns about ecosystems and limited availability of adequate substitute on account of depletion of water resources, demand adequate institutional measures and investment priorities to mitigate deforestation and address climate change. Even today, Indian textbooks conceptualize water as 'free good' and 'abundant in supply' which creates the wrong or notional impression that it can be used recklessly as it is observed in the behaviour of the economy or society be it for agricultural, industrial and domestic use. Water is most disregarded and abused good in terms of over extraction (excessive use of ground water) and exploitation (pollution of water bodies like The River Ganges). This has resulted in scarcity of water where water is no more treated as renewable resource, rather, it is treated as conditionally renewable if there is a huge mismatch between excessive water use and over its percolation of water table over time. It has become reality in India as ground water table reached rock-bottom whereas percolation is unable to restore the balance of water table. However, in case of surface water, overall it is unfit for consumptive and productive use due to awful quality issues such as water pollution. Both reckless use and abuse have made the water resource the scarce or economic good and it no more a renewable resource and it has become already a conditionally renewable resource. Therefore, the traditional societal attitude towards water as free good and renewable resource should change as water is essential for survival and it is already scarce it needs to be efficiently and equitably distributed among various needs of the economy and environment. Apart from treating water as economic good, water also be treated as social good as the right or entitlement of the society is involved, a minimum of 50 to 100 litres of water per person per day (WHO, 2016) are needed to be ensured to meet essential drinking and health needs at free of cost by the government. Water as an environmental good is very crucial to maintain the biodiversity or ecosystem or hydrological cycle. Water as cultural and aesthetic good, the implicit value must be recognized. This implies that water has multiple uses and benefits and overriding importance should be given to all attributes of water by considering the total economic value for its conservation. Therefore, a wide variety of economic models are needed to assess the economic benefits of water. Further, surface water bodies including rivers and lakes are considered as common pool resources which involve multiple users and water is non-excludable and hence, government plays an important role in ensuring equitable access and efficient allocation of water on a sustainable basis.

The land use and land cover modifications have already limited the availability of water and its services. Unless river catchments and basins are protected, it is difficult to bridge the growing gap between water supply and demand and achieve equity and efficiency in water resource management. Payment for ecosystem services as market-based instrument will help protection of river catchments. This approach helps in protection and conservation of natural capital including forests in river catchment areas like Western Ghats and Himalayan forests where most of the rivers originate and meet both economic and environmental needs of India (see Major River Basin Table 2 and Map 1).

Table 2: River Basins of India

S. No.	Basin Name	Area (Sq. Km)	Percentage
1	Indus (Up to border)	321,289	9.95
2	Ganga	861,452	26.69
3	Brahmaputra	194,413	6.02
4	Barak and others	41,723	1.29
5	Godavari	312,812	9.69
6	Krishna	258,948	8.02
7	Cauvery	81,155	2.51
8	Pennar	55,213	1.71
9	East flowing rivers between Mahanadi and Pennar	86,643	2.68
10	East flowing rivers between Pennar and Kanyakumari	100,139	3.10
11	Mahanadi	141,589	4.38
12	Brahmani and Baitarni	51,822	1.60
13	Subernarekha	29,196	0.90
14	Sabarmati	21,674	0.67
15	Mahi	34,842	1.07
16	West flowing rivers of Kutch and Saurashtra including Luni	321,851	9.97
17	Narmada	98,796	3.06
18	Tapi	65,145	2.01
19	West flowing rivers from Tapi to Tadri	55,940	1.73
20	West flowing rivers from Tadri to Kanyakumari	56,177	1.74
21	Area of inland drainage in Rajasthan	0	0
22	Minor rivers draining into Myanmar & Bangladesh	36,202	1.12
	Total and percentage	3,227,021	100

Source: Ministry of Water Resources, GOI (2016).

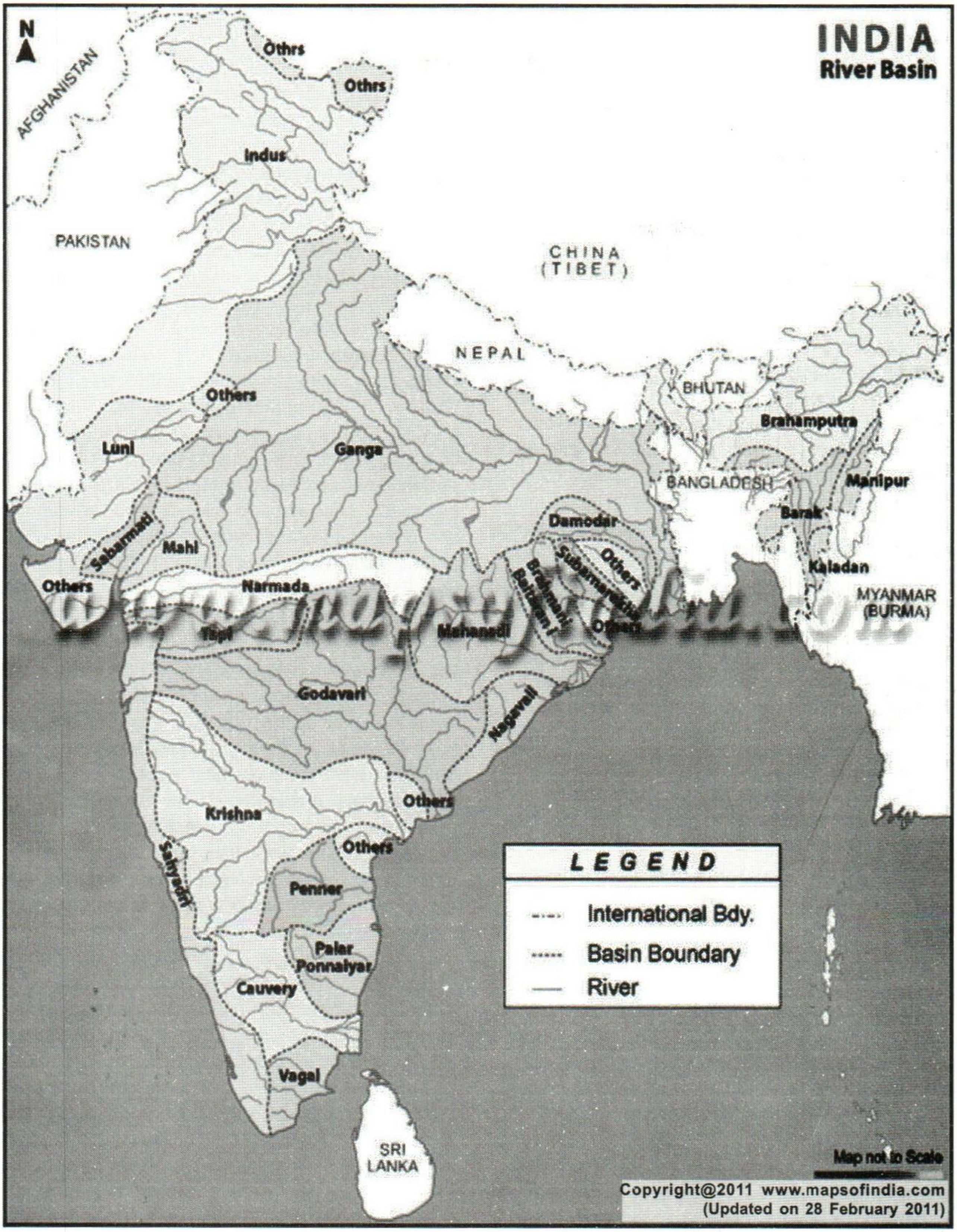


Figure 1: Major River Basins of India

Economic development of India and Indian states depends on sustainable availability of water resources in these river basins. Majority of the cities and towns impound water from these river basins for drinking water needs of billions of urban households. Bangalore city meets 90 per cent of drinking water needs from the River Cauvery. The water system becomes inefficient and costly in case water ecosystem dries up; this situation warrants allocate water to the highest value uses such as drinking water needs over agricultural and industrial needs which affect their economic activities and cause lasting water disputes among riparian states in recent years between Karnataka and Tamil Nadu.

The Western Ghats forests give birth to many rivers including the River Cauvery. Protection of these virgin forests which attract rain is completely neglected as deforestation and encroachment continues unabated. Commercial crops like coffee, tea, rubber, areca nut, have successively replaced virgin forests for many years. Fast growing species like eucalyptus and other trees which are alien to the ecologically sensitive region are rapidly introduced substituting native shade trees in coffee plantation areas. The recent land use change in Kodagu districts gives the stark reality of the Cauvery River, about 3,000 acres of agricultural land is being put to commercial and housing needs making the Kodagu forest fast dwindling which will catastrophically impact on the flow of river and availability of water both in catchment and command areas. Many developmental activities like erecting of power lines, construction of roads and hydel projects, sand extraction continues without valuing ecological sensitivity of the regions. The trees hold more than 30,000 litres of water that slowly makes its way into rivulets and rivers. Land use change, uncontrolled growth of home stay and tourism activities have destroyed the forests in Kodagu district. Kodagu district alone contributes for 70 per cent inflow of water to the Krishna Raja Sagar dam in Mandya district of Karnataka state.

Frequent incidents of climate change make water scarcer and also expensive as rainfall pattern are uneven over the years. Severe droughts would adversely affect the water flow in the river basins and replenishing ground water. Increasing reliability on river water supply for meeting various economic needs and particularly drinking water is unsustainable unless we take coping and adaptation measures. Whereas, developed countries are quickly evolved coping mechanisms to face climate change led economic implications, however, developing countries including India lag behind taking climate change very seriously to protect the river basins. Therefore, adoption of New York City Model will help protection of River Catchment Areas for lasting supply of water. There are striking similarities in dependence and impounding of water for New York and Bangalore cities. Both cities impound water away from more than 100 km and depend on critical watersheds or river catchments. New York City completely depends on Catskill and Delaware Watersheds for water supply and Bangalore depends entirely on the River Cauvery which has watershed in Tala-Cauvery and Bhagamandala in Western Ghats in Kodagu. When New York City faced severe drought conditions in 1980s, protection of Catskill and Delaware water bodies was taken up. The New York City Corporation made one-time huge investment to protect both forest and agricultural lands by compensating farming community, taking afforestation and also imposing restrictions on using chemical fertilizers and pesticides by promoting organic farming. This includes practices of sustainable farming, limiting use of fertilizers and preventing of dumping waste products. All these efforts have ensured high water quality with the strong partnership with local stakeholders and communities. This has led to increasing availability of clean water which serves a population of 8 million in New York even without the cost of water treatment. These challenging efforts to mitigate climate change led water shortage in catchment areas has reduced the huge cost of water treatment and ensured reliability of water supply. Whereas, in case of Bangalore city, drinking water needs of 8.5 million people rest with water drawn from the river Cauvery. Failure to protect the watershed of Western Ghats, unabated deforestation in the river catchments have largely impacted on the raining pattern which caused lasting catastrophe to end abundance of Cauvery Water. The reduced the flow of the water in the riparian states of the river Cauvery River rarely appreciate this fact and value the water and watershed of Western Ghats. Creating Cauvery River Watershed Protection Fund by the river riparian states particularly Karnataka and Tamil Nadu will help addressing climate change or droughts, helps afforestation efforts, compensates the farming community to protect the forests and ensures water availability for all the states. The creation of Payment for Ecosystem Services (PES) in Kodagu districts on the lines of New York City Model for conservation of forests in Kodagu district is very important for the sustainability of the river Cauvery river basin for meeting water demands of riparian states.

New York City has effectively adopted both supply-side (water enhancement) management through catchment area conservation and demand-side management by efficiently managing water by reducing the demand (See Figure 2). Both supply enhancement and demand reduction policies have effectively addressed climate change led water scarcity in New York City. The demand for water has come down from 1,500 million gallons daily to 1,000 MGD despite growth of population from 7.5 million in 1980s to 8.25 million in 2010 (Figure 2).

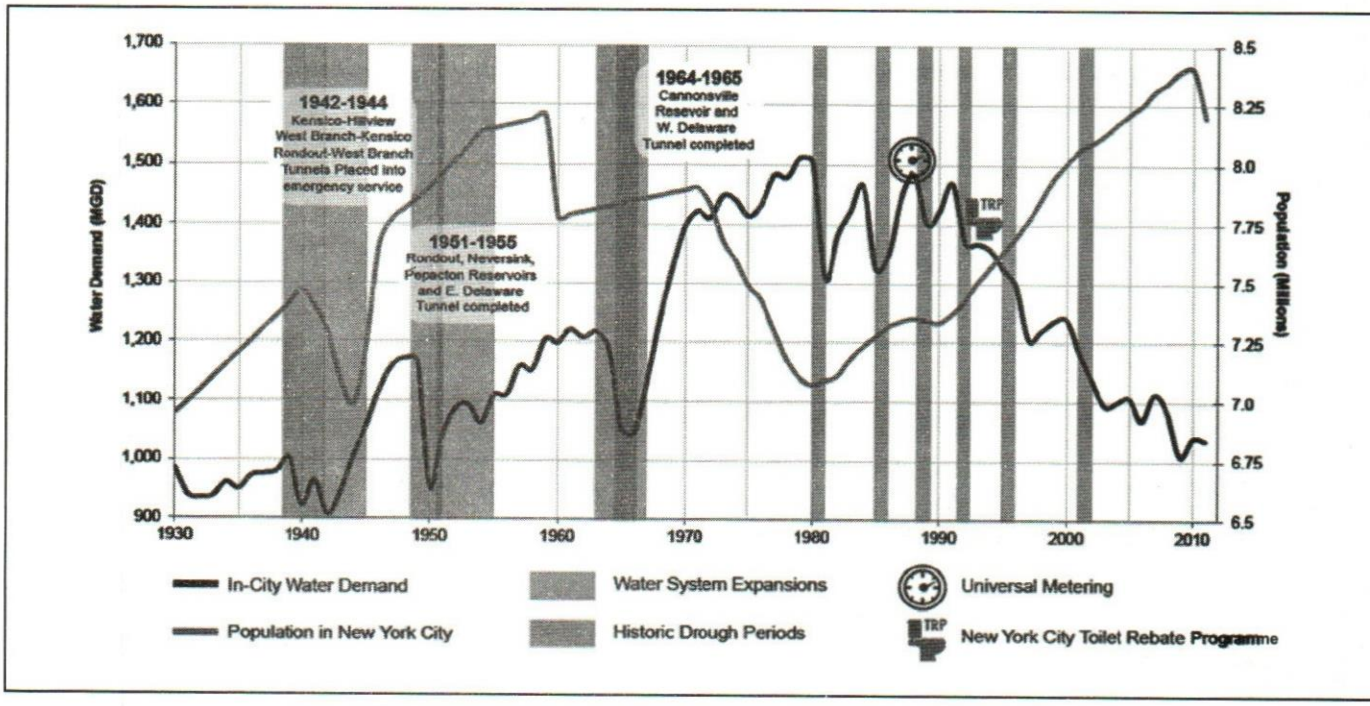


Figure 2: Supply and Demand Side Management of New York City Water

Whereas, Bangalore city regardless of climate change and water scarcity continues to depend on supply enhancement strategy which is leading to high rate of non-revenue water or UFW and revenue loss. The present status of water supply in Bangalore city shows that the city is excessively relying on surface water sources from the river Cauvery for meeting drinking water necessities with the unprecedented fall in the ground water table due to over exploitation and pollution of lakes in and around the city. The city is also constantly searching new water sources for meeting drinking water needs in future. Bangalore city currently receives 1,350 million litres Daily water meet the drinking water needs of 8.5 million people which is sufficient. However, water is supplied in alternate days with limited to 3–4 hours and water available at 50 LPCD which reflects growing water scarcity not due to non-availability of water but due to an increasing share (48 per cent) of Unaccounted for Water (UFW) in total water production (Figure 3). The shortage or inadequate provision of water in the city is mainly due to lack of demand side management including reducing the loss of water due to leakages and theft. The 48 per cent of UFW is very high compare to the optimum level of UFW in well managed urban water utility (5–10 per cent) in the world cities (Krishna Raj, 2013). This implies that the problem of water is not associated with economics or scarcity but politics (poor governance).

Cauvery Catchment area is 81,155 sqkm with average water yield of 21.4 billion cubic metre and all India average yield is 1,869 BCM whereas Brahma Putra is 537. The Ganges is 525 which represents low yield in Cauvery basin but high demand for water among riparian states for various agricultural, industrial and drinking water needs. Cauvery river basin with relatively higher degree of urbanization is also characterized by arid or semiarid climate with extremely low renewable water availability, and therefore cannot support high degree of urbanization unless water is efficiently managed or drawn from sources outside the basin. This reflects stark reality of water stress in the Cauvery Basin and calls for demand-side management of water including save the water at both utility and consumer level.

Today, even though water is becoming scarce commodity, due to obligation to people and their entitlement to right to water, governments are willingly not favouring markets to dominate water supply in many cities of the world despite cash crunch, inefficiency or institutional failures, etc. Under the globalization, markets tend to pose themselves with animal spirit (confidence) to manage water efficiently, but equity issues concern governments. Globalization has impacted on the growing stress of water resources with increasing corporate siphoning off of water for surplus production of various goods and services without treating and reusing wastewater this 'free-riding' approach systematically undermines societal drinking water needs. But there are international benchmarks in urban water management which show that without leaving water supply to market mechanism, government agencies have efficiently managed water in large metropolitan cities like New York. Therefore, India's ethos towards conservation of water and environment is just euphoria as people worship the rivers but hardly respect, value and conserve them including the most revered rivers, the Ganges and the Cauvery. The payment for ecosystem approach makes riparian states more economically and environmentally responsible in equitable sharing of water and avoid interstate water disputes.

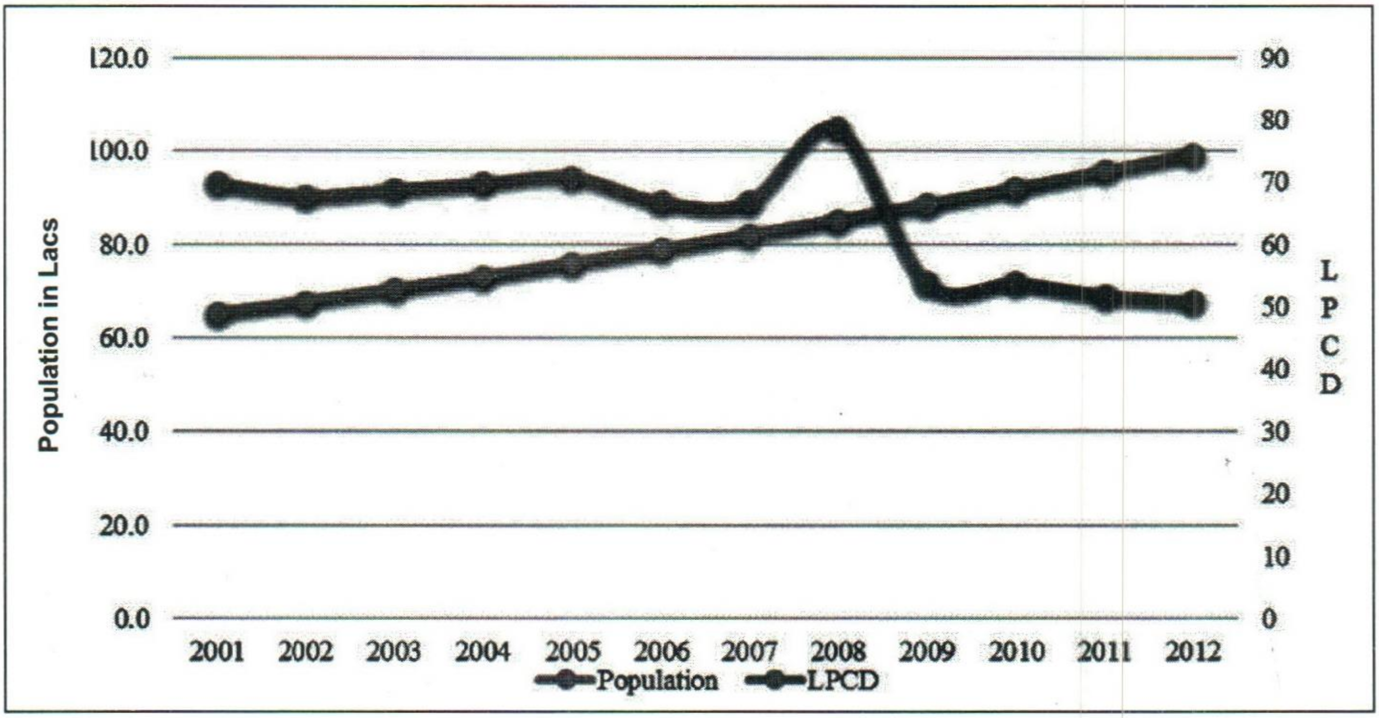


Figure 3: Reduction in per capita Availability of Water in Bangalore City

3. Understanding India's Growing Water Scarcity

Water crisis is increasingly being viewed in terms of increasing imbalance between water supply and demand; however, it's economic, ecological, social and health causes and consequences are pervasive in nature. The world water resources (both surface and ground) are unequally distributed among countries of the world. The world statistics on wealth of nations and water resources or availability suggest that countries with high GNP have also high per capita water availability. The paradox is that the Western developed countries abundantly endowed with water but largely export less water intensive industrial goods, whereas, developing countries scarcely endowed still export water intensive agricultural goods like rice and sugarcane. India with 2.4 per cent of the world's total area supporting 16 per cent of the world's population endows only 4 per cent of the total available fresh water. The international standard suggests that if per-capita water availability is less than 1,700 m^3 and 1,000 m^3 per year then the country is categorized as water stressed and water scarce, respectively. India is in threshold of reaching these stages as per capita surface water availability in the years 1991 and 2001 were 2,309 and 1,902 m^3. It is estimated that by 2017, India will be 'water stressed' with the decline in per capita availability to 1,600 m^3 (Biswas et al., 2010). Projections for the years 2025 and 2050 also show that per capita water availability will be further drastically reduced to 1,401 and 1,191 m^3 respectively (Kumar et al., 2005). The scarcity of water has been estimated based on per capita availability of water. Water scarcity is growing with increasing population and growing demand for water from all sectors of the economy; consequently, the per capita availability of water in parts of India is very low and it also varies in time and season. This clearly gives stark diagnosis of dwindling water resources in India with imminent realisms like growing population, sprawling utilization and ever expanding economic activities. Water demand for consumptive (drinking, health and sanitation needs) and productive uses (agricultural, industrial production, power generation, mining operations and navigation and recreational activities) has increased tremendously while water supply has declined with depletion and degradation of water resources causing water distress or scarcity. The progressive water shortage and competitive demand with mounting population and economic growth has posed a challenge to water management particularly in the context of equitable access to water and its benefits. This will largely alter economic activities and limit productive capability of the economy. The declining trend in the economic contribution of water resources has occurred due to physical and economic water scarcity which results in insufficient use, poor management, declining water productivity, and increasing environmental and economic costs (Figure 4). Obviously, the outcome is growing imbalance between water needs and supply augmentation capability in the country. Inefficiency in water use and management mainly caused by market failure, poor property rights and improper allocation has further complicated operationalizing water policies.

Further, water demand and supply are particularly sensitive to variations in climate change. Alteration in water levels in river basins or stream flows, watersheds and ground water have already impacted on the performance of different sectors of the economy which results in search for alternate sources of water to ensure reliability of drinking water needs. For instance, residents over depend on ground water and water markets when water sources from piped water supply developed into irregular and insufficient. This situation is aggravated the ground water depletion in India causing water quality to deteriorate with the depth of extraction which directly imposes health cost on the society and limits system's resilience. The climate condition makes water scarce and expensive. Recent estimates indicate that 20 per cent of global water scarcity is directly induced by climate change. The climate change can also exacerbate water scarcity which can cost 6 per of India's GDP. Besides, depletion of quantity and degradation of quality of water has restricted the availability of water for consumptive and productive uses and consequently caused 'negative externality' which imposes high economic and social cost on the society. India faces serious water problems throughout the year (8 to 12 months) as per the World Bank study (Figure 5) which has a serious implication on production and consumption behaviour of economic agents. The detailed inter-linkages of drivers, pressures and economic impacts of water resources are discussed in the Figure 6.

3.1 Water Poverty and Growing Water Market

Water poverty is already ubiquitous in many parts of rural and urban areas where water access is limited due to deficit in supply exceeding demand. Water scarcity, water use inefficiency and inequity in water distribution have already resulted in prevalence of water poverty all over India. In many villages and cities water availability both surface and ground water is limited, access to drinking water is reduced, water use efficiency is low. Water poverty Index estimates the water stress due to water scarcity and availability of water among socio-economic groups. This shows that poor households often suffer from insufficiency, unsafe, inaccessible, unaffordability of water which result in economic loss of labour and time. Majority of the Indian cities despite growing scarcity of water have achieved neither equity nor efficiency in water supply and sufficiency (Krishna Raj, 2015). The details of slab-wise water connections and consumption (2013) in Bangalore city (Table 3) shows that about 68 per cent of water connections at less than 25000 water slabs in the city consume 32 per cent of water or (127 million litres daily), whereas, 32 per cent connections above 25,000 water slabs consume high quantity of water at 68 per cent water or 273 MLD. This shows high water inequality in water consumption of rich and poor households. Further, 32 per cent of connections or households consume or get 28 litres per capita daily

Table 3: Water Inequity in Bangalore City

Slabs	No. of Connections	Consumption in MLD	Consumption per HH or connection	Per capita Water Consumption	Water Rates Per 1000 litres (Rs.)
0–8000	1,87,055 (32.2)	21 (5.2)	111.3	28	6
8001–25000	2,05,863 (35.4)	106 (26.5)	514.2	129	9
25001–50000	1,43,990 (24.8)	165 (41.3)	1148.6	287	15
50001–75000	34,457 (5.9)	68 (17.0)	1969.0	492	30
75001–100000	7,275 (1.3)	21 (5.2)	2853.9	713	36
>100001	2,701 (0.5)	19 (4.8)	7154.4	1789	36
Total	5,81,341 (100)	400 (100)	688.0	172	-

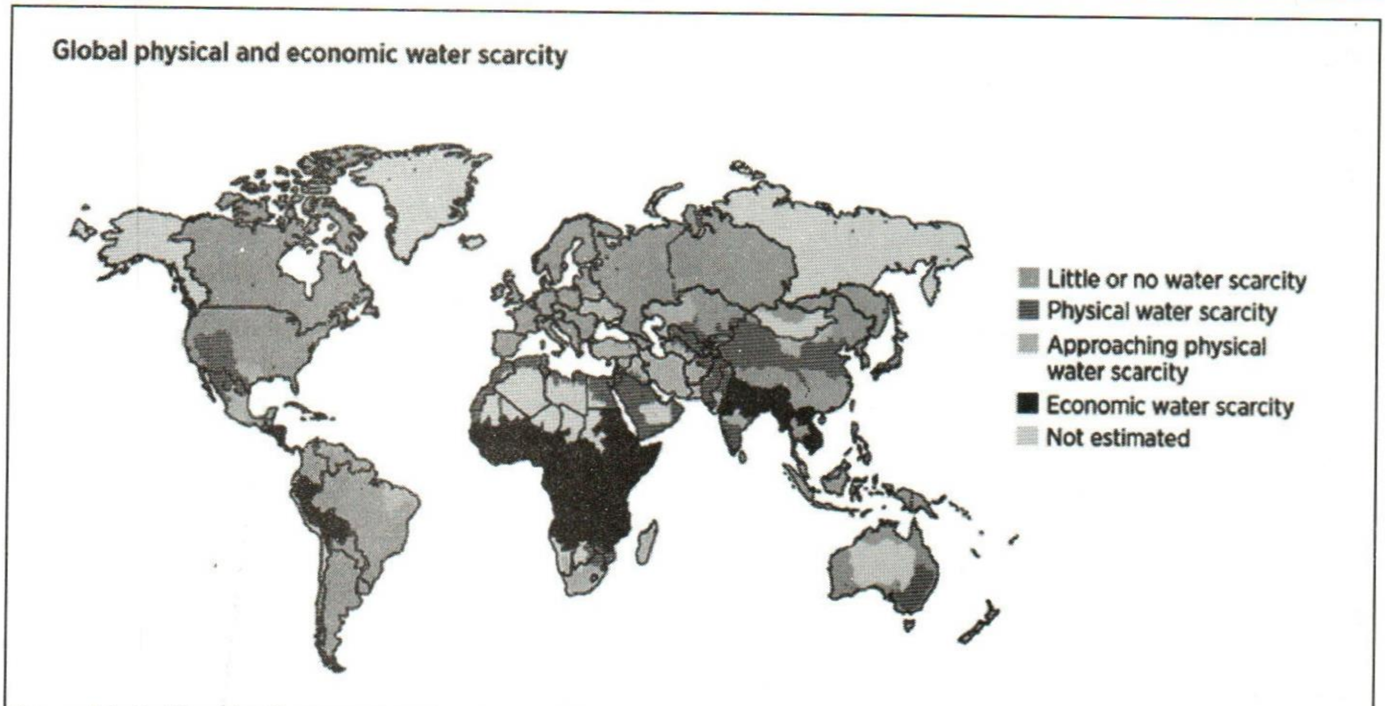
Source: Author's Estimation using BWSSB Data (2013).

which is highly insufficient whereas the remaining 68 per cent households consume from 129 to 1,789 LPCD. The water consumption differentials cause water inefficiency and households depend more on water market to meet the insufficiency in water availability.

The inequitable distribution of water among various socio-economic groups and inefficient use of water with high theft of water without legal connection, leakages, wastage of water have clearly reflected in intermittent supply of water which imposed high costs on the society or economy as water market emerged as alternative to the public water scarcity. Increasing inaccessibility to potable water supply, people are increasingly depending on market for meeting their drinking water needs particularly from private water suppliers such as bolted or packaged water industry. The demand for packaged water is in increase due to health concerns among the people with increasing pollution of water bodies particularly ground water and also poor quality water supply by public water supply authorities. The Karnataka state, as per the Bureau of Indian Standards, has 200 bottled water manufacturing industries. Private appropriation of water bodies has resulted in absolute loot of ground water in the absence of ground water regulation authority. Augmentation of drinking water supply through an integrated approach of accessing water from rivers, tank rehabilitation, rain water harvest and conservation and appropriate valuation of drinking water is a rational option. Bottling plants industries have been proliferated all over the cities making use of both surface and ground water indiscriminately for quick profiting. If they are not controlled ground water is siphoned off indiscriminately imposing high costs on the neighbours who depend on ground water for drinking. The unregulated ground water exploitation has resulted in water table has reached on an average 822 feet to get the water which clearly reflects the quantum of water extracted over replenishment. Bangalore and surrounding areas have 408 (Bangalore urban 283, Bangalore Rural 57 and surround districts), 64 (Kolar, Tumkuru, Chikkaballpur and Ramanagaram) comprising 57 per cent of the total bottling units of 708 in the entire state with an extraction of 1,500 litres to 25,000 litres. The scarcity of drinking water also reflected in the omnipresence of water tankers in many areas particularly where the water is intermittently supplied and newly added villages of BBMP. The water price for each tank varies from Rs 600 to 1,500 but water quality is not assured. The water poverty among lower income groups is highly prevalent in all the major cities of India.

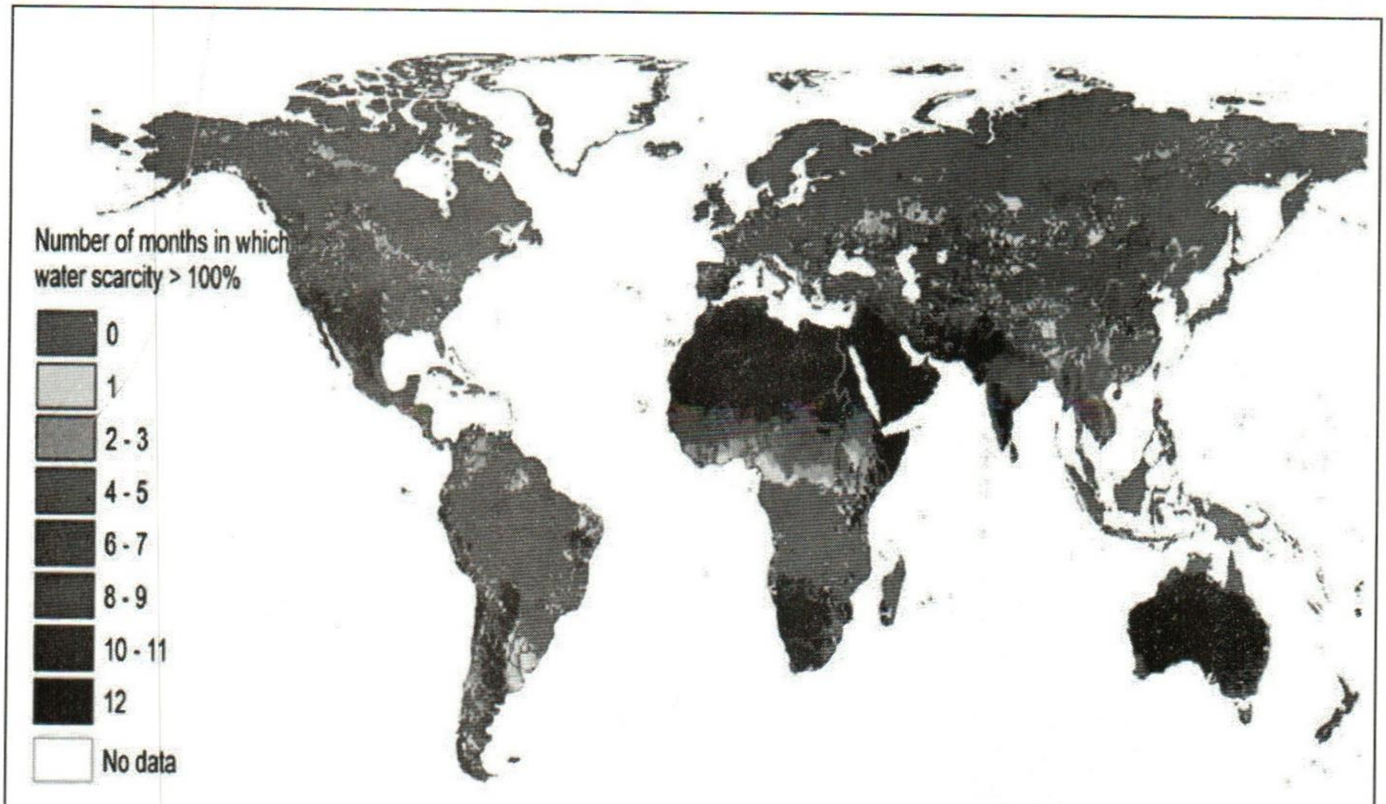
3.2 How to Achieve Water Efficiency

Water is an economic good and capital resources, the end of surplus or abundance gives the stark reality of the water economy. Therefore, the production and consumption behaviours of industry and consumers should be on the path of sustainable development practices. Drinking water is supplied at free of cost in major Indian cities which is cost high operation and maintenance cost. Universal water



Source: Adopted from the 4th World Water Development Report (2012).

Figure 4: India's Economic and Physical Water Scarcity



Source: World Resources Report (2011).

Figure 5: Climate Change-lead Water Scarcity in the World

metering and rationing can effectively reduce water theft as well as water leakage which are alarming high in many metropolitan cities of India. Water utilities need to change flat rate to meter billing to improve in the system performance and ensure water reliability and reduce consumption of water by 50 per cent. Further, all India campaign in support of production of water saving fixtures or taps, water tubs, and their replacement in all the households as government measure will reduce the water wastage or slow the flow of water, this policy measure which will save nearly 70 per cent of the drinking water. Replacement of high water flush toilets with low water consuming toilets will result in significant water saving. Waste water recycle and reuse is made compulsory for the industries, commercial establishment, apartments, malls, hospitals, institutes and large buildings. The city corporations should also prohibit sale of high flow showerhead, faucets, and toilets. Consumer awareness programme and computerization of water billing are more effective in water saving as proved in New York City where consumers receive text message for excess consumption of water may be due to actual use or wastage of water. New buildings should have rainwater harvesting provision which will reduce water consumption for gardening and other activities. Restriction on vanity projects like water recreation and swimming pools help reduce water or should be encourage to use recycled water rather using fresh or drinking water. Improvement of economic efficiency depends on evolving an effective water pricing mechanism considering the economic status and ability to pay by the households. Economic status influences the peoples' willingness to pay for improvement in access and quality of water supply. Policy of water pricing, therefore, needs to achieve two objectives simultaneously: recovery of the full cost of production from supply of water, and provision of efficient and reliable water supply service to the consumers. Without any provision for better water supply services, mere increase in water tariffs are doomed to fail in this objective as observed in many research studies.

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> *Since natural resources are finite, increased consumption must inevitably lead to depletion and scarcity.*
>
> *–Paul Ehrlich*

Focus

Water Productivity: A Perspective on Enhancing Ecosystem Functioning and Harvesting Opportunities

VIR SINGH AND NANDA NAUTIYAL

This paper attempts to present a perspective on water productivity in agriculture and in food and nutrition security. Water plays a central role and is vital for ecosystem functioning including productivity of its own, which is inevitable for ecological and environmental outputs, as well as for socio-economic well-being. Water productivity is one of the indicators of sustainable development. In some countries, like India, water resources are limited. Water resources in the Himalayan region are crucial for environmental balance and sustaining livelihoods in South Asia. Also referred to as the Third Pole of the Earth, the Himalayan Mountains need a region-specific development intervention to maintain high water productivity in the region. Various vegetational, social and engineering measures for ensuring sustainable water supplies could be used in the fragile mountain ecosystems. Water productivity is one of the central factors for ecological integrity of the biosphere. Judicious use of water, prevention and control of pollution, harnessing opportunities available in nature (e.g., native biodiversity and ecological regeneration of forests), workable water policies, conservation-oriented and water productivity-enhancing development intervention is an imperative for us to usher in a sustainable future.

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1. Introduction

Planet Earth is a water planet. It is due to being a water planet that the planet Earth is a Living Planet, the lone living planet in the cosmos. No life process can occur in the absence of life. Thus, water is not only a physical resource but also a phenomenon in itself. Water, along with carbon dioxide, in the presence of chlorophyll and light fixes itself into living matter.

Most of the Earth is water, and so are all the organisms. Proportion of water on planet Earth and in the living organisms is almost equal. Water stays in dynamism, so do the living organisms. Since all the living activities take place in the presence of water, the very dynamisms of the living organisms, in essence, is the dynamics of water itself. The productivity of life, therefore, has to be governed by water itself. In other words, productivity of water has direct bearing on the productivity of life.

Let us not regard productivity of life as number of living beings per unit area and time. When the productivity of life is referred to human life, it ought to carry a different notion. Productivity here carries the notion of socio-economic performance. Productivity of all the resources of basic human needs used as pertinent indicators to measure living standards is a critical criterion to have bearing on Gross National Product (GNP) of a nation. In the context of Bhutan, this productivity is directly related with Gross National Happiness (GNH). Thus, speaking ecologically, water productivity is, as it should be, the very basis of GNP and GNH. Productivity of life encompasses the whole philosophy of life. Productivity of water, thus, has to have bearing on the overall philosophy of life.

Water is not only critical to life, in the era of Green Revolution, since the 1960s, it has emerged as one of the most basic needs to increase and sustain food production. In the pre-Green Revolution Era, rainwater used to be the source of irrigation to a great extent. Since the 1960s, irrigation-water is a paramount need to ensure agricultural production. This has influenced the ways of water management. Now agriculture sector has emerged as the biggest consumer of water with as much as 72 per cent of global and 90 per cent of developing-country water being diverted for irrigation purposes alone (Cai and Rosegrant, 2003). Irrigation-water, the major chunk of water of human use, is all that matters to sustain food security of the masses. Further, industrial sector is also not lagging behind in water consumption. In the Globalization Era, competing industrial sectors are at the state of proxy war with each other over limited water resources.

Water needs will increase with an increase in human populations. World's human population is projected to increase to 7.8 billion by 2025. Continuous increase in human population would increase pressure on limited water resources for agriculture production purposes. Industrial production would also increase with human population. On the whole water management is going to face myriad challenges in the times to come.

Thus, water productivity, i.e., the physical or economic output per unit of water application, as elaborated in the special context of water consumption in relation to food production by Molden (1997), Molden et al. (2001) and Cai and Rosengrant (2003), appears to be a promising criterion to develop strategies of water management to sustainably fulfil the basic needs of our contemporary world.

2. Water Productivity in Agriculture

Our sustainable future depends on sustained supplies of food. As food production is an ecosystem function and water is one of the components of an ecosystem vital for ecosystem functioning, food production can be considered as one of the functions of water. Increasing food productivity requires certain amount of water. If the amount of food production is higher per unit of water involved in ecosystem functioning, it would infer that water productivity is also higher. Food productivity, thus, is a function of water productivity. The higher the food productivity per unit water, the higher the water productivity (in terms of food production).

Water productivity (WP), according to Cai and Rosegrant (2003), is defined as crop yield per cubic metre of water consumption (WC). The WC embraces two types of WCs, viz., beneficial water consumption (BWC; crop yield contribution of water at river-basin scale) and non-beneficial water consumption (NBWC; distribution and conveyance losses to evaporation and sinks). Whereas BWC is of direct economic consequence and is characterized in water use efficiency in agriculture, NBWC is not economically reusable, although it has its own environmental implications. The following are the equations (Keller et al., 1996; Cai and Rosegrant, 2003):

$$WP\ (kg/m^3) = \frac{P\ (kg)}{WC\ (m^3)}$$

$$WC = BWC + NBWC = \frac{BWC}{BE}$$

where,

WP = Water productivity

P = Crop production

WC = Water consumption

BWC = Beneficial water consumption

NBWC = Non-beneficial water consumption

BE = Basin efficiency

The WP varies from region to region, from area to area in the same region and from field to field in the same area depending on many factors (Figure 1). The WP can be enhanced by increasing crop production (P) and/ or by decreasing WC, which would also depend on many factors.

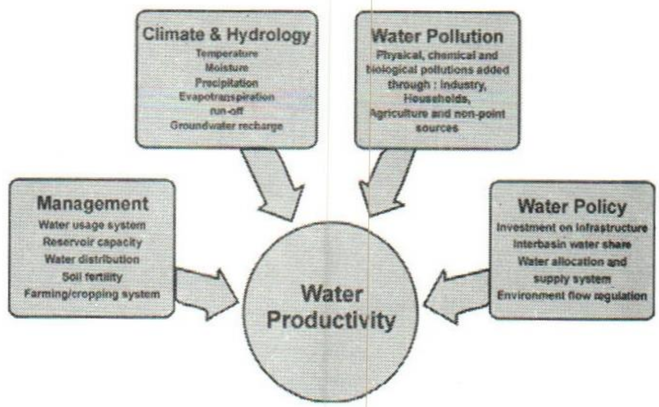

Figure 1: Factors Influencing Water Productivity in Agriculture

Development of seed varieties of higher water use efficiency, designing irrigation systems (such as sprinklers) to prevent wastage of excessive water, efficient management of water resources including rainwater harvesting, increased recharge of groundwater sources and regulating water cycle through intensive forestation on uncultivated lands especially in the Himalayan Mountains, etc., are some of the measures through which we can utilize limited water resources of the country as efficiently as possible towards boosting development processes which inevitably require applications of adequate water.

Water productivity is expected to increase at a global scale by 2025. Projecting water productivity by 2025 based on their estimates of 1995, Cai and Rosegrant (2003) inferred that the global average water productivity would record an increase from 0.39 to 0.52 kg/m^3 and from 0.67 to 1.01 kg/m^3 for rice and other cereals, respectively. Increase in crop yield to a great extent and improvement in water basins to a lesser extent would be the reasons for the enhanced water productivity by 2025 and beyond.

3. Water Productivity in Food Security

With more than 17.5 per cent world's population, India's share in world's water sources is only about 4 per cent. On the whole, India is a water-stressed country. Adding fuel to the fire, water pollution prevailing almost throughout takes big toll annually. According to a recent report (Arthur, 2016), as many as 37.7 million Indians fall ill annually due to lack of water sanitation with as many as 1.5 million children dying of diarrhoea alone. As many as 66 millions of people in India are compelled to drink water with excessive fluoride, while another 10 million are cursed to be dependent of groundwater with excessive arsenic.

In a water stressed region or a country water productivity must be measured against access of populations to pure (uncontaminated and germ-free) water necessary to maintain human health and productivity in terms of output per individual per unit time to contribute to social/national development. With tall figures of morbidity and mortality associated with polluted water, the water productivity would naturally be seen as dismally low. This can be enhanced by preventing and controlling water pollution, implementing social, engineering, ecological, environmental and legal measures and ensuring supplies of pure and 'productive' water to our people.

Water is not a nutrient. But water is inevitable for nutrition. Digestion, absorption and assimilation of foods/ nutrients take place in the presence of water. All metabolic enzymes function only in aquatic medium. Thus, food security of a society or nation inevitably requires the primacy of potable water security—availability and access of populations to pure water for drinking and sanitary purposes. Productivity of water in this respect also links with food security. In this case, water productivity would be defined as the amount of available and accessible water ensuring food security of the masses. Underlying precondition is that for the food security to be ascertained there should be no dearth of availability of and accessibility to healthy foods.

The criteria of water productivity for food production and for food security are to be adjudged differently. In case of agriculture, minimum possible water pronounced in potential production will be indicative of high productivity. However, digestion, absorption and assimilation of foods/ nutrients cannot be compromised or ensured by 'minimum possible' water. Water productivity pronounced in food security fulfils the water use efficiency or the 'minimum water, maximum food production' principle in agriculture, i.e., in creating availability of food. The second and more pertinent part of food security, i.e., digestion, absorption and assimilation of food, embraces no criterion like 'minimum water, maximum digestion, absorption and assimilation of food' or 'water use efficiency in nutrition'.

Water productivity necessary for ensuring food and nutrition security of a society or a nation would emanate from the water management systems, water policy, infrastructure and natural factors. Our water-related security aspects are challenged by increased chances of environmental pollution. Preventing water sources from getting polluted and unhealthy, rather than depolluting it by means of a variety of chemicals and physical measures, must be the primacy of our water-related management systems and national water policy.

4. Third Pole of the Earth

Most of the water sources on Earth have been polluted to a certain degree. Only the Himalayan waters (and some sources in the other mountains and highlands of the Earth) are regarded to be pure sources of potable water. The Hindu Kush-Himalayas (HKH) extending into the boundaries of the eight Asian nations—Afghanistan, Pakistan, India, China, Nepal, Bhutan, Bangladesh and Myanmar—are the largest storehouse of fresh water in the lower latitudes and as such serve as important 'water towers' for more than 500 million people.

The highest, the youngest and the most fragile mountains of the HKH provide origin to major river systems, viz., the Indus, the Ganga, the Yarlung-Tsangpo, the Brahmaputra, the Nu Salween, the Yangtze and the

Mekong. The HKH Mountains are also called as the 'Third Pole', for they contain the largest mass of ice and snow outside the Earth's Polar Regions. There is a permanent snowline above 5,000 m. Some of the glaciers in the region are longest outside the poles of the Earth (Banskota and Chalise, 2000).

Himalayan mountains' water productivity must be gauged in terms of the amount of snowfall to maintain cryosphere (glaciers-laden environment) and water flow per unit time (say annually) in perennial (snow-fed) streams to be used for all purposes in their basins before they eventually drain into Indian Ocean.

To keep the 'Third Pole' of the Earth preserved through assured conservation of the water resource is one the greatest challenges for our contemporary world. The HKH Mountains are the fragile natural resource. For the conservation of the waters of this region, the entire world needs to extend help and support. As the mountain ecosystems have enormous bearing on the Earth's systems, their special care, regeneration and conservation of their pristine resources would fetch happiness, peace and prosperity to the larger parts of the world. The Agenda 21, Chapter 13 of the United Nations underlines the importance of the mountains for the world as a whole: 'mountain environments are essential to the survival of global ecosystem'.

However, due to mal-development, mismanagement and continuous neglect, the Himalayas' aquatic resources are in hot waters. Dry spell all over can be witnessed, especially in summer season. In the land of plentiful water, most of the villages are suffering from the lack of drinking water. Majority of the people do not have easy access to potable water. Only some 10 per cent of the arable land is irrigated, and the rest 90 per cent depends on rain. So gloomy is the situation in the area that provides origin to numerous rivers draining almost the entire plains of North India (Singh, 2005).

The Uttarakhand Mountains are especially rich in their water resources. This area is home to dozens of perennial streams and numerous other rain-fed rivers along with innumerable rivulets, waterfalls, ponds, etc. India's largest river system—the Ganga River System—also takes its origin in the Uttarakhand Mountains. In Garhwal Himalayas, the largest glacier Gangotri, the origin of the river Ganga, has an estimated volume of well over 20 km^3 of ice, which is much more than even the maximum capacity of storage created by the Bhakra Dam on Sutlej, which is less than 8 km. This glacier, unfortunately, now continues to recede. Apart from these streams and rivers, there are several lakes in the area as also the perpetual ice fields and glaciers.

Uttarakhand's glacier-fed rivers are being seen only as a potential source of hydropower. Mega projects carrying potential risk to ecology as well as to humanity, like the Tehri Dam Project, have been constructed. Ruthless mismanagement of Himalayan waters might trigger potentially negative consequences not only in Uttarakhand but also in the entire Indo-Gangetic Valley. Aquatic ecology in the mountains, on the whole, is in a bad state, affecting the integrity of the entire food production system (Singh, 2005).

As Himalayan mountains supply water through perennial and rain-fed streams, rivers and rivulets to a vast area of South Asia, water productivity of the Himalayan region must be measured in terms of the amount of water that is utilized in the whole basin for drinking, irrigation, groundwater recharge, industry and domestic purposes, etc., before it is drained into the Indian Ocean. To enhance Himalayan water productivity to its maximum level, we would have to rely on ecological development of the region. Himalayan mountains constitute extremely fragile ecosystems. At the same time, they harbour extreme biodiversity. Further, high degree of inaccessibility limits efforts for development intervention. Therefore, ecological development of the region is a bit complex phenomenon (Singh et al., 2014). Eco-development intervention in tune with mountains' specificities is an imperative for better management of the Himalayas' waters.

5. Restoring Productivity of Potable Water Sources in the Mountains

Potable water sources in the Himalayan Mountains of Uttarakhand, locally called *naula* (step-wells), are in crises due to several ecological and social reasons. Such springs are found to occur at the intersection of sloping ground and impermeable strata with the ground water table. In most cases, the water sources of such springs are unconfined aquifers where water flows under gravity (Negi and Palni, 2009). Due to a number of environmental crises exacerbated by anthropogenic factors, potable water is increasingly becoming inaccessible to local populace in the mountains. As a result, increased frequency of social conflicts is also apparent in the region.

It has been found that the rate and total flow in springs is positively correlated with rainfall pattern. In recent years, owing to ominous climate change, rainfall pattern has been quite erroneous. According to Negi and Palni (2009), only as little as 0.18–2.59 per cent of the annual rainfall is collected as spring discharge. This leads to faster recession of the springs.

Productivity of drinking water in the specific context of the mountains' such 'small-scale' water sources would convey availability of water to the local population for drinking, for making their livestock drink and for other domestic purposes. The water productivity, measured in this context as the number of households a particular water source (such as, a spring) would fulfil the drinking and other domestic needs without undergoing stress of its over-exploitation, is a major concern of the majority of mountain people in relatively remote rural areas.

How to boost and restore water productivity for socio-economic and ecological well-being of the mountain areas? There are three potential measures, as also mentioned by Negi and Palni (2009), which we must pursue and ensure to implement, viz, vegetative, social and engineering measures.

5.1 Vegetative Measures

- Plantation of site-specific native plants such as *Quercus* spp., *Alnusnepalensis*, *Prunuscerasoides*, etc., and raising plant biodiversity that can flourish in the chosen area;
- Application of leaf litter to barren spots to check evaporation and enhance water filtration into land;
- Protection of the area from grazing, cutting of trees and fire incidents.

5.2 Social Measures

- Consultation of local people regarding choosing of native vegetation and engineering designs;
- Participation of people in the resuscitation of water sources through ecological regeneration of deforested lands;
- Encouragement of rationing of water to avoid over-exploitation of the resources.

5.3 Engineering Measures

- Protection of water sources by means of bio-fencing;
- Harvesting of rainfall using appropriate techniques;
- Construction of mid-and-stone ponds and alkathene ponds to collect rainwater.

6. Water Productivity and Ecological Integrity

Water, in fact, is the most important factor to strike ecological integrity of the biosphere. Hydrosphere of the planet is more dynamic than lithosphere, but less dynamic than atmosphere. It is hydrological cycle that governs the very ecological integrity of the biosphere. Simultaneously occurring in all the three states of the matter—solid, liquid and gas—water carries distinctive and most extraordinary properties. It is thanks to hydrological cycle that the whole biosphere blossoms with life. Water productivity at ecosystem, regional and global scales itself is a function of water cycle. Water cycle is a natural phenomenon. However, it is largely influenced by anthropogenic factors. Water productivity in agriculture and food and nutrition security is 'governed' by the ways we manage our agriculture and settlements (villages, towns, cities). Vegetation of the ecosystems plays crucial role in global water cycle. Since most of the ecosystems now cease to be natural due to humans' large scale 'development intervention', the global cycle is to be, as it is being, influenced by anthropogenic factors.

Photosynthesis, through which solar energy is fixed into living (biochemical) energy, feeds the biosphere. It is photosynthesis through which water becomes an integral part of the living organisms. It is photosynthesis which creates a living dimension of global pathway of water dynamism. It is photosynthesis which determines the patterns of global climate, making it benevolent for the biosphere. Photosynthesis, in essence, is a phenomenon to strike ecological integrity (Singh et al., 2014). Photosynthesis, however, itself is largely governed by anthropogenic factors, for most of the terrestrial ecosystems to inhabit photosynthesizing organisms (especially chlorophyll-containing green vegetation) are managed by human beings. Since structure and functioning of Earth's ecosystems is significantly influenced by anthropogenic factors, the on-going changes in global climate system are also owing to human intervention.

Water productivity of ecosystems, eventually, is a function governed by energy flows of the biosphere largely governed by photosynthesis; hence, by human factors. An ecologically sound management of Earth's ecosystems that leads to enhancement in photosynthesis to its maximum efficiency would be phenomenal in increasing water productivity to be pronounced in ecological integrity of the ecosystems.

Sustainable development, in essence, emanates from ecological integrity. Ecological integrity optimizes ecosystem functions, maintains ecological equilibrium, combats entropy and ensures flows of the ecosystem products of socio-economic significance, including water, foods and raw material of materialistic values. We can restore ecological integrity of our ecosystems through their ecological regeneration to their ecological climax state. Terrestrial ecosystems stocked with climax vegetation and vibrant with photosynthesis at maximum efficiency will serve as a cornucopia of socioeconomic development of our societies.

7. Conclusion

Hydrosphere is vital in regulating functioning of our biosphere. Productivity (both primary and secondary) is an ecosystem function. So is the water productivity. Overwhelming anthropogenic intervention has led to affect the overall water cycle of the biosphere leading eventually to affect water productivity of different ecosystems. Water productivity in agriculture, defined as crop production per unit of water, is of vital implications. Limited resources of water for irrigation pose problems to food production to keep pace with burgeoning human populations. Increased water productivity (maximum possible food production with minimum possible amount of water) is the key to ensure food supplies to future generations on a sustained basis. Opportunities to increase water use efficiency based on research findings, water resource management, agriculture/water policies, etc., are there for us to avail and implement effectively. The second and equally important aspect of food security is digestion, absorption and assimilation of nutrients in the food, which all are enacted by water. Availability of adequate potable water per individual needs to be ascertained to ensure food and nutrition security of our populations. Very wise use and conservation-based management is crucial for sustainable environmental, ecological, and food and nutrition security. As water security is a prerequisite of food security, our efforts for ensuring water security must precede our efforts for food security.

Water productivity decreases if the potable water gets polluted. Polluted water, in addition, costs public health. Prevention and control of water pollution will increase per capita availability of potable water and will also contribute to nutrition and health security.

Himalayan Region, owing to the third largest geographical area covered with snow and ice caps outside the two Poles—the North and the South Poles—is often referred to as Third Pole. This region provides origin to water sources for more than 500 million people in South Asia. For water security and enhanced water productivity, fragile mountains obviously require high density of climax vegetation with enormous diversity of all types of native plants–trees, shrubs, herbs, creepers, etc. Such vegetation, in addition to contributing biomass to cropland so crucial for soil fertility management, also responds to the problems associated with fragility of the Himalayan mountain ecosystems.

While coverage of larger mountain slope areas with dense climax vegetation is a key measure to ensure conservation-oriented management of water resource, ecological farming practices with special care to native biodiversity, water and soil conservation measures; minor irrigation systems built through local perspective planning; water harvesting techniques requiring prudent technology; and rational use of water resources to be made effective through policy perspective are some other important means of water management.

It is true that we have limited water resources, but they can also be increased in volume and amount with very little investment. Global water cycle knows no boundary. We can attract more water to our land through rains and snows. This phenomenon, in order to operate, would require extended length of time. Nevertheless, it goes on along ecological regeneration of our land resources. Large chunk of the nation's geographical area if is covered by natural forests, it would be conducive to trigger the environmental factors inviting more rain and snowfall over our territory. Moreover, large areas covered with natural forests will be instrumental in regulating water cycle with minimum soil erosion and controlled landslides on the one hand and in continuous recharging of rivers, streams and groundwater on the other.

We often hear many concerned citizens and environmentalists saying that the Third World War would be fought over water resources. Looking across the current intensifying conflicts between groups, states and countries, a larger war over water appears to be in the gestation period in the womb of the time. Water management, undoubtedly, is a key concern to world peace also. A radical change in national water policies with global consensus is also an obvious imperative of our times. Since the Himalayan area is shared by many countries in South Asia, a separate Himalayan Policy might be instrumental in restoring one of the most precious natural resources of the Earth.

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Fierce national competition over water resources has prompted fears that water issues contain the seeds of violent conflict.

–Kofi Annan

Focus

Improving Irrigation Water Productivity in Agriculture

O. P. SINGH

Water is one of the most important and scarce natural resources. It has power to enhance crop productivity by providing conducive environment to farmers to adopt improved agronomic practices, use of high yielding variety of seeds, chemical fertiliser, etc. Improving agricultural water productivity is important in overall managing agricultural water demand as 69 per cent of total water withdrawal is used for crop production globally whereas it is 82 per cent in India. The economic value of water use in agriculture is much lower than other sector. The present study was an attempt to find out different ways to improve irrigation water productivity. The overall objective of this study was to estimate crop water productivity under different situations. The study was based on primary data and it was collected from four Indian states, viz., Uttar Pradesh, Bihar, Punjab and Gujarat. Results suggest that irrigation water productivity was higher for diesel pump owner as compared to electric pump owner in Uttar Pradesh and Bihar. In case of canal and groundwater irrigation, water productivity was higher for groundwater irrigation as compared to canal irrigation in Punjab. In Gujarat, water productivity was enhanced by adoption of water saving technologies as compared to traditional method of irrigation.

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1. Introduction

Agriculture is one of the important sectors which provide foodgrains to feed the fast growing population of the country and provides raw materials to agro-based industries. Indian agriculture is one of the largest sectors which provides employment to 49 per cent workforce of the country and which is growing at the rate of 1.1 per cent per annum during 2014–15. Agriculture and allied sectors contributed about 13.9 per cent to India's GDP at constant 2004–05 prices during 2013–14. Water is one of the important and scarce natural resources has the power to enhance crop production by providing conducive environment for adoption of improved agronomic practices, use of high yielding variety of seeds, application of chemical fertiliser, etc. The Green Revolution Technology which was built through synergy of technology, policy, crop inputs, extension services and farmers, ushered in 1968, was also a success in those regions where assured irrigation facility was available like Punjab, Haryana and Western Uttar Pradesh.

The use of water in the world has increased by more than 35 per cent over the past three centuries. Globally, total water withdrawal and use was estimated to be 3,918 km^3 per year. Out of this share of water used for agriculture, industry and domestic and municipal uses was 69, 19 and 12 per cent, respectively (FAO, 2014). In India, the share of water use for industries, domestic and municipal uses and agriculture was estimated to be 10, 8 and 82 per cent, respectively.

Initially, supply side intervention was made to augment water availability for various uses including crop production in the country. Now, further augmentation of water through supply side intervention either fully utilised or has limited scope. The demand side interventions now become the key to the overall strategy for managing scarce water resources (Molden et al., 2001,18). Since agriculture is the major (about 82 per cent of total water use) competitive user of diverted water in India, demand management in agriculture in water-scarce region would be central to reducing the aggregate demand for water to match with the available future supplies, thereby reducing the extent of water stress that the country is likely to face (Kumar, 2003a and Kumar, 2003b, 1). Improving water productivity in agriculture is important in the overall managing agricultural water demand. The saved water from agriculture can be transferred to economically more efficient or other high priority sector (Barker et al., 2003, 23; Kijne et al., 2003, xi). The economic value of water in agriculture is much lower than that in other sectors including manufacturing (Barker et al., 2003, 22). Growing physical shortage of water on the one hand and a scarcity of economically accessible water owing to increasing cost of production and supply of the resources on the other, had preoccupied researchers with increasing productivity of water use in agriculture in order to get maximum production or value from every unit of water use (Kijne et al., 2003, xiii). Rising water productivity is the important concept of any demand management strategy. The definition of water productivity is scale dependent. Water productivity can be analyzed at the plant level, field level, farm level, system level and basin level, and its value would change with the changing scale of analysis (Molden et al., 2003, 2). The classical concept of irrigation efficiency used by water engineers omitted economic values and looked at the actual evapo-transpiration (ET) against the total water diverted for crop production (Kijne et al., 2003, xii). Moreover, it does not factor in the "scale effect" (Keller et al., 1996, 2). Increasing the productivity of water in agriculture will play a vital role in reducing competition for scarce resources, prevention of environmental degradation and provision of food security (Molden et al., 2003, 5).

The water productivity can be measured in three dimensions, that is, (a) physical water productivity expressed in kg per unit of water consumed (kg/m^3); (b) combined physical and economic water productivity expressed in terms of net return per unit of water consumed (^{1}/m^3); and (c) economic productivity in terms of net income returns from a given amount of water consumed against the opportunity cost of using the same amount of water (Kijne et al., 2003, xiii). There are two major ways of improving the physical productivity of water used in irrigated agriculture. First, the water consumption or depletion for producing a certain quantum of biomass for the same amount of land is reduced. Second, the yield generated for a particular crop is enhanced without changing the amount of water consumed or depleted per unit of land. Often these two improvements can happen together with an intervention either on the agronomic side or on the water control side (Kumar et al., 2008a, 122).

1.1 Context

The crop water productivity is varying from crop to crop, methods of irrigation and sources of irrigation water and price paid by the farmers for water and energy use. Major sources of irrigation water in the country are groundwater and surface water. Among the different sources of surface water (i.e., canal, ponds, tanks, rivers, etc.), canal irrigation is one of the important source for providing irrigation water to the farmers and water charges for the canal water is fixed by the state government on the basis of type of crop and area allocated by the farmers under particular crop. Some Indian states were providing canal water free of cost to the farmers for irrigation purpose for example Uttar Pradesh. Under this situation, the marginal cost of using canal water is zero because canal water charges are fixed and farmers have no incentive to use less canal water for crop production. Under fixed price regime and less reliable source of irrigation, farmers tend to use more and more canal water when water is available in the canal to irrigate their crops. Due to this, farmers in canal command area were getting lower land and irrigation water productivity.

In case of groundwater irrigation, farmers are using electricity and diesel pumps for pumping groundwater. In case of electricity, almost all Indian states are providing electricity on subsidized rate to farm sector and they are charging energy on the basis of connecting load factors, that is, flat rate/horsepower basis. Marginal cost of pumping groundwater under the flat rate tariff regime is zero, because farmers are paying fixed energy charges and they do not have any incentive to run their pump for fewer hours. Therefore, farmers tend to using more irrigation water for crop production. As a result of this, farmers are getting lower crop water productivity. In case of diesel operated pump or electricity charge based on actual energy consumption (for example, farmers in Gujarat are paying electric charge on actual energy consumption in farm sector), the marginal cost of pumping groundwater is equal to the cost of diesel or unit price of electricity. In this situation, farmers tend to use less irrigation water for crop production because they want to save cost of diesel/energy.

Therefore, farmers are getting higher crop water productivity as compared to canal irrigation and flat rate energy tariff regime.

In water scarce regions, farmers are using water saving technologies to irrigate their crop. Besides the different constraints associated with the adoption of water saving technologies, it helps farmers to reduce irrigation water use and enhance crop yield as compared to traditional method of crop production (Hapase et al., 1992, 898; Naryanamoorthy, 1996, 350; Naryanamoorthy, 1997, 728). The real water saving through the use of micro irrigation (MI) systems is a function of the crop grown, the soil type, type of MI technology, the climate and geo-hydrology (Kumar et al., 2008a, 122). Therefore, applied water saving also would be a function of the first three factors. The most perceptible impact of adoption of MI system is likely to be applied water saving, as it would be high in semi-arid and arid climate, sandy soils and for row crops. The saving of water would be more for drip irrigated row crops due to the reduction in non-beneficial soil evaporation (Allen et al., 1998, 72; Kumar et al., 2008b, 2).

1.2 Objectives

The overall objective of present study was to estimate the crop water productivity under different situations in different regions of India. The specific objectives of present study were:

a. To study the applied irrigation water productivity under different mode of energy pricing in Uttar Pradesh and Bihar;

b. To estimate applied irrigation water productivity under canal and ground water irrigation in Punjab; and

c. To compare applied irrigation water productivity under water saving technology and conventional method of irrigation in Gujarat.

2.0 Research Methodology

2.1 Sampling Procedure

The present study was based on the primary data. The primary data was collected from four different Indian states, viz., Uttar Pradesh, Bihar, Punjab and Gujarat, and it was selected purposively. Uttar Pradesh and Bihar have higher diesel pump density along with electric operated pumps in farm sector and farmers were using it for pumping out groundwater to irrigate their crops. Punjab has a high density of canal network and electric pumps for irrigated crop production. North Gujarat region of Gujarat is one of the water scarce regions in the country and farmers are adopting and using water saving technologies to irrigate their crops.

In case of Uttar Pradesh, the district of Varanasi was selected purposively for primary data collection. Two villages from Varanasi district were selected and the criteria for selection of these villages were that sufficient number of electric and diesel pump used by the farmers to irrigate their crop. From the both villages 60 electric pump and 60 diesel pump owners were selected randomly. In case of Bihar, two villages, that is, one village dominated by electric pump and another diesel pump dominated village from Patna district were selected purposively. From each village 60 farmers were selected randomly for primary data collection. In case of Punjab, two villages, that is, one village dominated by electric pump irrigation and another village dominated by canal irrigation were selected purposively from Hoshiarpur district. From both villages, 60 canal irrigated and 60 electric pump irrigated farmers were selected randomly. In case of Gujarat, primary data was collected from 49 villages of eight talukas from Banaskantha and Mehsana district. From the 49 villages, 114 water saving technology adopters and 51 non-adopter farmers were selected randomly.

Primary data was collected from selected sample farmers for all crops. The parameters for primary data collection included cost of ploughing, cost of human labour, cost of seed, cost of fertiliser, cost of insecticide, cost of irrigation, cost of harvesting, electricity charges, cost of diesel, canal water charges, types and cost of water saving technology, number of irrigation water applied by farmers for each crop, time required for each irrigation, crop output (both main and by-products), farm harvest price (both main and by-product), pump discharge rate, etc.

2.2 Analytical Procedure

2.2.1 Water use for crop production

For the quantification of irrigation water used for crop production following equation was used (Singh, 2004, 444):

$$\theta_{(m3)} = In \times H_{pi} \times P_d \qquad [1]$$

Where, $\theta_{(m3)}$ is total irrigation water used for crop production measured in m³/ha, I_n is number of irrigation given to a particular crop during crop period; H_{pi} is the hours required to provide one irrigation to particular crop,

P_d is the pump discharge rate measured as m³/hour.

2.2.2 Physical water productivity

The physical water productivity (kg/m³) for a given crop was estimated using the data on crop yield and the estimated volume of water applied to a particular crop. The physical water productivity of crop was estimated through following equation:

$$WP_{(kg/m^3)} = \frac{Q_{(kg)}}{\theta_{(kg)}} \qquad [2]$$

Where, *WP* is the physical water productivity of a particular crop measured as *kg/m³*, $Q_{(kg)}$ is crop yield measured in kg per hectare and $\theta_{(m3)}$ is the total irrigation water used during crop period measured in m³/ha.

2.2.3 Net combined physical and economic water productivity

For estimation of net combined physical and economic water productivity (₹ /m³), data related to the crop yield (both main and by-product), farm harvest price and total input costs were used. The combined physical and economic water productivity for crop production was estimated using following equation (Singh, 2004; Kumar, 2007):

$$WP_{(/m^3)} = \frac{NI_{()}}{\theta_{(m^3)}} \qquad [3]$$

Where, $WP_{(/m^3)}$ is the net combined physical and economic water productivity (₹ /m³); $NI_{(Rs)}$ is the net income received from a particular crop (₹ /ha) and $\theta_{(m^3)}$ is the total irrigation water used during crop period measured in m³/ha.

3. Results and Discussion

3.1 Impact of Energy Pricing on Water Use and Water Productivity

Crops grown during kharif season are consuming irrigation water along with rain water, but for estimation of crop water productivity, only irrigation water was considered. In case of paddy, electric pump owners were received higher physical water productivity (1.53 kg/m³) as compared to diesel pump owners (Table 1). Paddy crop is generally grown under the standing water and farmers are maintaining it in the paddy field during the crop period. In case of diesel pump owners, farmers are unable to maintain the required standing water in the paddy field due to high marginal cost of pumping groundwater, that is, cost of diesel. On the other hand, electric pump owners are maintaining required depth of water in paddy field because the marginal cost of pumping groundwater is zero under flat rate tariff regime. Due to this, electric pump owners were receiving higher physical and economic water productivity for paddy crop as compared to diesel pump owners in Varanasi district. Diesel pump owners were applying less irrigation water to all crops as compared to electric pump owners in the study area. The physical (kg/m³) and net economic water productivity (₹ /m³) were higher for all under diesel pump irrigation except for paddy crop. The highest net economic water productivity was observed in case of tomato followed by mustard and maize as compared to electric pump owner (Table 1).

In case of Bihar, electric pump owners were applying more irrigation water as compared to diesel pump owners for all the crops grown by the sample farmers (Table 2). The diesel pump owners applied 8.36, 22.98, 14.09, 13.71 and 9.84 per cent less irrigation water for paddy, wheat, potato, mustard and onion crops, respectively. The diesel pump owners were getting higher physical and net economic water productivity for all crops as compared to electric pump owners except for paddy crop.

3.2 Impact of Source of Irrigation on Water Use and Water Productivity

The major crops grown by the sample farmers in Hoshiarpur district of Punjab State during kharif season were paddy, maize and bajra. Major crops grown by the sample farmers during rabi season were maize and barseem (fodder crop) using canal and ground water. The net economic water productivity for all the crops was estimated to be higher for groundwater irrigation as compared to canal irrigation except for paddy and barseem crop (Table 3). In case of paddy and barseem, the net economic water productivity was higher under canal irrigation as compared to groundwater irrigation. Under the canal irrigation, sample farmers were using higher doses of irrigation water as compared to groundwater for all the crops. As the marginal cost of applying more water under canal irrigation was zero, farmers were paying fixed canal water charge on the basis of area under particular crop. Under groundwater irrigation, sample farmers were getting higher physical water productivity for paddy, maize and wheat crop as compared to canal irrigation, whereas in case of bajra and barseem higher physical water productivity was observed under canal irrigation. The higher net economic water productivity was observed for maize, bajra and wheat under groundwater irrigation, while it was higher for paddy and barseem under canal irrigation (Table 3).

Table 1: Irrigation Water Use, Crop Yield, Net Income and Water Productivity under Different Mode of Energy Use, Uttar Pradesh

Name of Season	Name of Crop	Irrigation water use (m^3/Ha)	Crop yield (Kg/Ha)	Net Income (¹†/Ha)	Water Productivity	
					Physical (Kg./m^3)	Net economic (1/m^3)
			Electric Pump			
Kharif	1. Paddy	2904.70	4444.19	10079.31	1.53	3.47
	2. Maize	685.80	2955.47	15749.69	4.31	21.51
Rabi	3. Wheat	2047.31	3221.25	14828.38	1.57	7.24
	4. Tomato	2430.00	15500.00	76828.13	6.38	31.62
	5. Potato	3199.90	18047.44	101180.84	5.64	8.71
	6. Chilli	3708.30	14536.54	71978.10	3.92	19.41
	7. Okra	3389.90	7796.77	36068.54	2.30	10.64
	8. Mustard	920.70	1233.74	10855.05	1.34	11.79
			Diesel Pump			
Kharif	1. Paddy	2770.20	4127.60	7064.01	1.49	2.55
	2. Maize	588.51	2938.95	14584.38	4.99	24.78
Rabi	3. Wheat	2255.92	4046.25	25294.38	1.79	11.21
	4. Tomato	1026.00	15437.50	67288.17	15.04	65.58
	5. Potato	2840.10	18261.84	44617.97	6.43	15.71
	6. Chilli	3001.90	12397.85	64330.72	4.13	21.43
	7. Okra	2981.50	7751.90	40071.36	2.60	13.44
	8. Mustard	694.50	1514.01	10945.32	2.18	15.76

Author's own estimate based on primary data

Table 2: Irrigation Water Use, Crop Yield, Net Income and Water Productivity under Different Mode of Energy use, Bihar

Name of Season	Name of Crop	Irrigation water use (m^3/Ha)	Crop yield (Kg/Ha)	Net Income (¹†/Ha)	Water Productivity	
					Physical (Kg./m^3)	Net economic (1/m^3)
			Electric Pump Owner			
Kharif	1. Paddy	2474.40	3191.98	12495.72	1.29	5.05
Rabi	2. Wheat	2265.10	3012.58	12299.49	1.33	5.43
	3. Potato	2355.30	26803.31	97038.36	11.38	41.20
	4. Mustard	1320.30	1848.42	18801.07	1.40	14.24
Summer	5. Onion	7061.90	29518.74	127749.77	4.18	18.09
			Diesel Pump Owner			
Kharif	1. Paddy	2283.50	2785.87	9978.90	1.22	4.37
Rabi	2. Wheat	1841.80	2983.72	10958.71	1.62	5.95
	3. Potato	2064.50	25393.35	88050.93	12.30	42.65
	4. Mustard	1161.10	1811.32	21155.24	1.56	18.22
Summer	5. Onion	6429.40	32018.41	133731.52	4.98	20.80

Author's own estimate based on primary data.

Table 3: Irrigation Water Use, Crop Yield, Net Income and Water Productivity under Canal and Ground Water Irrigation, Punjab

Name of Season	Name of Crop	Irrigation water use (m^3/Ha)	Crop yield (Kg/Ha)	Net Income ('†/Ha)	Water Productivity	
					Physical (Kg./m^3)	Net economic (1/m^3)
Groundwater Irrigation						
Kharif	1. Paddy	3318.50	1169.50	548.80	0.57	0.32
	2. Maize	598.70	941.70	1629.30	1.53	6.44
	3. Bajra	1497.90	6025.00	3425.50	7.82	0.43
Rabi	4. Wheat	915.40	1003.60	754.10	1.97	4.45
	5. Barseem*	1184.50	4864.60	9474.00	1.72	12.99
Canal Irrigation						
Kharif	1. Paddy	5849.80	1661.20	6183.80	0.41	1.50
	2. Maize	2600.00	880.00	4336.20	0.53	2.00
	3. Bajra	1935.80	8122.20	7358.20	10.41	0.09
Rabi	4. Wheat	1109.00	1100.60	2465.40	1.57	3.46
	5. Barseem*	2488.50	7216.70	16454.00	3.60	24.01

*: Green fodder crop

Author's own estimate based on primary data

3.3 Impact of Water Saving Technologies on Water Use and Water Productivity

With the adoption of MI system, the total irrigation water application rate had reduced significantly for many crops (Table 4). The reduction was more than 50 per cent in some cases, while insignificant in some others. The extent of reduction in irrigation water is function of the technology used for irrigation. This again is determined by the crop. For most of the crop, drip irrigation was used (castor, chilli, brinjal, cotton, fennel and pearl millet) by the sample farmers. For potato, cluster bean, groundnut and millet, micro sprinklers were used. Per hectare yield was higher for cluster bean, castor, groundnut, chilly, cotton, fennel, potato under MI system as compared to traditional method of irrigation. In case of brinjal, pearl millet and millet crop yield was lower under MI system as compared to traditional method of irrigation (Table 4). The net income for different crop was estimated by the subtracting total input cost

Table 4: Irrigation Water Use, Crop Yield, Net Income and Water Productivity With and Without Water Saving Technology, North Gujarat

Name of the Season	Name of the Crop	Irrigation Water use	Method of Irrigation	Yield (Qt/Ha)	Net Income (1/Ha)	Modified Net Income	Water Productivity	
							(Kg/m^3)	(1/m^3)
Before Adoption of Water Saving Technologies								
Kharif	Cluster bean	2549.00	Traditional	14.34	13194.24	13194.24	0.56	7.68
	Castor	7890.10	Traditional	21.40	21070.10	21070.10	0.27	3.04
	Groundnut	5602.80	Traditional	20.80	11133.74	11133.74	0.37	4.13
	Chilli	11500.00	Traditional	600.00	411833.33	411833.33	5.22	34.90
	Brinjal	5966.70	Traditional	466.67	157533.33	157533.33	7.82	44.91
	Cotton	7150.60	Traditional	32.72	68876.42	68876.42	0.46	10.30
	Fennel	2455.25	Traditional	7.17	12333.33	12333.33	0.29	6.30
Rabi	Potato	13964.90	Traditional	337.37	60684.85	60684.85	2.42	7.04
Summer	Pearl Millet	8368.20	Traditional	48.97	19771.10	19771.10	0.27	3.49
	Millet	11338.60	Traditional	59.00	26797.62	26797.62	0.52	2.15

After Adoption of Water Saving Technologies								
Kharif	Cluster bean	1305.00	Sprinkler	15.00	20575.00	17811.55	1.15	13.65
	Castor	7695.00	Drip	33.33	51150.00	40360.51	0.43	5.43
	Groundnut	5258.20	Sprinkler	21.78	27894.17	24039.10	0.41	7.70
	Groundnut	5258.20	Sprinkler	21.78	27894.17	24039.10	0.41	7.70
	Chilli	3540.00	Drip	750.00	524250.00	520162.19	21.20	146.90
	Brinjal	1180.00	Drip	250.00	86650.00	82562.19	21.20	119.00
	Cotton	3510.00	Drip	39.71	52822.88	29617.54	1.13	12.44
	Fennel	1728.00	Drip	15.84	23730.29	18034.76	0.92	36.91
Rabi	Potato	12721.40	Sprinkler	345.34	98024.13	93538.60	3.10	11.39
Summer	Pearl Millet	5030.80	Drip	40.68	15082.45	12494.82	0.81	3.84
	Millet	8776.10	Sprinkler	55.18	22099.55	19458.53	0.63	2.66

Author's own estimate based on primary data.

from the gross income. The modified net returns are obtained by subtracting the annualized cost of the MI system from the net return for the crops. The physical water productivity and net economic productivity was higher for all crops under MI system as compared to traditional method of irrigation.

4.0 Summary and Conclusion

Water productivity is one of the important concepts that is used by researchers, water resource engineers and policy makers to counsel farmers on which crop is more suitable in particular regions and how water productivity can improve without negatively affecting water resources and farmers' income. In case of electric and diesel pump owners, the irrigation water productivity was higher for all the crops that grown by the sample farmers under diesel pump irrigation with less water except for paddy crop as compared to electric pump. It means that when confronted with positive marginal cost of irrigation water, farmers are encouraged to use irrigation water more efficiently as found in case of Uttar Pradesh and Bihar. In case of canal and ground water irrigation, groundwater irrigators were using water more efficiently as compared to canal irrigators. Analysis showed that adoption of MI systems is leading to large-scale impacts at the crop and farm levels for both physical and socio-economic perspectives. Not only this, the reduction in water use is significant, but the income enhancement is quite phenomenal.

5.0 Policy Implications

From the study it was found that flat rate mode of pricing electricity and fixed water charges for canal water resulted in inefficient and unsustainable use of groundwater and canal irrigation (Kumar and Singh, 2001, 388; Kumar, 2005, 39). From this study, the outcomes for policymakers are:

a. The government should introduce pro-rata pricing for electricity in farm sector in place of flat rate tariff (as showing in case of diesel pump irrigators). It would create direct incentive to farmers for efficient and sustainable use of groundwater as it induces positive marginal cost of water application.

b. The government should introduce volumetric price for canal irrigation for efficient use of canal water. Introduction of volumetric price would create incentive for farmers to reduce use of canal water.

c. MI systems is playing an important role to enhance irrigation water productivity in water scarce regions. The government ispaying subsidy on adoption of MI systems. The subsidy amount is transferred to manufacturers of MI and ultimately farmers at the time of purchase. The government should provide subsidy on MI to farmers directly in phased manner. This would ensure the use of MI for longer period.

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> *A river seems a magic thing. A magic, moving, living part of the very earth itself.*
>
> *–Laura Gilpin*

Focus

Impact Assessment of Rainwater Harvesting SBI–CAIM Interventions in Vidarbha Region of India

JOGINDER SINGH, ARUN PANDHI AND AMITANSHU CHOUDHARY

The assessment of water harnessing intervention made by Navajbai Ratan Tata Trust in Vidarbha region of Maharashtra state of India indicated fruitful results in improving the economic lot of vulnerable small farmers. The water saved through various area-specific measures was used for providing 1–2 protective irrigations to cotton, soybean and red-gram crop, improving the crop yields by 2–3 qt per acre. It also minimized the soil erosion, introduced new potential crops raising the cropping intensity, boosted the livestock enterprises and addressed to the problem of shortage of drinking water in the area.

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1. Introduction

Vidarbha region in Maharashtra comprising of 11 districts, viz.,Yavatmal, Akola, Amravati, Wardha, Buldhana, Washim, Nagpur, Chandrapur, Bhandara, Gadchiroli and Gondia, has, for various reasons, remained backward. Livelihood of two-third rural population of this region is largely dependent on agriculture. However, majority of farmers operating small farm holdings faced comparatively low productivity of cotton and soybean which are the most important cash crops of region. Besides sloppy land with a shallow soil surface, rainfall distribution is not well spread, resulting in high run-off of water causing soil erosion. The rainwater harvesting is essential to ensure the distribution of entire year's monsoon water. This can be done through schematic interventions for watershed development, creating rainwater harvesting structures through small need-based farm ponds or collective initiatives. Runoff water conserved through in-situ and ex-situ measures of moisture conservation will be sufficient to provide one to two protective irrigations. In-situ conservation measures maintain high level of available soil moisture in the root zone and increase the ground water availability which is depleting very fast. Apart from this, the soil is deficient in nutrients; pest attacks are serious due to monoculture and various other social, economic and institutional gaps of this region contribute to lower productivity of crops. Moreover, dependence on rain and fast adoption of Bt cotton, which is more sensitive to shortage of water, has made cotton cultivation a high risk–high cost cultivation system in Vidarbha region.

The efforts made by the Navajbai Ratan Tata Trust in this direction were placed under Sukhi Balaji Initiative (SBI) and thus coverage of 320 villages in Yavatmal, Amravati, Wardha, Akola, Washim and Buldhana districts was further strengthened by the Government of Maharashtra which initiated a project, namely, Convergence of Agricultural Interventions in Maharashtra Program (CAIM) with the support of International Fund for Agricultural Development (IFAD) to address the agrarian distress issue in this region.

Initially it was started with IPM with the basic objective to rationally minimize the cost of agro-chemicals (fertilizers and pesticides) which were used indiscriminately on the cotton crop. The project outcome with startlingly significant cost reduction without adversely affecting the crop yield was exemplary. The project was further extended to other crops such as soybean, a short duration replacement for cotton and red-gram (*tur*), an intercrop for both. Realizing that water scarcity continued to be the fundamental issue of the farming, the measures to check soil erosion, adopt water harvesting techniques, enhancing water-use efficiency and moisture conservation techniques were focused simultaneously. Specific attention was given to *phad* irrigation, bore wells, drenching, bund making, contour cropping, drip and sprinkler irrigation, check dams, recharge pits and existing wells, etc., and planned at appropriate locations. To facilitate the process is short time, some organizations were made partners.

It was contentious to study the impact of such interventions made in the Vidarbha region, particularly on the farmers' economy. Therefore, this study was mounted with following specific objectives:

a) To study the support provided to the farmers for IPM and augmentation of water resource through rainwater harvesting and other water saving measures.

b) To examine the achievements and implications of these interventions on the livelihood of farmers covered under the project and analyse other social, economic and ecological impacts.

2. Methodology

Under the project, 320 villages from 6 out of 11 districts of Vidarbha region, namely, Akola, Amravati, Yavatmal, Buldana, Washim, Ralegaon have been covered. Due to farm-related problems of low yields, small farm size, poverty, water problem, exploitation by market middlemen, etc., certain specific interventions were made in terms of farm ponds, recharge pits, farm bunds, pumping sets, *phads*, micro-irrigation and various other low-cost structures. The impact assessment project was carried out in 2014–15. The detailed research plan was chalked out in collaboration of SBI and the following activities have been carried out. Keeping in view the interventions made for improving livelihood of rural poor of the area and study objectives specified, a farmer's questionnaire to capture the impact was prepared. A training of the 15 *krishidoots* (local extension workers) selected for data collection and compilation was organized. The data from 300 farmers of Yavatmal, Ghatanji, Ralegaon, Zari Zamani talukas of Yavatmal district were collected and compiled, which were further analysed with the help of various statistical tools such as averages, correlation, regression analysis and compound growth rates (CGRs). On the basis of such analysis, some inferences were drawn and are presented below.

3. Results

The district-wise secondary data for the area, yield and production of major crops in the region for the period 1998–99 to 2010–11 were analysed. The area under cotton crop in Yavatmal, Wardha and Buldhana districts did not show any specific trend. However, Washim, Amravati and Akola witnessed declining trend with CGR as -7.34, -6.29 and -4.60 per cent, respectively. The area under soybean did observe increasing conspicuous trend in all these districts with 15.17 per cent in Yavatmal, 15.75 per cent in Buldhana, 13.30 per cent in Akola and 12.21 per cent in Washim. The *tur* crop also showed increase in area but at slower pace. The average yield of cotton increased rapidly (2–4 times) due to introduction of Bt varieties, water availability and other production technology. The average yield of cotton increased at CGR of 9 per cent in Washim, Akola and Buldhana districts while increase was as high as 11.44 per cent in Amravati. The yields of soybean and *tur* crops varied widely from year to year and from one location to another.

3.1 Socio-economic Background of Respondents

An average family of respondents had 5.5 members, of which adult male, adult female and children comprised 44, 34 and 22 per cent. Though the major source of livelihood was farming, yet about 30 per cent reported to be engaged in off-farm employment (mostly they were doing labour on other farms, nonfarm jobs, opened small shops in the village and supplementary poultry enterprise). Quite a number of them maintained livestock such as cows, buffaloes and goat well integrated with crop farming. Yet a large number of those staying in agriculture indicated desire to get siphoned away to off-farm employment elsewhere, provided reasonable opportunities were created.

The average farm size did vary across the talukas but overall average worked out to 6.14 acres of which 5.59 acres was owned land and rest leased in from other landowners, mainly on cash rent basis. About 70 per cent farmers owned less than 2 hectares of land, falling under marginal or small farmers. Another 26 per cent were possessing 2 to 4 hectares farm holdings. Those with more than 4 hectare were negligible in proportion to the total number. Therefore, the project has targeted the vast majority of vulnerable farmers who are struggling for their livelihood. Regarding the topography of land, 64 per cent respondents had almost plain land while the rest 36 per cent reported to have sloppy and undulating land.

It is amazing that while the country is fast progressing in terms of farm mechanization, this region growing at a slow pace. Almost about 90 per cent respondents were having their own one or two pairs of bullock to perform various agronomic operations while only 4.3 per cent had owned tractors for this purpose. Custom hiring was resorted to by most of them depending upon the requirements and time urgency. Normally rates charged in case of custom hiring varied from one situation to the other but modal amount worked out to Rs 2,000/acre for land preparation plus sowing, Rs 1,000/acre for sowing only and Rs 2,000/acre for hoeing and inter-culture operations.

Upkeep of draught animals is costly and uneconomical. Maintaining own tractor by small farmers is also not advisable. But custom hiring of machinery is more feasible solution which needs to be advocated in the area. The farmers should be encouraged to organize self-help groups (SHGs) who jointly purchase the tractor and other matching machinery and manage for use by the member and non-member farmers. This would minimize the cost, help in timely and accuracy in farm operations and thus improve crop yields.

Cropping pattern: The most predominant crop of the area is cotton which covered over two-third of the cultivated area and soybean accounted for 16 per cent area on the sample farms. Thus, taking cotton and soybean together, 85 per cent was put under these two crops. Red-gram is an important pulse crop normally grown as intercrop with cotton or soybean with 8:1 ratio. The other crops included jowar, wheat, gram, vegetables, fruits and fodder crops. As compared to the cropping pattern of 2013–14, virtually, there was not much change in 2014–15.

Yield level: The crop yield on a farm is dependent upon soil fertility, irrigation water availability and a large number of other crop management practices. Therefore, it varied from farm to farm. On the whole, cotton yield averaged to 5.37 qt/acre and soybean yield recorded to be 5.85 qt/acre. In case of red-gram, yield averaged to 2.48 qt/acre in 2014–15. These yields were reported to be slightly higher than those of last year by 39, 34 and 22 kg/acre, respectively, possibly due to efforts made under the IPM project. The modal prices (price at which most of the transactions were made) were worked out. In case of cotton, price realized by the farmers was Rs 5,000/qt, for soybean Rs 4,000/qt and in case of red-gram, it came out to be Rs 3,900/qt. The impact of the project due to yield improvement thus was estimated as Rs 195, Rs 136 and Rs 86 per acre.

Livestock: Apart from draught, animals kept by about 90 per cent respondents, livestock for milk and meat purposes was kept by the farmers as complementary enterprises. The goat is a potential animal of the area due to availability of forest and barren lands with bushy plants and pastures which are helpful for them to thrive upon. Fast breeding of this animal for sale is an important source of livelihood.

Water harvesting component: Water is the most crucial resource of this area. Most of the other parameters including technology adoption and livelihood are dependent upon soil and moisture conservation. The surface soil of the area, by and large, is shallow in depth and topography is undulating. In spite of heavy rainfall with an average of around 1,000 mm, it causes rapid run-off causing soil erosion and water-logging at certain pockets and is also not properly harvested for use during critical months of the crop. It was, therefore, realized that appropriate water harvesting structures should be developed. The need was felt to:

a) Increase productivity of rain-fed cotton farming in Vidarbha region through rainwater harvesting, intensive irrigation and better crop management;

b) To bring maximum crop area under protective irrigation and better soil moisture practices through in-situ and ex-situ conservation measures;

c) To augment the existing irrigation resources through provision of water lifting devices for filling of storage; and

d) To enhance water use efficiency through application of drip/sprinkle irrigations.

3.2 Interventions

Interventions in terms of various water harvesting technologies by the SBI partners were of following types:

- Farm ponds
- Community ponds
- Wells
- Recharge Pits
- Pumping sets
- Micro-irrigation: Drip, Sprinkler, etc.
- Farm bunding
- Check dams; Low cost water harvest structures
- Integrated watersheds and *phads*

The three major NGOs, namely, CSSM, VSS and SSP were roped in to carry out water harnessing operations in the area, a brief description of their work is given below:

1. **CSSM** reported to have made remarkable progress in this area in Yavatmal district, enhancing the livelihood of 579 farmers with two community ponds (each measuring 15 m* 15 m* 3 m depth) in Ganeshpurand Chuaki villages, two low-cost community ponds, stream deepening of 1,100 m in Wadagaon and Murzadi villages, 59 *boriband* water flow check dams, 163 recharge pits (each with 20 ft diameter and 10 ft depth), 251 sprinkler sets (each with 30 pipes + 8 nozzles), 4 drip irrigation and 50 oil engines for lifting water. The low cost community ponds have been developed using fibre sheets which has reduced the cost of structure to nearly one-third as compared to cement concrete structure. The cost depends upon the size of the water pond. In case of recharge pits with specification of 10 ft depth, most of the farmers got it excavated further to build up more capacity.

2. **VGSS in Ghatanji** reported two stream widening and deepening cases, 13 low-cost harvesting structures with *boriband* check dams, one with fibre glass sheet (which was partially damaged), 100 recharge pits (each measuring 20 ft diameter and 10 ft depth) were provided in 6 villages, namely, Pandorana BK, Pandorana KD, Mowada, Rajurwadi, Kotha and Hivardharea. To enhance the capacity, the pits were mostly deepened further by the farmers themselves along with farm bunding. This provided cover irrigation to about 200 acres. Stylo grass was planted around the cavities which helped in check of soil erosion and provision of livestock fodder. In 6 villages 225 sprinkler/drip irrigation set were also provided.

3. **SSP in Washim** Stream widening and deepening 185 m + 180 m + 130 m in Valki village and 168 m in Adolki village was a major work carried out by it. It got excavated a community pond of the size 15 m* 15 m* 3 m depth in Pandavuvra village ensuring economic benefit to 68 acres. As many as 121 sprinkler/drip irrigation sets were arranged. The number of recharge pits 20 ft dia, 10ft deep was 120 and farm bunding with excavated soil was done. Most of farmers deepened such pits further in 7 villages (Walki, Adolki, Pandavuvra, Tandli, Kokalgaon, Velgaon and Nagthana).

Some sites visited to understand the rainwater harvesting systems and structures and their impact on farm economy were estimated. Typical cases and their impact assessed about these interventions are explained below:

(i) **Farm pond:** To store water in the rainy season on the farm for its use during scarcity, a pit is excavated on the lower surface of the field. The entire field serves as its catchment area. The soil is generally hard such that there is minimum seepage from it and the stored water can last for a few months which are hence made use of to provide protective irrigation to the crop. Normally grass is planted on its banks to have minimum depletion of soil and prolong the life of the structure.

(ii) **Recharge Pits:** A recharge pit is normally excavated earth pit of artificial recharge structures, which is sufficiently deep to penetrate the low-permeability layers overlying the restricted bottom area. In such structures, the infiltration generally occurs laterally through the walls of the pit or a cavity connected with it through a filter to minimize soil filling in it. The cost of a recharge pit of 20 ft diameter and 10 ft depth along with farm *bunding* made out of dug out soil amounted to Rs 20,000 which was shared by farmer 20 per cent and NRTT 80 per cent. Most of farmers deepened further at their own cost for increasing the capacity of pit to store water.

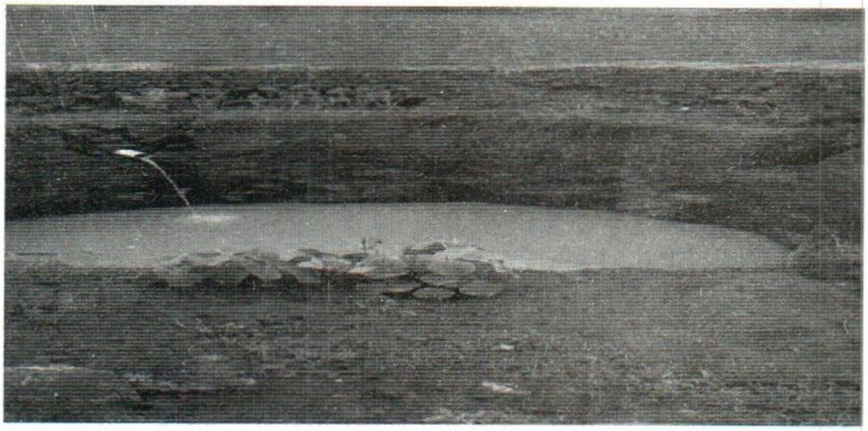

Figure 1: A Recharge Pits in WarudVillage of Yavatmal CSSM

(iii) Community pond: Depending upon the topography of land, pond be dug common for a few farmers or the entire village, called as community pond. Community ponds of the size 15 m* 15 m* 3 m were excavated in certain villages where flowing water stream goes waste. The average cost of such a pit was estimated as Rs 25,000, 10 per cent of which was shared by the farmers apart from taking the responsibility of regular cleaning and maintaining it.

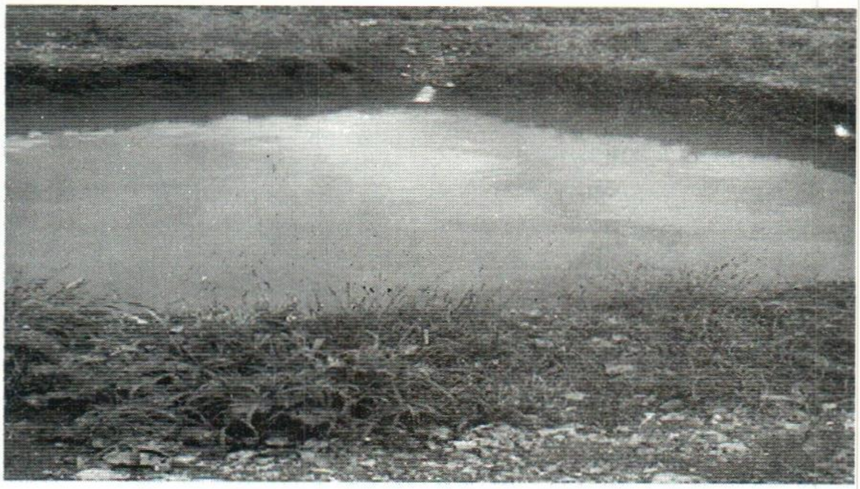

Figure 2: A Case of Community Pond

Ganeshpur village has highly undulating land. A canal is passing along the village land and facilitating irrigation to the adjoining farms. Those located away from it are totally rainfed. Water flowing in a drain nearby during the rainy season was tapped with the effort of SBI to form a pond, proving a check on the water on a community land. The water is thus stored in the rainy season for use for proving protective irrigation during the scarcity period. For lifting the water, one pump with a sprinkler set was provided to every three small farmers on subsidy. As many as 27 sprinkler sets has been provided in the village. This community pond has coverage of 30 acres and almost two irrigations are provided depending upon the availability of water in the pond which further depends upon the precipitation in the catchment area. The crop yields in the area were reported to be enhanced as under;

Cash Flow Statement

Crop	Average yield (qt/acre)		Net Monetary gain (Rs/acre)
	Before the project	After the project	
Cotton	4.0	5.0	4,000
Tur	0.67	1.0	1,800
Total			**5,800**

Thus, total net gain to the beneficiary farmers was estimated as Rs 1,74,000 per year while the cost of the pond was reported as Rs 3,27,000 which indicates that the pay-off of the project is 2 years. An SHG of the beneficiary farmers was made to monitor and carry out the repair and desilting of the pond regularly.

There could be much higher return from the project if the soil were not sandy and poor in water holding capacity. The entire cost of the project was borne by the government. The farmers were using fertilizers on ad-hoc basis and planting was also done across the slope. Therefore, soil and water testing of the area needs to be taken up to help the farmers in educating them about the use of fertilizers and improving the water use efficiency.

(iv) Stream widening and deepening of check dam

Stream widening and deepening is another activity taken up in some villages which has improved the land productivity in the area and due to which rabi crops are also being raised as seen in the photographs below. Apart from this, soil and water testing facility is extended to these families in 9 villages. It has also constructed 350 recharge pits apart from 1 km nala and one community pond to harness water availability to the farmers.

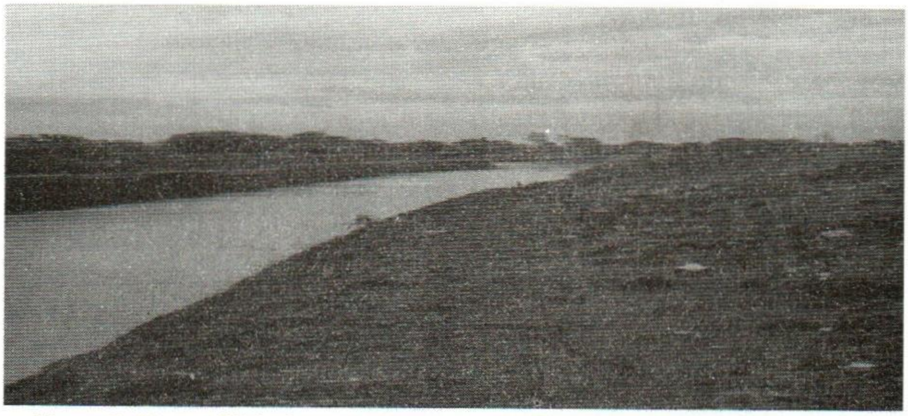

Figure 3. Stream Widening and Deepening in Walki Village of Washim District

Figure 4. The Lush Green Fields in Rabi Season Followed by Rainwater Harvest

In Warud village of Yavatmal district, work of stream widening and deepening and construction of check dam was initiated in early 2015. It has 5 farmers who are direct users of augmented water resource while 2 other farmers experienced rise in the water table in their wells. Cost incurred was Rs 80,000 of which 20 per cent was shared by the beneficiary farmers.

This project helped in covering 22 acre area. Additional four irrigations were availed by the farmers. There was a substantial improvement in the cotton crop yields by way of change in crop variety from Ankur to Brahma, Mallika, etc. increase in crop duration, stand of the crop, foliage and boll formation and number of pickings.

Cash Flow Statement

Crop	Average yield (qt/acre)		Net Monetary gain (Rs/acre)
	Before the project	After the project	
Cotton	3.5	7.0	14,000
Tur	3.0	4.0	7,000
Over all			**10,500**

Cotton and *tur* are the major crops of the area which stand to gain by an average profitability of Rs10,500/acre.

In the village, as many as 40 recharge pits were constructed, provided 37 sprinkler sets and 20 pump-sets. Apart from irrigation potential, the project has positive impact on drinking water, living conditions, education of children.

Due to low rainfall this year rabi crops could not be tried but only cotton crop is allowed to continue for some extra time netting an additional gain to the farmers. As more water gets channelized in it, wheat, fodder and gram crops would also come in their crop rotation. The possibility of increase in the livestock keeping was also reported.

(v) Sprinkler/drip irrigation

Sprinkler/drip irrigation set comprising 30 pipes with 8 nozzles, the cost of which was Rs 28,000, which was shared by Farmer: NRTT: Government in the ratio of 25:25:50 was also made available. The basic purpose of such micro-irrigation was to rationally use every drop of scarce water made available through water harvest structures.

Figure 5. A View of Sprinkler Irrigation

(vi) Check dams with low-cost water harvesting structures

The natural flow of water in some areas create flood like situation in the rainy season. Some locations, particularly in Walki and its adjoining villages, were facing such a problem. Widening, deepening and extending the flow and contain water in the canal itself for use in rabi season and for cotton in kharif season was taken up, the cost of this effort was shared by farmers and NRTT in the ratio of 20:80. The overall cost depends upon the length and breadth of the dam and the command area of it. For instance, if the command Area is 4–5 ha, cost is estimated up to Rs 6,00,000 per unit Common Pool Resource.

Recently, low cost structures are made with fibre sheet supported by stones on both sides enmeshed into a wire net placed to check water flow and store it back.

(vii) Percolation tank

Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation to recharge the ground water. These can be built where land is available and topography is suitable. In loose soils, water is collected and allowed to percolate in the soil in order to raise the underground water level. In Antergaon village, one such structure was constructed as shown in the photograph below.

(viii) Water motors to lift water

Water lifting from wells, ditches, streams, ponds, etc., is essential for which water motors/engines are

Figure 6. Low-cost Water Harvesting Structures in Wadgaon Village of Yavatmal District

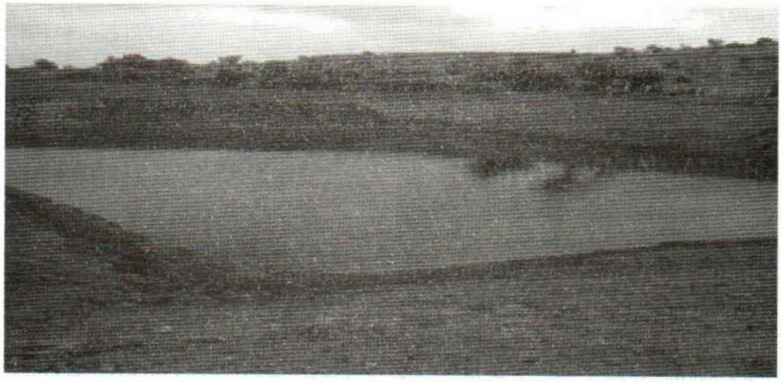

Figure 7. Percolation Tank in Antergaon Village

used. In many cases electricity is not available. Therefore, diesel moors of varying horse powers are recommended under different situations. On an average cost of Rs 60,000 to Rs 70,000 was incurred on a motor which too was subsidized.

3.3 Impact Visualized

As a result of various water harvesting interventions, it was reported that

a) The water saved through such measures was used for providing 1–2 protective irrigations to cotton and soybean as well as *tur* crop. This enhances the main crop yield by 2–3 qt every year. It further minimizes the risk of drought in the forthcoming season.

b) Soil erosion through flooding the fields in rainy season is saved from water-logging conditions.

c) New crops have been added raising the cropping intensity as wheat and gram in rabi season have been taken by some such farmers.

d) This has also given Philip to the livestock enterprises.

e) Change in cropping pattern from cotton/soybean to vegetable crops is in transitional phase.

f) Water table has started rising by recharge structures and thus availability of water for drinking and other domestic purposes has increased.

3.4 Determinants of Yield Improvement—Regression Model

In order to highlight the major determinants of yield increase of cotton, soybean and *tur* crops taken together, the possible determinants were assumed and tested for their impact.

X_1 : The weighted average yield of major crops

X_2 : Additional water: was taken as a dummy variable viz. the farms availing protective irrigation were given value 1 and others 0

X_3 : Farm size was taken in owned area in acres.

X_4 : Slope of the field was also used as dummy variable with sloppy land having value 1 and plain lands 0 score.

X_5 : Amount of short term credit (in Rs) availed by the farmer

The linear form of the regression equation was fitted which showed the following results.

3.5 Derivations of Regression Analysis

It is clear from the results presented above that

a) The variables included as independent variables in the equation together accounted for about 52 per cent of the variations in the yield improvement.

b) The existing level of crop yields and availability of additional water for protective irrigation were the most important factors exerting highly significant effect which together explained about 50 per cent of the dependent variable (yield improvement). It showed that farmers already progressive gained more from the project and irrigation was the most important yield determining factor.

c) The effect of farm size was negligible indicating thereby that the project did not favour any specific farm size and effect on every one was alike.

d) Similarly, the topography of land also was neutral in terms of effect on crop yield. Perhaps, the water harvesting on sloppy lands was responsible in neutralizing the effect.

3.6 Suggestions

- As a consequence of widening and deepening of stream, only a few farmers located near the stream/ drain get the benefit of it while those located a bit away remain deprived of it. There is need to spread it across their fields in other directions as well.

- Such water harvesting structure depending upon the quantity of water stored and period of storage may be viewed for the possibility of fish farming and orchard plantations.

- The recharge pits are standardized to 3 m depth while a majority of farmers deepen it further by about 2 m to enhance its water storage capacity. There is need to reconsider for increasing its standard depth.

- Gujarat experience of moisture conservation with plastic sheet cover needs to be inculcated, which not only evades soil moisture evaporation, also keeps weeds under control and improves quality of produce.

- The trust may reduce focus on IPM and focus more on water harvesting, soil and moisture conservation and related activities which has more visible impact and is helpful in IPM activities.

- For better livelihood with water enhancement, goat farming needs encouragement for which genetic improvement of animals, meat processing unit are needed.

Table1: Linear Regression Analysis Results

	X_1	X_2	X_3	X_4	X_5	Intercept	R^2
Reg, Coeff.	0.1640	0.6259				0.5482	0.5081
SE	0.0382	0.1670				0.2029	
t-value	4.2931**	3.7472**				-2.6655*	
Reg, Coeff.	0.1643	0.6355	-0.0062	-0.0646		-0.4694	0.5131
SE	0.0388	0.1712	0.0306	0.1802		0.2806	
t-value	4.2346**	3.7122**	-0.2035	-0.3588		-1.6730	
Reg, Coeff.	0.1643	0.6278	-0.0106	-0.0764	0.000008	-0.4623	0.5154
SE	0.0389	0.1738	0.0346	0.1855	0.000003	0.2822	
t-value	4.2269**	3.6123**	-0.3063	-0.4117	0.2728	-1.6381	

Note: ** significant at 0.01 level, * significant at 0.05 level.
R^2 is the coefficient of multiple determinations.

- The trust may minimize its operation through partners and have its own field staff to perform. Systematic and uniform record keeping about expenses incurred and impact indicators would lower the load cost and enable SBI to highlight the performance of the project.
- Spreading interventions across a large number of villages does not make the impact apparent. Water harvest and conservation structures should be concentrated in specific areas and locations such that it impact in clearly visible. It would also be possible to quote such cases and may become exemplary case studies.

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We need a new global culture that finds the existence of millions of thirsty people thoroughly and immediately unacceptable.

–Jean–Michel Cousteau

Feature

Assessment of Continuous Improvement Initiatives for Improving Performance of SMEs of Northern India—An Empirical Investigation

JAGDEEP SINGH AND HARWINDER SINGH

Continuous Improvement approach is a management approach of achieving major enhancement in the process through incremental improvements in the manufacturing system processes. Continuous Improvement helps to eliminate waste in manufacturing system processes through small improvement. This study attempts to access the initiatives of continuous improvement approach, viz., Continuous Improvement system and structure, customer and supplier relationship and organization culture in SMEs (small medium enterprises) of northern India. Correlation and Multiple regressions indicate both positive and negative potential of CI initiatives on firm performance. Continuous Improvement system and structure significantly aimed at reducing product configuration based on perception of actual performance. Customer and Supplier relationship significantly aimed at improving Product Innovation of new parts and processes based perception of actual performance and Organization Culture significantly aimed at improving the product configuration.

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1. Introduction

Kaizen, pronounced 'KAI+ZEN', is a Japanese word that means 'gradual and orderly continuous improvement'. Kaizen ideas suppose that our working, social and home lives should be the focus of constant improvement efforts. Kaizen is a never-ending journey towards waste elimination, quality improvement and effective utilization (Al-Tahat and Eteir, 2010). Today, irrespective of the business domain, companies must focus on speed, efficiency and customer value to be globally competitive, and the long-term health of any organization depends on their commitment to continuous improvement. This type of vision helps companies remain competitive in the face of customers' constantly changing and evolving expectations. The principles, practices and techniques embodied within continuous improvement form a comprehensive organizational philosophy that strives to effectively fulfil customers' needs (Kovach et al., 2011). Due to an increasing pace and complexity of business environments, organizations no longer compete on processes but the ability to continually improve processes (Teece, 2007). Continuous Improvement (CI) is an array of powerful techniques that has produced substantial improvements in numerous companies and organizations. Continuous Improvement provides perhaps the most central and universal component of TQM (total quality management) which itself has helped many companies achieve high quality and productivity (Zangwill and Kantor, 1998).

The purpose of this study is to investigate the role of CI initiatives towards improving firm performance for enhanced competitiveness. The role of different initiatives towards obtaining potential in the form of benefits has been discussed.

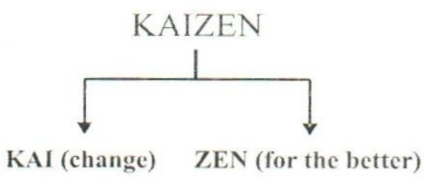
2. Literature Review

The relevant literature is classified in three different categories, i.e., literature related to concept of CI approach, related to case studies and related to surveys. This section describes the viewpoints of different researchers regarding the concept of CI approach, case studies and surveys performed by various researchers in this field.

2.1 Review of Literature Related to Concept of CI Approach

Kaizen is a compound word involving two concepts:

Figure 1 shows the meaning of Kaizen



Source: Palmer (2001).

Figure 1 Meaning of KAIZEN

The term came from Gemba Kaizen in Japanese meaning 'continuous improvement'. Continuous improvement is one of the core strategies for manufacturing excellence and is considered vital in today's competitive environment (Dean and Robinson, 1991). It is based on making small changes on a regular basis—reducing waste, continuously improving productivity, safety and effectiveness (Cheser, 1998) and making significant reduction to production costs (Williams, 2001). Continuous Improvement concept is an organization-wide process of focused and sustained incremental innovation (Bessant and Caffyn, 1994), generates process-oriented thinking since processes must be improved before improved results are obtained (Hammer et al., 1993) and increases the competition capability against competitors by effective utilization of continuous improvement tools in different life periods of an organization (Abdolshah and Jahan, 2006). It is the most important way to improve the quality and manage business through the concepts of 'Zero defects' and 'Do it better each time' (Yeo et al., 1995) to achieve fundamental improvement on the shop floor (Deniels, 1995) and provides major potential benefits like increased business performance (in terms of reduced waste, set-up time, breakdowns and lead time), increased people performance in the form of improved development, empowerment, participation and quality of work life of employees (Hyland et al., 2004).

2.2 Review of Literature Related to Case Studies

Continuous improvement approach aimed at developing the product with higher quality, lower cost and higher productivity in meeting the customer requirements in small sized custom-made furniture industry (Radharamanan et al., 1996); improved the productivity and sustained competitiveness at Morris Electronics Limited, an Indo-Japanese joint venture firm (Chaudhari, 1997); increased production rate of about 80 per cent and the error drop rate from above 50 per cent to about 1 per cent were obtained after implementing continuous improvement tool, i.e., Poka-Yoke on fuel-fitter assembly (Erlandson et al., 1998); supported continuous improvement process by using simulation as a tool in commercial manufacturer and aerospace manufacturer (Adams et al., 1999); reduced the space requirements, material handling costs and scrap rates in mid-western company developing a dynamic tri-resin fiberglass rod (Lee et al., 1999); reduced 25 per cent of the unit cost, reduced floor space requirement by 15 per cent and developed a better communication network throughout the organization of virtual manufacture of meat tenderizer (Chen et al., 2000); improved the work environment for the employees and motivated them to achieve excellence after implementation of KAIZEN methodologies including 5S technique and team training at Nichols Foods manufacturing food products (Lee, 2000); increased the sales by multiple of not less than 69 per cent and its profit by 54 times at Toyota Company (Ashmore, 2001); reduced the process time from 610 hours to 290 hours and a saving well over million dollars per year in a study on the 'Inventory management KAIZEN' conducted at 'BAE SYSTEM' (Palmer, 2001); provided a basis for a total cost management system by using two matching approaches target and KAIZEN costing in a construction company (Granja et al., 2005); increases productivity by focusing into the performance indicators (PIs) currently being measured by the company in a casting based manufacturing plant (Ahmed et al., 2005); eliminated major functional problem and rework processes, reduced the quality rejections and a considerable cost savings in automobile assembly production line (Chandrasekaran et al., 2008).

2.3 Literature Related to Surveys

Voss et al. (1998) proposed that continuous improvement is an effective method to improve the company's competitiveness. Japanese companies derived much of their competitiveness from the success execution of total quality control in the 20th century. Bessant (2000) presented a survey that was conducted by continuous improvement research advantage (CIRCA) at UK firms. Survey suggested that 65 per cent of companies consider CI to be strategic importance, around 50 per cent had instituted some form of systematic programme to apply these concepts, 19 per cent claimed to have a wide spread and sustained process of CI in operation and of those firms using CI. 89 per cent claimed that it had significant impact on productivity, quality, delivery performance or combination of these.

Hongming et al. (2000) carried out a survey in Chinese companies that not all companies that had carried out CI activities achieve desired results. It had significant impact on companies in which CI implementation required adequate input on company capital human resource and organizational activities. It is a challenge for companies in the organizational structure business principle and operations methods. Mellor et al. (2001) carried out a survey in Australian manufacturing industry to check the level of importance and usage of CI problem solving tools, importance and usage of CI support method and the role of management in CI. Results indicated that these firms utilize problem identification tools, checklists and seven basic quality tools most frequently. Seven new quality tools are rated least important, and used least frequently. Management support, face-to-face communication and supportive leadership are highly ranked by these firms.

Gonsalves (2002) performed a survey about the effect of ERP and CI on the performance in 500 manufacturing companies. The author concluded that CI implementation has positive influence on business process reengineering (BPR) execution. Integrated CI and BPR had positive effects on the company's performance.

Terziovski (2002) compared the effectiveness of radical, incremental and integrated innovation strategies on performance excellence in Australian and New Zealand manufacturing companies. Three performance excellence outcomes were used as dependent variables and the data was analysed using multivariate analysis. Result indicated that a 'bottom-up' continuous improvement strategy is preferred strategy to improve customer satisfaction and productivity in the firms and a 'top-down' strategy is considered appropriate for increasing relative technological competitiveness. An integrated strategy had the least explanatory power on performance excellence.

Malik and YeZhuang (2006) performed a survey in 105 Spanish and 50 Pakistani companies to analyse the outcome of continuous improvement practices carried out in these companies. Twelve CI tools were investigated. Results indicated that Spanish companies utilize these tools more than Pakistani companies. Spanish companies were comparatively more experienced and advanced from Pakistani companies.

Yan-jiang et al. (2006) conducted a survey by using data of the global continuous innovation network to analyse the influencing factors of continuous improvement. This survey designed 18 questions to describe the reasons why companies were implementing continuous improvement activities, 13 questions to describe the company's external environment and 11 questions to describe the situation of continuous improvement activities in functional departments of the companies. Results indicated that the internal motivation factors were responsible for popularization of continuous improvement activities and had varying degree of influence on these activities.

Malik et al. (2007) conducted a survey by comparative analysis between two Asian developing countries, China and Pakistan, by investigating how they were deploying continuous improvement practices. The questionnaire consists of 18 selected blocks of questions related to organization and its operation of CI, supporting tools used in improvement activities, effects of improvement activities and company background and its characteristics. Results indicated that companies in both of the countries were deploying continuous improvement methodologies, but with different proportions.

3. Research Methodology

Figure 2 shows the methodology used for the research work.

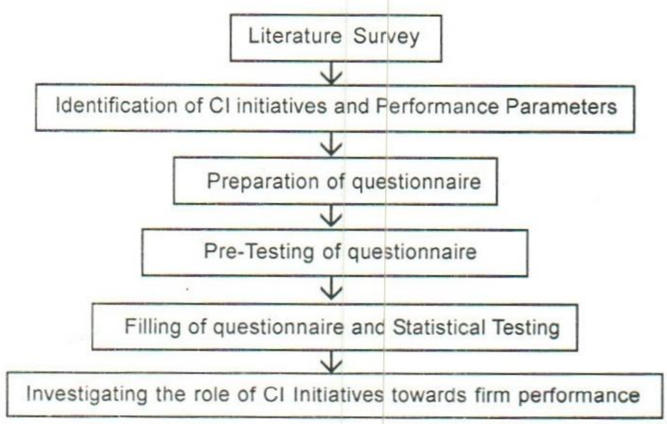


Figure 2 Methodology Used for Research Work

For this survey, a questionnaire has been designed which consists of three different section, first section consists of questions related to general organizational information, name and designation of respondent, size of the industry, whether they are applying CI initiatives or not and the number of years since CI initiatives adoption. The measurement of other two sections is done on four point Likert scale, i.e., Degree of effectiveness of CI initiatives is determined on the scale (1 = Disagree, 2 = Neutral, 3 = Agree, 4 = Strongly Agree). Prior to data collection, the survey instrument is pre-tested for content validity in two stages. In the first stage, two experienced researchers were asked to criticize the questionnaire for the ambiguity, clarity and appropriateness of the items contained in the questionnaire; based on feedback received from these researchers, the instrument was modified to enhance clarity and appropriateness of the items. In the second stage, the survey instrument was sent to two experienced managers of an industry and was asked to review the questionnaire for structure, readability and completeness. The final survey instrument incorporated feedback received from these managers, which enhanced the clarity of instrument. This process yielded a survey instrument that was judged to exhibit high content validity.

4. Data Collection

The final structured questionnaire has been sent to 250 manufacturing organizations randomly selected from among the membership of the Confederation of Indian Industry (CII) and Directorate of Industries. The

Table 1: Input and Output Parameters

Input Parameters	Output Parameters
A) *Continuous improvement System and Structure* 1	*Firm Performance*
1) Employee search for information, new ideas and technologies as a part of CI practices.	1) As a result of CI in product, faster speed to market occur based on perception of actual performance (FP1).
2) Employees facilitate and encourage informal relationship as part of continuous improvement practices.	2) As a result of CI in product, the higher product configurations occur based on perception of actual performance (FP2).
3) Employee takes reasonable risks by continuously experimenting with the new ways of doing work.	3) As a result of CI in product, higher success of new products launched occur based on perception of actual performance (FP3).
4) Employees use failures as opportunity to learn as part of continuous improvement.	4) Improved Product Innovation of new parts and processes occur based perception of actual performance (FP3).
5) Employees let organizational objectives guide the evaluation of new ideas and information as part of continuous improvement practices.	
6) Employees actively monitor progress by using action plans to ensure the goals of continuous improvement programme.	
B) *Customer and Supplier Relationship*	
1) The firm's reputation is important to the firm's competitive advantage.	
2) The product supplied is important to the firm's competitive advantage.	
3) The customer satisfaction is important in the firm's competitive advantage.	
C) *Organizational Culture*	
1) The organizational culture encourages employees to hold knowledge closely.	
2) The organizational culture reinforces behaviour that upholds traditions.	
3) The culture encourages managers to closely monitor work time.	
4) The culture focuses on short-term performance.	
5) The culture encourages employee to interact with other people.	

Table 2: Correlation between Input and Output Parameters

	Firm Performance (FP)
Continuous Improvement System and Structure (CSS)	0.01704*
Customer and Supplier Relationship (CSR)	0.20812*
Organizational Culture (OC)	-0.1022*

*Correlation is significant at 5% level (critical value = 0.1965)

questionnaire has been sent to the companies via post, along with a cover letter and pre-paid reply envelope. Various efforts, e.g., follow-up telephone calls and faxes as well as personal connections have been employed to encourage respondents to complete and return the questionnaires. In this study, 101 manufacturing organization responded (response rate 40 per cent) have been extensively surveyed, to ascertain contributions made by CI approach in the Indian manufacturing industries towards realization of manufacturing excellence. Table 1 shows different input and output parameters as identified from literature.

5. Correlation between Input and Output Parameters

On the basis of the responses received from the industry, an assessment of association of various CI initiatives with Firm Performance parameters has been made. In order to explore the role of CI implementation initiatives towards manufacturing performance improvement, the Pearson correlations have been worked out to ascertain the significant factors contributing to success of the CI initiatives implementation programme in the organizations. The correlation analysis depicts that how CI initiatives are related to different benefits of CI approach in terms of Firm Performance or important benefits that these manufacturing organizations had achieved after successful implementation of CI strategies. The positive value of Karl Pearson Coefficient of Correlation depicts that each initiative has positive effect on the performance parameters of continuous improvement. The highest value of correlation coefficient and least value of negative correlation have been tested at the level of significance adopted (if the calculated value of correlation coefficient is less than table value at [n-2] degree of freedom, it is concluded that sample statistic is significant). The correlation coefficient is shown in Table 2.

6. Result Discussion of Correlation between Input and Output Parameters

The results of investigation demonstrated that Customer and Supplier relationship in terms of firm's reputation, product supplied and customer satisfaction highly aimed at improving the firm performance ($r = 0.20812$) followed by Continuous Improvement System and Structure ($r = 0.01704$). Organizational Culture shows negative potential towards firm performance.

In order to investigate critical success factors, the significant correlations thus obtained as a result of Pearson's correlation is validated through muitiple regression analysis, as depicted in Table 4. The notations depicted in the table include: β = regression coefficient (beta coefficient) and R = multiple correlation coefficient.

Table 3: Correlation between Input and Sub-Output Parameters

	FP1	FP2	FP3	FP4
CSS	0.00302*	-0.0388*	0.09444*	0.11053*
CSR	0.00674*	0.0954*	0.01224*	0.49718***
OC	-0.0339*	0.1575*	-0.2658*	0.0408*

*Correlation is significant at 5% level (critical value = 0.1965).
**Correlation is significant at 1% level (critical value = 0.2550).
***Not Significant.

Table 4: Multiple Regression Analysis between Dependent and Independent Variables

Dependent variables	Independent variables	Beta value	t-value	p-value	R-square	F-value
FP1	CSR	0.3265	2.8434	0.0512	0.356*	8.4727
	CSS	0.6413	3.7924	0.0073		
FP2	OC	0.8761	2.9441	0.05474	0.4501*	9.3429
	CSR	0.7605	4.5024	0.00816		
FP3	CSS	0.1476	2.8306	0.05581	0.7346*	8.2611
	CSR	0.2019	4.0185	0.00585		
FP4	CSS	0.3499	3.2066	0.00836	0.886*	8.2404
	OC	0.1294	4.2334	0.0495		
F(critical) = 9.87						

The significant factors with beta (β) significance level, multiple correlation coefficients (R), R-square values and F values for each performance parameter are indicated in Table 3.

7. Result Discussion of Correlation between Input and Sub-Output Parameters

R-square value signifies how much percentage of dependent variables is explained by independent variables taken together. F Value signifies whether R-square is significant or not. All values are significant. If the calculated value of F is less than critical value of F (9.87) it is concluded that sample data is significant. All values of calculated value of F is less than critical F value so the sample statistics is significant. Results indicated that CI system and structure significantly aimed at improving firm by higher success of new products launched based on perception of actual performance (r = 0.13392) followed by improving performance based on improving product innovation of new parts and prccesses based perception of actual performance (r = 0.111403), improving the speed to market based on perception of actual performance (r = 0.030805) and shows considerable decline in the product configurations based on perception of actual (r = -0.04605); Customer and Supplier relationship significantly aimed at improving speed to market based on perception of actual performance (r = 0.06984) followed by improving product configurations occur based on perception of actual performance (r = 0.05358) and higher success of new products launched based on perception of actual performance (r = 0.01114). Operating Culture significantly aimed at improving product innovation of new parts and processes based perception of actual performance (r = 0.08219) followed by improving the product configurations occur based on perception of actual performance (r = 0.1071). Operating Culture of Kaizen shows significant decline in speed to market based on perception of actual performance (r = -0.09518) and success factor of new products launched occur based on perception of actual performance (r = -0.25921).

8. Conclusion and Limitation of the Study

For achieving 'manufacturing excellence', SMEs must exploit all available CI initiatives to supplement firm performance in the form of product configuration, speed of market and higher success of the product launched. The present study has outlined the significance of CI initiatives as a vital factor for enhancing manufacturing performance in the manufacturing organization. The study critically reveals the contributions of CI strategic implementation for achieving manufacturing performance improvement of the manufacturing SMEs of northern India. Thus, in today's competitive environment CI approach can prove to be an effective global strategy, for Indian manufacturing organizations, rendering firms a consistent enhancement of performance in terms of achieving manufacturing performance improvement. The limitation is that the selection of manufacturing organizations is based on convenience sampling technique and study is limited to northern Indian SMEs. Generalization of CI initiatives is limited, but the study does contribute to the literature on further development of sophisticated CI initiatives in organizations. Moreover, study is limited only to northern Indian manufacturing organizations.

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Water is the driving force of all nature

–Leonardo da Vinci

Feature

An Empirical Analysis of Comparative Advantage in India's Agricultural Export: Post WTO Era

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Current developments in the global trade scenario and corresponding alterations in India's foreign trade policies depicted far-reaching implications for agricultural sector in general and agricultural exports in particular. The present study has ascertained the changes in comparative advantage status of India's major agricultural exports during the PreWTO (1980–94) and Post WTO period (1995 to 2012). The RCAs in export commodity and agriculture products were higher than unity and RSCAs were positive and higher except wheat. Rest of the commodities RCA value has declined in post WTO compare to pre WTO period, i.e., 1980–84 compared to 1995–2012 indicating declined comparative advantage in these crops. The RSCA among all agricultural commodities during the study period suggested that India is gaining specialization in agriculture export commodities. A contrasting result from RSCA to RCA is that the mean value of RSCA export commodity as coffee green, oil of vegetable, sugar, tobacco and wheat for the entire period under study was below unity. India has, by and large, comparative disadvantage in the export of crops despite advantage in export of the agricultural commodities during the period of post WTO.

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1. Introduction

Indian agriculture even in 21st century has been currently at the forefront of the debate over the globalization. The agreement under the auspices of World Trade Organization (WTO) allow all nations to focus on the benefits from realizing comparative and competitive advantage in the international economy and increasing competition would force resources to be allocated more efficiently. The potential impact of liberalization of global trade on developing nations is a controversial subject. The liberalization of global agricultural trade, in particular, has been the focus of the debate for many years and is part of the current WTO negotiations. Trade policies are believed to have influenced a country's comparative advantage, so as a concept for evaluating the pattern of trade are widely accepted and often used in theoretical and policy discussions. Livestock and livestock products, in the global trade, account for about sixth by value of all agricultural trade (Miraei, 2013).

India's agricultural commodities have come to occupy a supreme position in the international market over the year. Currently, India is a major supplier of several agricultural commodities (tea, coffee, rice, spices, cashew and oil meals) to the international market. Export of various agricultural commodities from India has responded differently in terms of comparative advantage during the post-reforms period. India has enjoyed a comparative advantage in tea exports but has depicted a declining trend over the years. However, Sri Lanka has shown a far better advantage in comparison to India and other countries like China and Indonesia. A similar pattern has been observed in coffee exports also, where India has been found losing its advantage to other coffee exporters like Vietnam and

Indonesia. An unstable pattern of comparative advantage has been observed in case of rice exports with intermittent ups and downs in the status. A gradual decline in India's comparative advantage has been depicted for exports of spices and cashew also. Vietnam has bypassed India in the later years in terms of comparative advantage in cashew exports. As opposed to other commodities, India has strengthened its position in the global markets in exports of oil meals. But as far as the exports of fresh fruits and fresh vegetables are concerned, India cannot boast to have a comparative advantage. While Philippines and Turkey have dominated in fresh fruits exports, Israel has been dominant in the exports of fresh vegetables. India's status in exports of meat and its preparations and marine products has not been very comfortable. Although marine products dominate India's agricultural exports, it cannot be attributed to India's comparative advantage in the global markets. It is assumed to be more due to a growing demand for these products among the international consumers. In a nutshell, India's comparative advantage in most of the important agricultural exports has been found to be eroding and losing out to other Asian competitors in certain commodities during the period after economic reforms (Shinoj and Mathur, 2008).

India agricultural exports witnessed impressed and unprecedented growth after trade liberalization that began in 1991 as a part of economic reform programme.This generated lot of optimism and euphoria about prospects of agricultural export from India. However, the rising export trend could not be sustained in post WTO period (Bhalla, 1996). It was believed that gradual opening up of Indian agriculture to world market is likely to bring terms of trade in favour of agriculture, creating a better environment for agricultural trade than the case in preceding decades (Rao and Gulati, 1994). The Agreement on Agriculture (AcA) under WTO pertaining to subsidies, market access and sanitary and phytosanitary measures would have a direct bearing on India agriculture. There is reasonably good evidence that Indian agriculture has comparative advantage in most of the products which often gets blurred due to huge subsidization of agriculture by the developed countries of East Asia, European Union and also by Canada and the US (Gulati and Kelly, 1999; Gulati and Narayan, 1999). Coffee export appeared to be unsatisfactory. The quota system tried to stabilize the quantum and unit values of coffee exports of the quota countries but at the same time it destabilized the trade with the non-quota countries (Dass, 1991). India's status in exports of cotton has not been very comfortable. Although cotton products dominate India's agricultural exports, it could not be reflected to India's comparative advantage in the global market (Kanaka and Chinadurai, 2012). The changing comparative advantage of these commodities exports during post WTO era shows that except wheat, in rest of the commodities RCA ratio value is declined during post WTO period, indicating declining comparative advantage in these commodities (Nagoor and Deshpande, 2008). At the global level, India has gloomy revealed comparative disadvantage of export in most of the products (Elumalai, 2007). Keeping in view of the above fact an attempt has been made in this paper to analyse the performance of India's agricultural export in both pre and post WTO period.

1.1 Objective of the Study

i) To analyse the composition of India's agricultural trade, both in pre and post WTO era.

ii) To analyse the growth rate and instability of India's and world export both in pre and post WTO period.

iii) To analyse comparative advantage of India's major agricultural export commodities/commodity in pre and post WTO period.

2. Data and Methodology

The study used the secondary time series data of major agricultural commodity/commodities groups like tea, coffee, rice, spices and cashew, tobacco, cotton, soybean and groundnut during the period under study from 1980 to 2012. The analysis of growth rate and instability is carried out for two sub-periods as pre WTO period (1980–94) and post WTO period (1995–2012). The data on exports of selected agricultural commodities are collected from various issues of FAO Trade Yearbook, published by the statistics division of Food and Agriculture Organization (FAO), Rome. The selected commodities corresponding to the various codes of Standard International Trade Classification (SITC) and their export values were provided in the US Dollars.

2.1 Measuring Growth Rate

The growth rate agricultural export value and export quantity of commodities/commodity groups is calculated by using the method of kinked growth model. This kink model of compound growth rate is an improved and alternative growth model where there are break points in time series data and different sub-periods.[1] The model is explained below with its generalization and then a particular model is derived from it based on the number of kinks present in our data series theoretically.

The generalized method of kink model where there are m sub-periods with $m-1$ kinks having kink points denoted as $k_1, k_2 \ldots k_{m-1}$, and the sub-period dummies as $D_1, D_2 \ldots D_m$, after applying $m-1$ linear restriction such as:

$$a_i + b_i k_i = a_{i+1} + b_{i+1} k_i \text{ for all } i = 1, \ldots m-1 \quad (1)$$

Can be obtained as:

$$LnY_t = a_1 + b_1\left(D_1 t + \sum_{j=2}^{m} D_j k_1\right) + b_2\left(D_2 t - \sum_{j=2}^{m} D_j k_1 + \sum_{j=3}^{m} D_j k_2\right) + \ldots + b_i\left(D_i t - \sum_{j=1}^{m} D_j k_{i-1} + \sum_{j=i+1}^{m} D_j k_i\right) + \ldots + b_m(D_m t - D_m k_{m-1}) + u_t \quad (2)$$

In case of one kink, i.e., two sub-periods, the discontinuity between two trend lines can be eliminated by imposing a linear restriction such that they intersect at the break point k:

$$a_1 + b_1 k = a_2 + b_2 k$$

Substituting for $a2$ and noting that $a_1 D_1 + a_2 D_2 = a_1$, we get the restricted form as: In case of single break point the kink growth model can be written as:

$$In\, Y_t = \alpha + b_1 (D_1 t + D_2 k) + b_2 (D_2 t - D_2 k) + u_t \quad (3)$$

Where Y is the concerned variable (export quantity or value of ith commodities) for which the growth rate is being calculated. D_1 is a dummy variable that takes on a value of 1 in the first sub-period and a value of 0 in the second sub-period; D_2 is a dummy variable that takes on a value of 1 in the second sub-period and a value of 0 in other sub-periods. The coefficient of b_1 is the growth rate during the first sub-period; and b_2 is the growth rate during the second sub-period. So the elimination of discontinuity between sub-periods and provides a superior basis for comparison of sub-period growth rate.

2.2 Measuring Instability

The instability of export values and quantities of India and World for selected commodities is measured by using a method as suggested by Paltasingh and Goyari (2013). This method is the modified version of Boyce (1987) method used by Vakulabharanam (2004), Chattopadhyay (2001).[2] This specification of instability is suitable theoretically when we have kinks in data series involving sub periods and the estimated growth equation is also a kinked model. Based on the growth model used initially this measure of instability can be derived as follows:

$$In\, Z_t = a + b_1 (D_1 t + D_2 k) + b_2 (D_2 t - D_2 k) + u_t \quad (4)$$

Where Z_t is the whole squared of the deviations of actual values from predicted values expressed as proportionate of predicted value. It can be defined as:

$$Z_t = \left[\frac{(Y_t - \hat{Y}_t)}{\hat{Y}_t}\right]^2 \quad (5)$$

In Boyce method, Z_t was regressed upon time t in a linear fashion leading to a misspecification error. However, this way of calculating instability takes care of that misspecification error.[3]

2.3 Measuring Revealed Comparative Advantage (RCA)

The concept of revealed comparative advantage (RCA) is based on conventional trade theory. It identifies the comparative advantage or disadvantage of a country for a particular commodity with respect to another country or group of countries. It provides a ranking of commodities by degree of comparative advantage and identifies a binary type of demarcation of commodities based on the comparative advantage (Ballance et al., 1987). Under the assumption that the commodity pattern of trade reflects the inter-country differences in relative costs as well as non-price factors, the index is assumed to 'reveal' the comparative advantage of the trading countries. The factors that contribute to movements in RCA are economic, structural, world demand and trade specialization. The advantage of using the comparative advantage index is that it considers the intrinsic advantage of a particular export commodity and is consistent with the changes in an economy's relative factor endowment and productivity. The disadvantage, however, is that it cannot distinguish improvements in factor endowments and pursuit of appropriate trade policies by a country (Batra and Khan, 2005).

The original index of RCA was first formulated by Balassa (1965) and can be written as:

$$RCA = \left[\frac{X_{ij}}{X_{ik}}\right] \Big/ \left[\frac{X_{nj}}{X_{nk}}\right]$$

where,

X_{ij} = Exports of country i of commodity j

X_{ik} = Exports of country i of a total agricultural commodities k

X_{nj} = Exports of a World *n* of commodity *j*, and

X_{nk} = Exports of a World *n* of a total agricultural commodities *k*

In the present study, country *i* refers to India, commodity *j* refers to any of the selected agricultural commodities, set of commodities *k* refers to the total agricultural commodities and *n* refers to World. When RCA assumed the value greater than unity for a given country in a given commodity, the country is said to have a revealed comparative advantage in that commodity. However, RCA suffers from the problem of asymmetry as pure 'RCA is basically not comparable on both sides of unity'. It is the index ranged from zero to one, a country is said not to be specialized in a given sector and if the value of the index ranged from one to infinity, the country is said to be specialized. The index is made symmetric, following the methodology suggested by Dalum et al.(1998) and the resultant index is called as 'Revealed Symmetric Comparative Advantage' (RSCA). Mathematically, it can be expressed by the following equation

$$RSCA = \frac{(RCA - 1)}{(RCA + 1)} \quad (7)$$

This measure ranges between -1 and +1 and is free from the problem of skewness. A commodity is said to have comparative advantage in its exports if the corresponding RSCA value is positive and vice versa. In the present study, the RSCA was used to look into the comparative advantage of the selected commodities.

3. Results and Discussion

3.1 Composition of India's Agricultural Exports

Table 1 presents composition of India's total agricultural export in terms of value. In 1980–89 tea stood at fist position contributing around 20.93 per cent followed by coffee green (8.19 per cent), cashew nuts shelled (7.91per cent), rice (9.28 percent). One of the interesting observations in this period is that the commodities like coffee extracts, vegetableoil and spices are contributing less compared to other commodities.

During 1990–99 rice (16.99 per cent) occupied first place than cashew nuts shelled (8.32 per cent) in world market. It was observed that the tea (9.81 per cent), coffee green (5.67 per cent) declined during that period. It is further observed that during 2000–12 rice contribution is highest (15.79 per cent) followed by cake of soybeans, cotton lint and cashew nuts shelled having a moderate contribution in total agricultural exports. The study period is further sub divided into pre and post WTO period and result provides comparison between these two periods. From the results we observe that in post WTO period export value of almost all exports agricultural commodities declined compared with pre WTO period except rice. This registered a 10.06 per cent and 16.75 per cent in pre and post WTO period, respectively. Thus, it indicates the requirement of an urgent need for dissemination of cost reducing technologies for production and in addition to that export. It should be encouraged by taking several steps such as building big infrastructures

Table 1: India's Commodity Composition of Agricultural Export in value (In %)

Items	1980–89	1990–99	2000–12	Pre WTO (1980–94)	Post WTO (1995–12)
Cake of Groundnuts	1.94	0.82	0.18	1.66	0.27
Cake of Soybeans	3.36	11.18	9.41	6.82	9.66
Cashew Nuts Shelled	7.91	8.32	5.01	8.72	5.51
Coffee Extracts	0.51	1.28	1.05	0.63	1.16
Coffee, Green	8.19	5.67	2.33	6.95	3.12
Cotton Lint	3.72	3.78	6.99	4.53	6.06
Oil of Castor Beans	2.16	3.06	2.31	2.40	2.50
Oil of Vegetable Origin, nes	0.57	0.09	0.17	0.42	0.14
Onions, Dry	1.60	1.35	2.09	1.69	1.87
Pepper (Piper spp.)	3.64	2.05	0.63	2.84	0.98

Spices, nes	0.97	0.88	1.00	0.94	0.97
Sugar Refined	1.55	1.05	2.75	1.44	2.36
Tea	20.93	9.81	4.29	18.03	5.01
Rice	9.28	16.99	15.79	10.06	16.75
Tobacco	6.83	4.18	3.97	5.96	3.96
Wheat	0.54	0.95	1.73	0.57	1.61

Source: Based on FAO(2013), @faostat.org.

Table 2: Composition of Agricultural Exports of India (Million Dollars)

Items	1980–89	1990–99	2000–12	% change from from 1st 1990–1999 compared to 1980–89	% change from from 2nd 2000–2012 compared to 1980–89
Cake of Groundnuts	46.33	34.66	17.71	-25.2	-61.8
Cake of Soybeans	80.33	472.62	933.29	488.3	1061.8
Cashew Nuts Shelled	188.98	351.88	497.25	86.2	163.1
Coffee Extracts	12.12	54.32	104.51	348.3	762.6
Coffee, Green	195.55	239.75	231.48	22.6	18.4
Cotton Lint	88.85	159.85	693.54	79.9	680.5
Oil of Castor Beans	51.53	129.43	229.30	151.2	345.0
Oil of Vegetable Origin, nes	13.72	3.61	16.85	-73.7	22.8
Onions, Dry	38.10	57.19	207.28	50.1	444.0
Pepper (Piper spp.)	86.82	86.51	62.10	-0.4	-28.5
Spices, nes	23.06	37.25	99.15	61.5	329.9
Sugar Refined	36.94	44.40	272.41	20.2	637.4
Tea	499.85	414.89	425.99	-17.0	-14.8
Rice	221.70	718.45	1566.96	224.1	606.8
Tobacco	163.18	176.79	393.55	8.3	141.2
Wheat	28.37	40.37	172.09	42.3	506.5
Agricultural Products,Total	2387.81	4228.20	9922.35	77.1	315.5

Source: Based on FAO (2013). @faostat.org.

such as ports, transport system, etc. This will give boost to the agricultural development in India. There is also need for deeper integration of these trading partners for reaping complementarities for the long term benefits (Singh et al., 2011).

Table 2 shows the composition of India's export in terms of million dollars. During 1980–89, tea was having a highest export unit value (average 499.85) followed by rice (221.70), coffee green (195.55), cashew nut shelled (188.98) and tobacco (163.18). It was observed that during 1990–99 major contribution is comes from cashew nut shelled (351.88), coffee green (239.75), cotton lint (159.85), oil of castor beans (129.43) and rice (718.45) which tremendously increased from previous value. Though, tea's contribution has declined but still remained a major contributor in total export value. During 2000–12, rice is highest contributor to total export value (1566.96) followed by cake soybean, castor oil, and tea. Total average export value in terms of million Dollars also increased more than double to 9922.35 from previous figure. The average export during 1990–99 for the commodities cake of groundnuts, coffee extracts, oil of castor, and rice increased by an average of more than 100 per cent compare to 1980–89. Cake of soybeans export has increased by more than ten times during 2000–11. Total agricultural export of India also increased from 0.25 in 1990-99 to 1.14 in 2000–12 in absolute terms.

As evident from the table 3, shows that India's percentage share in world export (in terms of quantity) during decades and pre and post WTO periods. During 1980-89, Cashew Nuts Shelled occupied first position (55.92 per cent) in total export quantity in world market, followed by cake of ground nuts (40.53 per cent) and oil of castor Beans (34.88 per cent) respectively. It was interesting that above table most of commodities show increased trend in 1990-99 as compare with 2000-09 expect the cash nuts shelled Paper (Piper spp.) and Tea. The comparison between both pre-WTO and post-WTO periods shows that cake of Groundnuts, cake of Soybeans, Coffee Extracts, Coffee green, Cotton lint ,Oil

Table 3: India's percentage Share in World Export Qty

Items	1980–89	1990–99	2000–09	1980–94	1995–2012
Cake of Groundnuts	40.53	40.31	50.27	39.39	47.82
Cake of Soybeans	1.65	7.43	7.42	3.50	7.55
Cashew Nuts Shelled	55.92	55.59	37.13	56.84	40.73
Coffee Extracts	1.29	3.35	3.30	1.61	3.49
Coffee, Green	1.90	2.57	2.37	1.97	2.54
Cotton Lint	1.28	1.99	7.75	1.66	5.79
Oil of Castor Beans	34.88	75.58	78.69	43.80	80.00
Oil of Vegetable Origin, nes	7.71	1.73	2.94	6.21	2.56
Onions, Dry	9.81	6.66	13.90	8.73	11.94
Pepper (Piper spp.)	20.30	14.65	8.14	18.74	10.44
Spices, nes	12.29	12.40	15.23	11.72	14.87
Sugar Refined	1.06	0.81	3.45	0.95	2.73
Tea	23.34	16.11	11.43	21.27	12.37
Rice	5.33	10.93	14.33	5.90	14.11
Tobacco	1.67	0.80	1.52	1.18	1.31
Wheat	0.08	0.25	0.77	0.10	0.66

Source: Based on FAO (2013). @faostat.org.

of Castor Beans nes, Onions dry, Spices nes, Sugar Refined, Tobacco, Rice and Wheat have increased during the post-WTO period, while for other items, India's share in total World export have declined.

From Table 4 we find during 1980-89, the Coffee Extracts occupied the first position (59.64 per cent) in India's total export share (in terms of value) in the world. Other important crops that occupied major share World share are Cashew Nuts Shelled (48.02 per cent), Cake of Groundnuts (41.38 per cent) and paper (23.20 per cent) respectively. It was observed during the periods 1990-99 and 2000-2009, percentage shares of Coffee Extracts (54.98 per cent), Cake of Groundnuts (39.22 per cent) in total world export value declined except Spices, nes (32.06) and Cake of ground nut (44.21 Per cent) Species, nes (41.19 per cent) and cashewnut shelled (36.21 per cent) and coffee extracts (28.68 per cent) declined last two decades. The highest important crops that contributed to major share in World agricultural export during pre-WTO regime, value are Coffee Extracts (56.32 per cent) followed by Cashew Nuts Shelled (44.77 per cent) and Cake of Groundnuts (40.12 per cent), Spices, nes (24.93 per cent). In post WTO period (1995-2012), Cake of Groundnuts (42.02 per cent) contributed highest share in World export value, followed by Spices, nes (39.33 per cent) cashew nut shelled (38.62 per cent).

3.2 Growth Rate of India's Agricultural Export

The kinked compound growth rate of India's export value and world total export value are estimated and represented in Table 5. It clearly indicates that there is a fluctuation in export value of commodities; compared to the post WTO with pre WTO period, i.e., 1980–1994 and 1995–2012.

The results are presented in Table 5 in the preWTO period (1980–84 to 2000–12). It shows that the value of cake of soybean export grew at a rate of 9.18 per cent

Table 4: India Percentage Share in World Export Value

Items	1980–89	1990–99	2000–09	1980–94	1995–2012
Cake of Groundnuts	41.39	39.22	44.21	40.52	42.02
Cake of Soybeans	1.65	7.29	6.51	3.56	6.85
Cashew Nuts Shelled	48.02	44.38	36.21	44.17	38.62
Coffee Extracts	59.64	54.98	28.68	56.32	34.43
Coffee, Green	1.64	2.61	9.20	2.26	7.05
Cotton Lint	1.29	3.13	3.38	1.64	3.55
Oil of Castor Beans	5.77	1.78	2.32	4.97	1.80
Oil of Vegetable Origin, nes	4.41	12.16	9.55	6.03	10.04
Onions, Dry	11.05	10.63	19.25	11.58	16.75
Pepper (Piper spp.)	18.17	14.58	8.54	16.58	10.34
Rice	3.24	10.37	12.81	3.70	13.22
Spices, nes	23.20	32.06	41.19	24.93	39.76
Sugar Refined	1.28	0.94	4.37	1.16	3.42
Tea	19.78	14.19	11.20	18.13	11.80
Tobacco	5.31	4.68	6.13	4.83	5.86
Wheat	0.09	0.25	1.14	0.12	0.90

Source: Based on FAO (2014) @faostat.org.

followed by wheat (4.09 per cent), rice (3.76 per cent) and oil of castor (3.06 per cent) and cashew nut shelled (2.51 per cent). These crops show positive growth rate during pre WTO period. But there is a negative growth rates among the crops like oil of vegetable (-8.77 per cent), cake of groundnuts (-3.47 per cent), cotton lint (-3.86 percent), Sugar refined (-2.52 per cent) and tobacco (-1.41 per cent) during pre-WTO period. In post WTO period, sugar refined occupied important place with a higher growth rate (9. 28 per cent), followed by cotton lint (8.33 per cent), oil of vegetable (7.49 per cent), onion dry (5.68 per cent), rice (4.68 per cent) and tobacco is having a growth rate of 4.860 per cent respectively. Commodities like cake of ground nut, pepper and wheat have registered a negative growth rate in post WTO period. The comparison between two periods shows that the growth rate of cake of soybeans, cashew nut shelled, coffee, pepper and wheat have declined in post reform period than pre-reform period. In case of world export value, the growth rate of tobacco is 3.430 per cent, followed by onion dry (2.84 per cent), pepper (2.04 per cent), cashew nut shelled (2.14 per cent), respectively, in pre WTO period. But that coffee extracts registered a growth rate of 1.81 per cent spices (1.82 per cent), and sugar refined (1.274 per cent). It was interesting that cake of ground nut (-1.298 per cent), coffee green (-0.852 per cent), oil of castor beans (-0.204 per cent), oil of vegetable (-0.363 per cent) and wheat (-0.544 per cent) have decelerated during pre WTO period. In post WTO period results show that almost all the commodities experienced acceleration except pepper and tobacco. However, the growth rate of ground nut decelerated but it is not statistically significant.

Table 6 presents the kinked compound growth rate of India and world export quantity. In the case of India, it shows that the cake of soybeans registered highest at growth rate followed by coffee extracts, wheat, rice, oil of castor beans in pre WTO period. During that period, cashew nuts, coffee green, dry onion registered low growth rate. The cakes of groundnut, cotton lint, oil of

Table 5: Kinked Compound Growth Rates of India and World Agricultural Export Value

Items	India		World	
	Pre WTO	Post WTO	Pre WTO	Post WTO
Cake of Groundnuts	-3.457*	-1.184	-1.298	-3.563
Cake of Soybeans	9.187***	2.331***	0.760**	3.315***
Cashew Nuts Shelled	2.512***	1.732***	2.148***	3.690***
Coffee Extracts	2.512***	1.732***	1.815***	3.428***
Coffee, Green	0.377	0.852**	-0.852	1.041
Cotton Lint	-3.868	8.329***	0.353	0.759**
Oil of Castor Beans	3.063***	3.368***	-0.204	3.079***
Oil of Vegetable	-8.775	7.497***	-0.363	5.148***
Onions, Dry	0.872	5.686***	2.840***	2.818***
Pepper (Piper spp.)	1.337*	-0.885	2.024**	1.527*
Spices, nes	1.473***	4.752***	1.821***	3.578***
Sugar Refined	-2.516	9.282***	1.274***	2.216***
Tea	-1.308	0.759	0.474*	1.997***
Wheat	4.096	-3.991	-0.544	2.033***
Rice	3.764***	4.682***	1.052**	3.038***
Tobacco	-1.414	4.860***	3.430***	0.782***

Note: The symbols like ***, ** and * indicate level of significance at 1%, 5% and 10%.

Source: Based on FAO(2014) @faostat.org.

vegetable have been decelerated during pre WTO period. During the post WTO period, sugar refined registered a highest growth rate (8.88 per cent) followed by coffee extracts (5.38 per cent), dry onion (4.83 per cent) and oil of vegetable (4.63 per cent), respectively. Cake of ground nuts, pepper and wheat experienced deceleration during post-WTO period.

In case of World export quantity, shows that almost all the crops experienced deceleration except coffee extracts during pre WTO period. In post WTO period, it indicates that the export quantity of most of the commodities registered higher growth rates compared to preWTO period. But the cakes of ground nuts decelerated in postWTO period at a higher rate than pre WTO period; though it is not statistically significant.

3.3 Instability of India and World Export Value and Quantity

Risk management in agriculture as well as agricultural trade is crucial for agricultural development. Minimization of risk or instability in agricultural trade has been one of the concerns in agricultural trade policy for the realization of sustainable agricultural development. The instability in case of export values of India along with that of world in both pre WTO and post WTO is calculated by the modified Boyce (1987) method as suggested by Paltasingh and Goyari (2013). This method is used to have a direct comparison between the instability in agricultural trade of India with world trade both in terms of quantity exported and export values.

The trend of India's export value was declined during postWTO period except cashew nut shelled, cake of soybean, cotton lint, wheat, vegetable oil, tea and spices, respectively. In world export value the instability in case of some crops like (cashew nut shelled, cake soybean, cake of ground nut, coffee, spices) rises during pre WTO period than post WTO period. But in case of other crops the instability of export value declines.

Table 6: Kinked Compound Growth Rates of India and World Agricultural Export Quantity

Items	India		World	
	Pre WTO	Post WTO	Pre WTO	Post WTO
Cake of Groundnuts	-2.550	-3.634	-0.542	-5.027
Cake of Soybeans	9.727***	0.927	1.433***	2.217***
Cashew Nuts Shelled	2.674***	2.114***	2.592***	3.249***
Coffee Extracts	6.605***	5.389***	1.923***	3.773**
Coffee, Green	2.122***	0.664**	0.657***	0.842***
Cotton Lint	-3.345	8.414***	0.715***	1.067***
Oil of Castor	3.950***	1.995***	0.564*	1.718***
Oil of Vegetable	-7.616	4.637***	-2.756	4.913***
Onions, Dry	1.508***	4.836***	1.879***	2.393**
Pepper (Piper spp.)	0.569	-0.696	1.094***	1.300***
Spices,	1.750**	3.779***	0.795***	2.468***
Sugar Refined	-2.345	8.886**	1.446***	1.734***
Tea	-0.986	0.484***	0.649***	1.321***
Wheat	6.610	-5.770	0.255**	0.716***
Rice	5.159***	4.011***	1.620***	1.896***
Tobacco	-0.740	3.254***	1.746***	1.135***

Note: The symbols like ***, ** and * indicate level of significance at 1%, 5% and 10%

Source: Based on FAO(2014) @faostat.org.

Table 7: Instability of India and World Agricultural Export Value

Items	India		World	
	Pre WTO	Post WTO	Pre WTO	Post WTO
Cake of Groundnuts	0.216	-0.078*	0.032	-0.016
Cake of Soybeans	0.005	0.004**	0.001	0.003
Cashew Nuts Shelled	-0.001**	0.001	-0.001	0.005
Coffee Extracts	-0.001*	0.001	0.001**	-0.001
Coffee, Green	0.011***	-0.008**	0.003**	-0.006
Cotton Lint	0.167*	-0.060*	0.001	0.004
Oil of Castor	0.002	-0.007	-0.002	0.001
Oil of Vegetable	0.046**	0.007	-0.008	0.002
Onions, Dry	0.008***	-0.002*	-0.0005	-0.001
Pepper	0.002**	-0.001**	0.003	-0.006
Spices	-0.001	0.001	6.88595	-0.0001
Sugar Refined	0.232	-0.194*	-0.004	0.005
Tea	0.001	0.001	-0.0006	0.004
Wheat	0.126	-0.173*	0.0002	0.001
Rice	-0.007	-0.005*	-0.001	0.009
Tobacco	0.002	-0.002*	0.0003	0.001

Note: The symbols like ***, ** and * indicate level of significance at 1%, 5% and 10%

Source: Based on FAO(2014) @faostat.org.

Table 8: Instability of India and World Agricultural Export Quantity

Items	India		World	
	Pre WTO	Post WTO	Pre WTO	Post WTO
Cake of Groundnuts	0.118	-0.028	-0.0011	0.0013
Cake of Soybeans	0.0001	0.002	-0.0001	0.0001
Cashew Nuts Shelled	9.826	0.0004	0.0014	-0.0026
Coffee Extracts	0.003	-0.048	0.0001	-0.0003
Coffee, Green	-0.001	0.0002	0.0001	-0.0001
Cotton Lint	0.156*	-0.090	-0.0001	0.0007
Oil of Castor Beans	0.0003	-0.005	0.0014	0.0002
Oil of Vegetable Origin,	12.220	-3.644	0.0009	-0.0028
Onions, Dry	0.005	-0.004	0.0003	-0.0003
Pepper (Piper spp.)	0.002	0.006	-0.0001	-0.0002
Spices	-0.001	-0.001	-0.0012	-0.0002
Sugar Refined	0.178	-0.102	-0.0001	0.0002

Tea	0.001*	-0.001	0.0001	-0.0001
Wheat	0.955	0.415	0.0000	0.0000
Rice	-0.015	-0.001	0.0001	-0.0003
Tobacco	0.002	-0.004	-0.0002	-0.0001

Note: The symbols like ***, ** and * indicate level of significance at 1%, 5% and 10%.

Source: Based on FAO(2014) @faostat.org.

From Table 8 India's export quantity clearly shows there was significant instability in case of vegetable oil followed by cashew nuts shelled and wheat during the preWTO period. It was observed that the coffee green, species and rice have shown a decline in instability. In case of world export quantity instability during post-WTO declined compare to pre-WTO period except cake of groundnuts, cake of soybeans, cotton lint, oil of castor beans and sugar and wheat.

4. Revealed Comparative Advantages of India's Agricultural Trade

The comparative advantage of India's agricultural trade in terms of both RCA and RSCA is presented in Table 9 for pre WTO and post WTO periods. A perusal of the Table 9 reveals the RCAs in export commodity and agriculture products were higher than RSCAs the results show RCA and RSCA was worked out for two sub-periods. A perusal of the Table 9 reveals those RCAs in export commodity and agriculture products were higher than unity and RSC As. The RCA is 59.70 per cent during 1980–94 and 28.69 during 1995–09 in post WTO period declined. All the agricultural commodities can group into different categories base on RCA value. (a), very high value (>50)

Table 9: RCA and RSCA India's Export and its Products 1980–94 to 1995–2012

Items	Pre WTO (1980–94)		Post WTO (1995–2012)	
	RCA	RSCA	RCA	RSCA
Cake of Groundnuts	41.38	40.36	33.69	32.67
Cake of Soybeans	3.68	2.63	5.32	4.24
Cashew Nuts	59.70	58.62	28.69	27.65
Coffee Extracts	1.69	0.69	2.46	1.45
Coffee, Green	2.07	1.04	1.79	0.76
Cotton Lint	1.74	0.72	4.08	3.00
Oil of Castor Beans	46.01	44.98	56.36	55.33
Oil of Vegetable	6.52	5.52	1.80	0.80
Onions	9.17	8.16	8.41	7.40
Pepper	19.68	18.66	7.36	6.35
Spices	12.32	11.31	10.47	9.47
Sugar	1.00	0.00	1.92	0.91
Tea	22.34	21.17	8.71	7.65
Rice	6.20	5.12	9.94	8.80
Tobacco	1.24	0.23	0.93	-0.07
Wheat	0.10	-0.85	0.47	-0.52

Source: Calculations based on FAO Data, 2014 @faostat.org.

for example cash nuts shelled, and oil of castor;(b) high RCA value (10 to 50) these are spices, tea, paper , and third RCA value less than 10 like onion dry, oil vegetable rice, cake of groundnut, coffee green, coffee extracts and coffee green. The main focus of this exercise is to observe the changing comparative advantage of major India's agricultural export's during pre and postWTO period. The result shows except wheat, RCA value declined during pre and post WTO period, i.e., 1980–84 compared 1995–2012 indicating declined comparative advantage in these crops.

The RSCA index also shows the same pattern in the distribution of comparative advantage of agricultural export commodities as RCA. The positive value of RSCA for a commodity indicates that the country has comparative advantage, while the negative value indicates country's comparative disadvantage in that product. The increasing positive value of RSCA for among all agricultural commodities during the study period suggested that India is gaining specialization in agriculture export commodities. A contrasting result from RSCA to RCA is that the mean value of RSCA export commodity such as coffee green, oil of vegetable, sugar, tobacco and wheat for the entire period under study was below unity. It shows that India is by and large, comparative disadvantage in the export of crops.

5. Conclusion and Policy Implication

The study conducted for a 32-year period (1980–84 to 2012–13) has revealed the growth scenario, instability and comparative advantaged in export of India's agricultural export commodities in the global market. The analysis shows a distressing picture, especially in post WTO period. India's agricultural export commodities in terms of quantity and value were worsen significantly during post WTO period as exports of almost all agricultural commodities experienced a deceleration compared to preWTO period except rice. The average export during 1990–99 commodities like cake of groundnuts, coffee extracts, oil of castor, and rice has increased by an average more than 100 per cent compare to 1980–89. During 2000–11 cake of ground nut, paper and tea, (in rest of commodities there is) overwhelming signifying in average export in absolute terms compared to the period 1980–89. Cake of soybeans export has increased by more than ten times during this period. Total agricultural export of India also increased during 1990–99 to 2000–11 in absolute terms. India's export share in world market in quantity terms declined post WTO compared with pre WTO period. In case of value terms except cashew nuts and oil of castor, all commodities declined in post WTO period. The results shows that growth rate of India and World export in both value and quantity terms were fluctuation in post WTO period compare to pre WTO period. The analysis of instability figures by the modified method illustrates that India and world in terms of value and quantity has declined in pre WTO compare to post WTO period except cake of groundnut.

The result of comparative advantage in export of India's in the global world market reveals that those RCAs in export commodity and agriculture products were higher than unity and RSCAs were positive and higher. The results shows that except wheat, the rest of the commodities RCA value declined during post WTO with compare to pre-WTO period, i.e., 1980–84 compared 1995–2012 indicating declined comparative advantage in these crops. The RSCA for among all agricultural commodities during in the study period suggested that India is gaining specialization in agriculture export commodities. A contrasting results from RSCA from RCA is that the mean value of RSCA of export commodity as coffee green, oil of vegetable, sugar, tobacco and wheat for the enter period under study was less than unity. It shows that India has by and large, comparative disadvantage in the export of crops.

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Notes :

[1] As Boyce (1987) pointed out, when the exponential growth rate is estimated independently in different sub-periods, the resulting trend lines are likely to be discontinued leading to anomalies that the sub-period growth rates are more or less than the growth rate of the whole period. But the kinked growth rate model takes care of that deficiency. Thus, this is an improvement over the discontinuous simple compound growth rate model. Because of the fact that the sub-period growth rates cannot be either greater or lesser than the growth rate of whole period.

[2] Other measures of instability can be found in Ray (1983), Parthasarathy (1984), Wasim (2007), Chand and Tiwari (1991), Chand and Raju (2008). However, in our study we have used the modifies Boyce method since the fact that choice of measures depends upon the growth trend applied calculating growth rate so that it would be more logical theoretically. Ease of estimation is another factor.

[3] For detail about loopholes of earlier Boyce method and argument behind the modification, please see Paltasingh and Goyari (2013).

Water is critical for sustainable development, including environmental integrity and the alleviation of poverty and hunger, and is indispensable for human health and well–being.

–United Nations

Feature

Outcomes of Training and Development Measures in Public Sector Banks of India: An Overview

KSHIRODA KUMAR SAHOO, CHANDAN KUMAR SAHOO AND SANTOSH KUMAR TRIPATHY

Training interventions have played a significant role towards attitudinal change, improve morale, bring attention and expertise, upgrade skill and enhance the level of knowledge of the existing human resource to an improved state along with a break from the hectic work schedule for refreshment benefiting individually and organizationally. In this era of rapid expansion of banks, the training system should cope with the increasing demands and real challenges faced by the banks such as talent acquisition, management, retention and development. The time is at the peak for reviewing and changing the old principles and practises and taking bold measures to face the global as well as internal challenges, pressure from the peers as well as to meet the expectations of the demanding customers for economic future of the country and nation building.

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1. Background

In the present competitive environment there will be great demand for competent human resource as one of the major challenges is to manage customers with varied needs and preferences, having complex mentality resulting in an array of relationships among the customers, organization and working groups (Jha and Anand, 2014). The nature of this sector requires tremendous scope for up-gradation of knowledge and skill continuously. People work for 'empowerment' and need dignified way of treatment and better ambience in this 'knowledge era'. There are a total of 27 Public Sector Banks (PSBs) in India [21 Nationalised banks + 6 State bank group (SBI + 5 associates)] including IDBI Bank and Bharatiya Mahila Bank. 'Public sector banks in the country are facing a great challenge with respect to availability of talent and leadership skill in the existing employees. Estimates put the manpower shortfall at four to five lakh,' said Padmaja Alaganandan, Executive Director, consulting at PwC Consulting and the number is decreasing day by day. Bridging the shortfall and to manage the new comers requires focus on fast-tracking high potential talent, she added. To bridge the gap, banks should go for rigorous process of training and development of the staff in the areas of customer care services on operational aspects and behavioural aspects of the business for delivering high quality services to the customers and have a competitive edge over their peers. The training of employees is to educate and enhancement of skill in operational, technical and allied areas where as development refers to learn principles, management techniques, administration, organization and allied ones

(Rani and Garg, 2014). Hence, training is defined as a method of learning effectively which expand the efficiency of individual, group and the organization as a whole (Goldstein and Ford, 2002). Development generally means the accomplishments and satisfaction leading to gaining of new abilities and skills individually. In this world of competition, everybody should be up to date and skilled with latest knowledge and technology for sustenance as per theory of 'survival of the fittest' by Charles Darwin because the fittest organism which attained the greatest development among the peers, are invariably the most numerous, the most prosperous and the most open to further progress.

2. Introduction

All organizations must manage four resources: money, equipment, information and people. The purpose of training programmes aim at improving employee capabilities and organizational effectiveness. If an organization wants to invest to generate more productive and effective employees, then skill and knowledge has to improve by training methods. Banking operations requires exercise of sound training and development programmes for their employees continuously as it is vulnerable to market conditions and demands. It was suggested that training creates opportunities to increase in high employee turnover and claimed that it is a beneficial instrument for employee retention (Colarelli and Montei, 1996; Becker, 1993). By definition, training is a planned human resource practice that can significantly influence on the accomplishment of the organizations if organized accordingly by the abilities, enthusiasm and talent of their employees.

The emerging business profile of banks include non-traditional areas like mutual funds, insurance services, merchant banking, factoring, venture capital and personal investment counselling along with system driven traditional services. Besides this, to be on the top, banks are trying their level best to continuously innovate to find still new areas of research and operations. These new skills would require new knowledge and behavioural modifications for which training will be an important intervention. As a result of the globalization processes, the Indian banking systems has already started feeling the need for new competencies and coupled with this the new profile of the bank employees would be a major reason for reorientation in training.

The PSBs have talented people with requisite traditional banking skills throughout the country. There is an emergent need for acquiring new skills and strengthening with new competencies to meet the burgeoning demands. Side by side for the new generation techno-savvy bankers, knowledge of fundamentals of banking is inevitable (Hedge and Kumar, 2013). Most of the PSBs have already constituted Training Advisory Committee to advise, guide in providing strategic direction to training and HR audit for better efficiency.

Most of the banks have large training infrastructure and tie ups with other institutes around the country focusing on functional training. Although workmen staffs constitute more than 60 per cent of the total workforce, less than 30 per cent of these employees are benefited from the on-going training system. The present efforts to train them are not adequately meet to increase their knowledge and properly re-skilling needs. Mainly staffs working in rural and semi-urban areas and particularly women are not getting the benefit of training mostly due to staffing constraints and family obligations, respectively, resulting certain degree of wastages. This signifies for a comprehensive review of the system, i.e., training needs, design, curriculum, methodology and review with regard to each bank's business environment and future plans. A new dispensation for training is thus called for which should bring attitudinal change in their front line staff and management techniques for the officers and executives for creating excellence on sustainable basis.

3. Literature Review

3.1 Training and Development Programme

It is not possible to create and develop an employee development programme in a mathematical way, but the important components include learning, career planning, goal setting and evaluation. Rigorous analysis is required in the training programmes of PSBs of India and the outcome has to be implemented on priority basis to meet the challenges of the present and prepare for the future.

Peters (2006) suggests four stages of management education in HR with different learning results:

1. Functional competence in understanding of finance, accounting, marketing, strategy, information technology, economics, operations and human resources management;

2. Understanding contextual theory and strategy, societal values, politics, global issues;
3. Ability to deal, influence and motivate people; and
4. Reflective skills such as organization goals and life goals.

To obtain maximum benefit from training and development programmes, organizations must constantly assess the needs of their employees' and plan accordingly keeping in view present and future. This will help the organizations to visualise in all angles, needs of every segment change over time and the prospects of employees for their careers.

Investment in HR through training, skill up-gradation and management development programmes improves individual performance and organizational effectiveness as investing in employee is not same as investing inequipment or machinery. The former generally appreciates day by day whereas the later depreciates gradually. Kirkpatrick (1959) has developed the mechanism for evaluation of training programmes which includes the following:

1. **Reaction :** Trainees taught the programme in various methods;
2. **Learning** : Learned principles, methods and techniques;
3. **Behaviour :** Job performance and efficiency of trainee assessed; and
4. **Output/Results:** The impact on organizational objectives, such as turnover, costs and profit.

Return on investment measurement for a training programme is generally the final level. Phillips (1996) summarizes that return on investment for training in variety of industries ranged from 150 per cent to 2000 per cent in the American Society for Training and Development.

Learning is the way by which overall performance rather than just enhancing their job skills can be improved (Gerbman, 2000). Just giving employees information and asking them to process it will lead to poor performance than asking them to pull knowledge from information by applying tools in their job which will make them to become critical thinkers (Garger, 1999). Sears Roebuck & Co. proved this concept because they want to give them the analytical skills to think differently and challenge the norm, if any rather thinking alike (Gerbman, 2000).

3.2 Design and Methods of T & D Programme

Training is continuous process and every employee should be periodically and regularly imparted in tune with changing trend in the market, business and technology. In the absence of this, training becomes a statistical game which leads to employee demotivation and unworthy expenditure. Training design is a planned education component including sharing the culture of the organization, which meant for new comers or job skills, developing leadership, innovative thinking and problem resolving, as the case may be for the existing employees (Meister, 1998). It can be defined as gaining knowledge and techniques, objectives and environmental conditions to improve skills and later apply on the jobs by the employees (Gerbman, 2000).

There are various types of training methods followed worldwide by different organizations (Martin et al., 2014). But organizations dealing with finance meant for growth and development of the country are more susceptible to risk, loss and failure in various fronts. Taking into consideration all aspects and wider angle for better quality service, productivity and profitability, the recommended training methods for employees of PSBs in India is reflected in Table 1.

3.3 Benefits of T & D Programme

Proper designing and organization of training programmes for building competence and confidence among the employees to achieve organizational goal in the competitive business environment is clearly visible from the proposed model (Figure 1).

Individual Benefits

3.3.1 Employee performance

The effects of training on behaviour of employees resulted in enhancement of performance level and finally positive outcomes towards the organization (Satterfield and Hughes, 2007). Improvement of employee performance ultimately enhances organizational output and productivity (Kraiger, 2002). In India, during a qualitative study related to mechanical job, Barber (2004) concludes that on-the-job training leads to superior ideas and new skills. Skill improvement has a greater role to play for augmenting the performance level of employees. Recently, Government of India has introduced skill improvement programmes throughout the country and PSBs have been asked to support financially as well as operationally. Therefore, skills related to technical and professional knowledge are the pillar to perform a job in an effective way by the employees (Jehanzeb and Bashir, 2013).

Table 1: **Most Common Methods of T & D**

On-site Design			
Training methods (Relevance)	**Definition**	**Example**	**References**
Induction training (For initiation of sense of belongingness)	Induction is the opportunity for any organization to formally connect with new entrants, shape their mindset and introduce them.	All employees of the bank generally undergone Induction training during initial phase of probation period to know the fundamentals.	Ballard & Carroll, 2005; Stedman, 1997
Case study (For enhancement of efficiency in analytical jobs)	Participants find an opportunity to develop skills by a practical/ theoretical problem, for them to solve without solution, or *with* a solution, how it was solved.	A bank administration or trainer has trainees from among employees, asked for financial analysis of theoretical balance sheets (without solution).	Bruner, Gup, Nunnally & Pettit, 1999; Elam & Spotts, 2004; Menkel-Meadow, 2000
Mentoring (building confidence)	It is one-to-one partnership between a novice employee with a senior employee. Mentorship aims to provide support and guidance to new or less experienced employees.	The Organizational Development & Learning Centre at the University of Toronto offers mentoring programmes of 12 months with senior university leaders to assist newly appointed ones in enhancing their job skills.	Andrews &Chilton, 2000; http:// www.odlc.utoronto.ca/ mentoring
Job rotation (acclimatize to every part of the job)	To be seasoned for a job by working for a limited duration in all aspect and area.	At Ingram Micro. participating employees rotate their jobs among five different process areas so that at the end of the programme, they can perform in all five centres.	Barbian, 2002; Ho, Chang, Shih, & Liang, 2009; Wilson, 2000
Team training (On-the job) (For refreshment, time management and team spirit)	Intended exclusively for groups of individuals that behave interactively, both for improve mutual knowledge within the team and train the team as a whole.	An exercise which has each team member write opinions to a prompt question, then come to team consensus.	Wheelan, 2005; Craig, 1996
Off-site Design			
Lectures/Audio-Visual/Class room trainings (Knowledge management)	By means of verbal lecture or instruction or involves training through instruction that is delivered in a course via DVD/CD player/ project or etc. of hard copies of materials.	The classroom teaching of trainees to watch and listen to the lecture presented by the course instructor, or slide presentations and/or lecture notes on a single web interface in E-class.	Zhang, Zhao, Zhou, & Nunamaker, 2004
Conferences/Seminars/Short-term courses/Workshops, etc. (To know latest trends)	Academic developments and research inferences either at an academic institution or locally offered by commercial or professional persons/organizations on a subject.	In a predefined place where assigned readings are discussed, questions put and debates made or formal presentation of research can be made.	Billings & Fitzgeral, 2002
Computer-programmed instruction (IT oriented trainings and techniques)	Connecting internet and by programming in computers without presence of an instructor.	In software training/user guide, an automatic speech and showing demos, to use and update the latest developments.	Gist, Rosen & Schwoerer, 2006; Neri, Mich, Gerosa & Giuliani, 2008; Russ-Eft, 2002
Stimulus based training (Motivate towards work and goal of the organization)	To reduce stress and for being relax and refresh, using stimuli (i.e., music, works of art, narratives, etc.) to motivate the learner to learn or perform at duty stations.	The use of slow music for relaxation at the end hours of the day for promoting the closing works systematically and plans for tomorrow.	Lam, Kolomitro & Alamparambil, 2011; Kumagai, 2008; Zemke, 1995

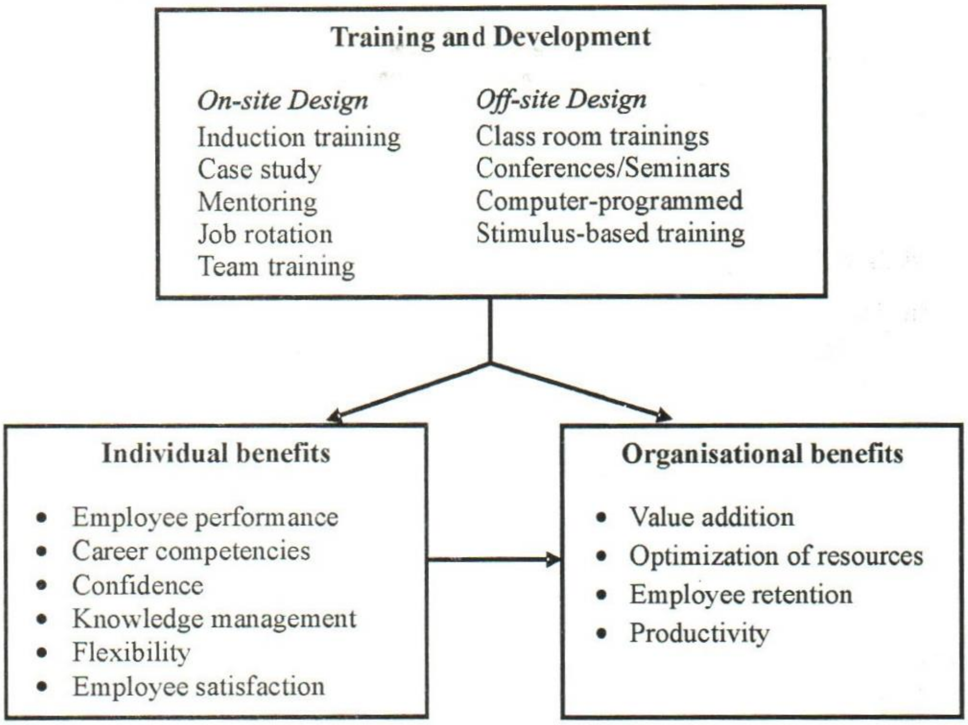

Figure 1: Benefits of T & D Measures

3.3.2 Career competencies

The learning of the soft and technical skills as required for the banking jobs will be an asset for building career in the field. It is obvious that a fresh graduate is not equipped to excel in every field in the job, but can be possible through continuous and rigorous training programmes (Gerbman, 2000). In a country like India, young professionals with entrepreneurial aim have shortage of experience and money, which can be compensated by PSBs mainly (as because they have to follow government guidelines mandatorily towards social security and development). Rural Self-Employment Training Institutions (RSETIs) by PSBs in district level generally provide all the support for self-employment and entrepreneurship. Sometimes, young mass having attitude to become role model join companies which provide training programmes to become innovative or entrepreneurial in long run to their employees (Feldman, 2000).

3.3.3 Confidence

The job of Officer or Executive of PSBs is very challenging, vulnerable to market condition (risky) and prone to profit and loss. This requires a lot of confidence to handle the transactions and taking decisions. Employees know that after attending training programmes they will put to superior duties and higher remuneration as they will be taught to handle pressure and build confidence (Fenn, 1999). Again, job satisfaction is necessary to improve their skills and knowledge rather doing repetitive works in the present context. The study reflects that their organizations are taking care of them which tremendously improve the confidence level leads to highest contribution towards the organization by the employees (Allen et al., 2003).

3.3.4 Knowledge management

In the 21st century, from organizations to nation, people are managing through their knowledge as knowledge is power. The person who earns knowledge and modern technology first becomes first in the race among other players. This also helps in customer attraction, brand management and employee retention. But it is recommended by researchers that to retain employee is to offer them opportunities for improving their scope of learning and acquire latest knowledge and technology (Logan, 2000).

3.5 Flexibility

Blau and Boal (1987) suggested in their research that trust and emotional attachment between organization and its employee are the central element of organizational growth and success. Gould-Williams (2007) concluded that implementation of social exchange theory by the organizations has commendable effects to care the interest of their employees. Employees favour to the organizations if they found optimistic attitudinal and behavioural actions (Settoon et al.,1996). However, training is definitely a tool for enhancement of organizational commitment by way of flexibility in the work culture (Bartlett, 2001).

3.3.6 Employee satisfaction

Employees will die to retain the goodwill of their organizations, if they feel their organizations are caring for them (Garger, 1999). Companies should make expenditure on their employees, encourage employees to work by incentive promotion, the employees will feel proud to work ultimately benefiting the organization (Wilson, 2000). It was proved that companies providing training and development programmes to their employees are achieving high level of employee satisfaction and have glorified results (Wagner, 2000). Training increase organization's trust as employees recognize that their organization is concern for their future (Rosenwald, 2000).

Organisational Benefits

3.3.7 Value addition

Greengard (2000) recommended that organizations should develop and promote the habit of learning for the employees to have competitive edge and growth of organization. Generally training programmes aim to have a return in the long run by paying price at present, which is called as investment. The best example of the world is Google, Microsoft, and General Electric Company are great and successful companies throughout the globe as they realize training as an investment, not expenditure (Kleiman, 2000).

3.3.8 Optimization of resources

Training and development programmes not only increase knowledge of staffs but also provide scope for optimization of resources and profit of the organizations. Organizations should prepare customized training and development modules for the current employees, perspective employees, even for customers of the company for smoother and better co-relation. By assisting employees to recognize their attitude, motivate them and convert them as superior contributors towards the organizational effectiveness (Petrecca, 2000). Finally, organizations can utilize training and development programmes to improve their presence in the open market and as best employer in the job compared to the peers.

3.3.9 Employee retention

Effectively design of training programme and train the employees as per their need and the need of the company (compatibility and synchronous way) can definitely increase in retention of the employees. Employee retention should be a volunteer move by organizations to create better environment for long term, in which the employees can be treated as of, by and for the organisation (Chaminade, 2007). For more effective retention, organizations may plan to have training and development programme that classifies volunteer assignments, requirements of the employees and expectations of the organization (Seigel and DeLizia, 1993). 'To retain employees, organizations must invest in training and development programme as it is one of the necessary tools' (Leonard, 1998).

3.3.10 Productivity

Bartlett (2001) recommends it is difficult to identify and propose an effective calculation of organization's growth. Blundell et al. (1999) also supplemented this as lack of requisite information and methodology prevents the assessment of impact of HR on performance of organization. However, training and development measures definitely impact human resource management practices on attitudes and work-related manners (Allen et al., 2003). To evaluate the effectiveness, one should check the relationship of training and organizational commitment of the employees by correlating to the efficiency of the organization (Bartlett, 2001).

Training and development measures has a significant role in improving technical and professional knowledge, acquiring new skills by new entrants and also existing employees enhancing employee performance, better career opportunities ultimately leads to organizational output. It also build confidence and to deal effectively in extreme pressure and unfavourable situations. As knowledge is power, talented employees will be the most important asset of the service organizations like Public Sector Banks. Finally, generating we feeling attitude, trust and organizations concern for the employees through the training measures will yield positive results. Value addition at every stage, innovation at different level and time, optimization of resources can only be made by improvement of knowledge by training which will finally resulted in employee retention and fruitful outcomes.

4. Implications

The relevance of the training programme is related to the difference in job performance between trained and untrained employees. The cost of the training programme has inverse relation to the utility on the organization. So, judicious planning and design of the programmes is very much essential for the organizations. To develop an integrated and proactive training strategy, corporate culture and visualization of the top executives of the organization is vital. In a service industry like banking, the most important assets are the employees who should efficiently manage in this competitive arena. The benefits of training programme contain knowledge management, factors related directly or indirectiy to performance. Most of the study has resulted in proving positive outcomes of training programme for the organizations. The main benefits comprise efficiency, effectiveness and profitability of the organization and other intangible benefits related to employee.

5. Conclusion

The PSBs have given emphasis on identification training needs and timely organization of training programmes for nurturing and enhancement of competencies of individuals along with behavioural modification towards goal attainment and organizational sustainability. Training and development activities in banks like breathing to human being. There is an urgent need for reforms in training measures in PSBs of India. The factors like training need, training resources, perceived training, training and development objectives, and latest training trends are to be identified by the management in accordance with organizational goal and employee need. The required change in curriculum, faculty, methodology and training resources is the need of hour. Accordingly banks should create a training budget as well as conduct training audit for the effectiveness of such programmes.

6. Scope for Future Research

Research continues and is never ending and can vary according to time, place and situations. The vertical transfer on impact of individual and organizational performance by training method with respect to market and industry types has to be measured in subsequent times. Empirical research on this aspect to be conducted in future to draw clear picture on this aspect. Secondly, more emphasis to be given on the factors affecting training, time frame (exact timing, duration and length of training) using applied and academic literature to measure usefulness of training programme (Holton, 2003).

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When the well is dry, we learn the worth of water.

–Benjamin Franklin

Feature

MGNREGA: An Empirical Study of Punjab

NAVNEET SETH, ROHIT MARKAN AND ANUPAM SHARMA

Mahatma Gandhi rural employment guarantee scheme was launched by UPA government in order to eradicate the poverty at the village level through providing the poor households at least 100 days of work in a year. This paper analyses implementation of this scheme in two districts in order to depict the real picture behind its implementation. Survey has been done to study the issues and problems faced by number of MGNREGA workers. The common problems faced by workers are non-availability of 100 days of work and delays in payment of wages. There is also an impressive engagement of women workers.

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1. Introduction

After independence, India is facing a serious problem of poverty and unemployment, and successive governments have been trying hard to overcome these social evils. For this, various schemes were initiated, but hardly any or very little success had been achieved from these schemes. To overcome these two main problems, governments have tried different subsidies to people who are living below poverty line or living in lower middle class. These subsidies covered different areas, that is, providing subsidized food through public distribution systems, cooking fuel at subsidized prices, unemployment allowances, etc. But due to poor performance of these schemes, the Congress-led UPA government passed an act to provide the employment opportunities to the people living in the rural areas as more than 60 per cent of total Indian population still lives in the villages; so by providing employment opportunities, these people will also develop and further help in strengthening the Indian economy.

To identify the availability of the skills of the labour working under MGNREGA, the results of the survey identified that there is non-availability of 100 days of work as mentioned in the Act and also delays in the payment of wages. On the other side, at some places, it has been observed that because of this scheme, impressive engagement of women workers can be seen, and in a way this is a bringing social equality at the rural level.

The UPA government passed the act named National Rural Employment Guarantee Act commonly known as NREGA which came into force on 2 February 2006. Initially, it was started in 200 most backward districts of India. But later it was extended to the remaining districts of India in two different phases. In 2009, the scheme was renamed as Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) as a tribute given to the 'Father of Nation Mahatma Gandhi'. The main objective was to provide every adult member of the poor family in rural area a minimum of 100 days of guaranteed employment in the financial year. The works include cleaning and construction of ponds, canals, street drains, repair and making of streets and roads, common resting place, etc. at the village level. These works were mainly done by unskilled labour. One of the main achievements of this scheme was that 33 per cent women got employment. The central government contributed 75 per cent of the total fund, whereas the state government contributed the rest of the 25 per cent of total cost.

2. Achievements of MGNREGA

In the year 2006–07 from Punjab, Hoshiarpur was the only district chosen under this scheme. In the year 2007–08, the budget allotted for NREGA scheme was increased to 12,000 crores INR for 330 districts. Then onwards, the budget has been continuously increasing, as in the year 2009–10 the scheme was fully implemented all over India and the budget allocated for the same had reached 40,100 crores INR. Under this scheme, the initial daily wage rate was 65 INR, which was later increased to INR 210 per day in the current financial year.

MGNREGA has provided employment to millions of people in almost all the villages of India from the year of its enactment, but since then MGNREGA has not been successfully implemented as a number of complaints regarding its implementation, corrupt activities, non-availability of work, non-payment/delay in wages, etc., have been continuously reported from various parts of the country.

3. Literature Review

Erlend Berg et al. said that 'It is difficult for developing country's government to enforce statutory minimum wages. Public works programs provide governments with an additional mechanism which influence wage rates in the rural unskilled labour market. Since the links between agricultural wages and poverty rates are well established, if public works can influence agricultural wages then they constitute an attractive policy instrument to reduce poverty' (Berg et al., 2012).

A study done by Jyoti Poonia compared the different employment schemes being operational in various states of India such as EGS in Maharashtra and NREGA in Kerala. NREGA also helped in social protection and hike in wage rate among women from INR 70–80 to INR 125 (Poonia, 2012).

The research by Pallavi Das stated that MGNREGA helped in increasing/providing employment to rural workers in the lean season. It helped small agriculturists to create surplus of cash to meet daily expenses. It also helped in stopping the migration from villages to cities during the off seasons (Das, 2011).

Suryavanshi in a case study of Sagar district found that MGNREGA has increased the labour wage rate in the agricultural sector, and problems of less availability of labour have also been analysed on one hand. It has not only helped overcome the problem of poverty but also created problem such as an increase in input cost of agriculture (Suryavanshi, 2014).

A study by D. Narsimha Reddy concluded said that agricultural wages have been increased from INR 700 to INR 2,000 per acre in just about 2 years in Punjab due to the implementation of NREGA. Farmers are blaming implementation of NREGA in UP, Bihar and Jharkhand. There is a great problem in the peak season in finding the labour to sow paddy in the month of July in Punjab (Reddy, 2011).

In a report, namely, Rozgar Sutra submitted to the Ministry of Rural Development (Govt of India), it was concluded that NREGA enabled higher women participation especially in Amritsar, Jalandhar and Hoshiarpur districts. Also, no gender discrimination is done in case of wage payments (Sutra, 2011).

In a report on NREGA all over India, a survey of 20 districts has been done and the same was submitted to the Govt of India which states that NREGA has increased the income levels of beneficiaries, but was not able to stop migration from villages to the cities. It has been revealed that around 70 per cent of the total migration is due to survival rather than for better wages (2008) [1].

In a report on 'Appraisal of impact assessment of NREGS in selected districts of Himachal Pradesh, Punjab and Haryana', namely, Hoshiarpur, Sirsa and Sirmaur, it has been analysed that there is an increase in the issuing of new job cards in all the districts, but the percentage of job card holders of getting 100 days work is very low (2009) [2].

Prof. Ranjt Singh Ghuman accessed that NREGA was not much fruitful in the initial years in Hoshiarpur district of Punjab. Workers were given an average of just INR 92 per day in comparison to the national average income of INR 148 per day. By this time, NREGA has not helped uplift the standard of living of the people (Ghuman, 2008).

In NREGA, Sameeksha Report prepared by Ministry of Rural Development Government of India has analyzed that about 16,600 billion INR has been distributed to the people from FY 2006 up to FY 2011–12. Maharashtra has observed highest increase in notified wages of about 200 per cent and Kerala at the lowest at just 31 per cent (Sameeksha, 2012).

K. Vatta et al. revealed that the poorest of the poor people are more inclined towards NREGA, but the average working days are 54.15 per annum. Also, the participation of scheduled caste people is more than backward class people. Even wages of casual labour have been increased due to an overall decline in the supply of labour in the agricultural sector (Vatta et al., 2011).

Jha et al. explored the important but relatively neglected issue of real income transfers, net of the opportunity cost of time, under India's National Rural Employment Guarantee Scheme. They used representative household-level primary data for three states: Rajasthan, Andhra Pradesh and Maharashtra to depict various individual and social characteristics of the population in these states as well as those of the participants in the NREGS (Jha et al., 2010).

Kareemulla et al. revealed that Rajasthan, Andhra Pradesh and Madhya Pradesh are the three states leading in scheme implementation with a large number of works, expenditure and employment. In Andhra Pradesh, soil and water conservation (SWC) works have accounted for more than 80 per cent. The share of labour wages under the scheme has been 80 per cent with only 20 per cent for material, which is well within the prescribed norm of 40 per cent for the latter. The field study in the Ananthapur district has indicated that almost two-thirds of the beneficiaries are farmers. The scheme has brought down the migration levels from about 27 per cent to only 7 per cent in the villages (Kareemulla et al., 2009).

4. Significance of Study

The study reflects the ground reality of the implementation of the employment scheme in the two blocks of Sangrur and Mansa districts of Punjab. It also helps in identifying the various issues and problems, which are required to be solved for the proper implementation of the scheme.

5. Scope of the Study

The study examines how MGNREGA helped in increasing the productivity in Sangrur and Mansa districts of Malwa belt of Punjab. The present research analyzes the implementation of MGNREGA in the villages. The study also examines its effect on the rural population of both the districts.

6. Objectives of Study

1. To study the social upliftment in the rural Punjab due to MGNREGA.
2. To identify the skills of the labour working under MGNREGA scheme.
3. To analyse the trends in the wages after implementation of MGNREGA.

7. Research Methodology

7.1 Research Design

This study is exploratory and descriptive in nature. Exploration has been done to find out the impact of MGNREGA in Sangrur and Mansa districts. For this, both primary and secondary data have been used. In primary data, labour attached or workings in MGNREGA from four villages of two blocks each of both districts have been personally interviewed and discussions have also been made with them. It is done with the help of structured questionnaires. Secondary data are collected from the government reports on MGNREGA and economic development, previous studies including research papers, articles in newspapers and magazines, previous PhD thesis and MGNREGA's official website.

7.2 Statistical Analysis

The present research was carried out as a cross-sectional descriptive study conducted on the people of Sangrur and Mansa district who were enrolled in MGNREGA. All the participants were asked to fill a self-explanatory questionnaire and the data collected were put to statistical analysis.

Descriptive statistical analysis using commercially available statistical software (SPSS) was carried out in the present study. Chi-square/Fisher's exact test was used to find the significance of study parameters on categorical scale between two or more groups.

7.3 Sampling Procedure

Purposive random sampling method has been adopted to select the villages to study the impact of MGNREGA. After this, random sampling has been used to select the sample respondents, that is, the workers for interview (who are associated with MGNREGA).

To analyse the implementation of MGNREGA, two districts, Sangrur and Mansa, have been selected in this study.

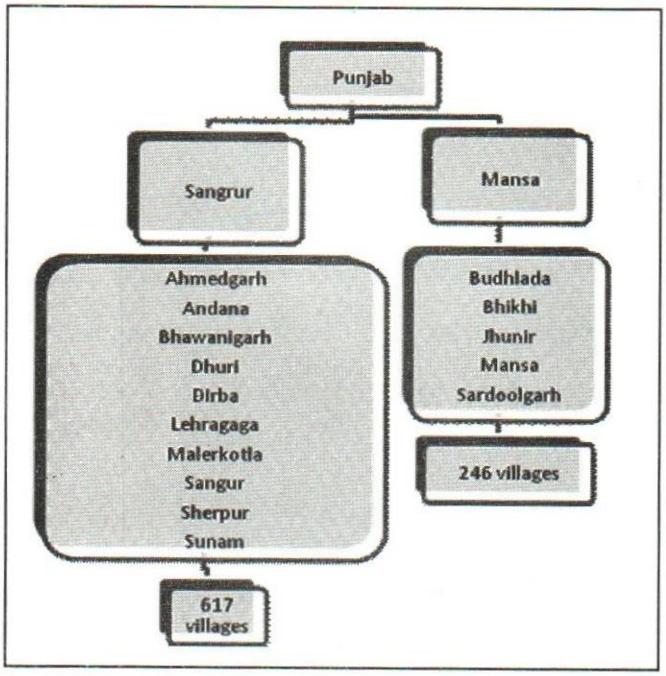

Figure 1: Punjab Division Under MNREGA Scheme

These districts have been selected by comparing the economic factors of both of them. Every year, Sangrur district bags one of the top three positions in growing wheat and paddy, thereby making it prosperous, whereas Mansa has been considered as one of the most backward districts of Punjab because of very less development, so two blocks from these two districts have been randomly selected to analyze the implementation of MGNREGA in its villages. Figure 1 shows that Sangrur district has the presence of 10 blocks, namely, Andana, Bhawanigarh, Dhuri, Lehragaga, Malerkotla, Sangrur, Sunam, Dirba, Sherpur and Ahmedgarh, whereas district Mansa has 5 blocks, namely, Budhlada, Bhikhi, Jhunir, Mansa and Sardoolgarh. Sangrur district has a total of 617 villages in it, whereas Mansa district has 246 villages. The blocks, namely, Dhuri and Lehragaga, from Sangrur district and Bhikhi and Budhlada from Mansa district are selected for the research.

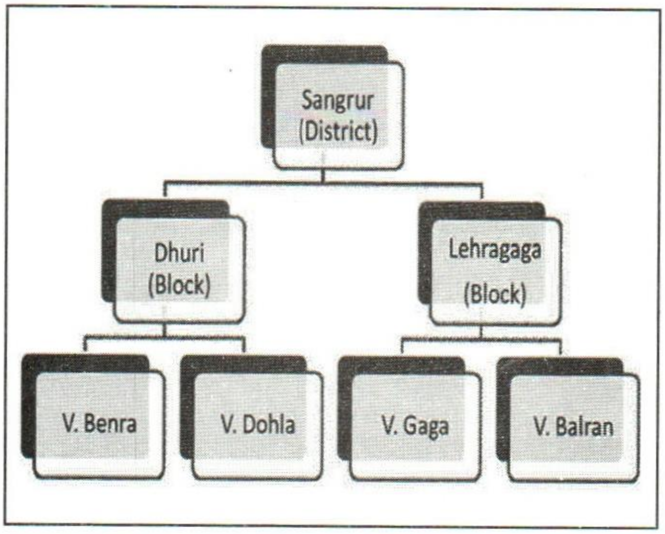

Figure 2: Sangrur District Covered Under MNREGA for Study

From these two blocks, two villages are randomly selected for the study, Benra and Dohla villages from Dhuri block, and Gaga and Balran villages from Lehragaga block (as shown in Figure 2).

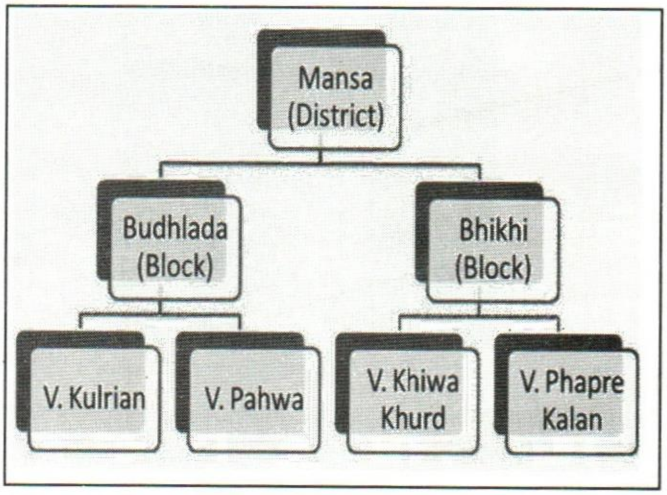

Figure 3: Mansa District Covered Under MNREGA for Study

Similarly, Figure 3 illustrates the selection of two villages from Budhlada block, namely, Kulrian and Bhava, and two villages, namely, Khiwa Khurd and Phapre Bahike, from Bhikhi block. Ten households from each given village are purposively selected for the study. These households are already working under MGNREGA for the past couple of years, and these persons are well aware of the working of MGNREGA.

Table 1 and Chart 1 show that totally 10,88,317 number of job cards have been issued in Punjab in the year 2014–15 to the MGREGA workers. Of this, around 8,13,071 job cards have been issued to the people belonging to scheduled caste category. It depicts that around 80 per cent of the total MGNREGA participants

Table 1: Employment Generated in Punjab in the Year 2014–15 Under MGNREGS

State	Job Cards Issued	Job Cards Issued to SC People	Total Persons Demanded Work	Total Persons Allotted Work	Total Persons Worked	Total Households Reaching 100 Day Limit	Total Person Days Worked by SCs
Punjab	10,88,317	8,13,071	4,19,784	4,18,273	3,36,028	2,029	49,30,345

Source: www.nrega.nic.in.

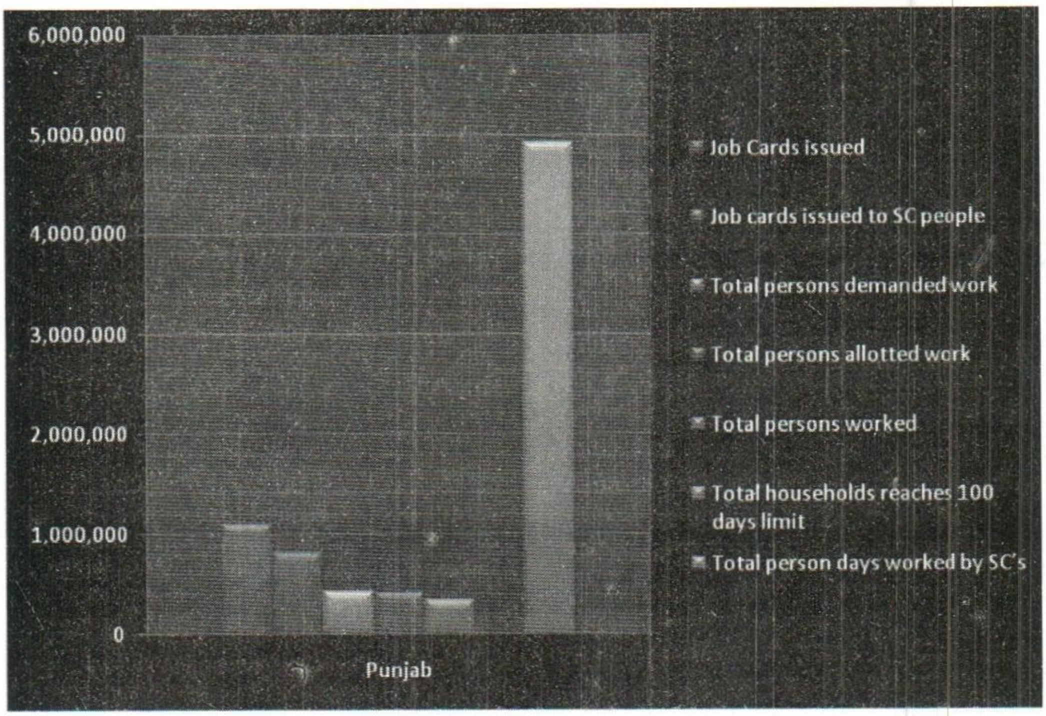

Chart 1: Employment Generated in Punjab in the Year 2014–15 Under MGNREGS

belong to scheduled class in Punjab. Similarly, majority of the people who have demanded work are allotted work. But only 2029 people have got 100 days of work in the year 2014–15. While total person days done by schedule class people is also very impressive.

In Table 2 and Chart 2, it has been shown that despite the issuance of less number of job cards in Dhuri block, more work has been given under the scheme in comparison to Lehragaga block. Dhuri block has provided 100 days of work to 10 households out of 34 given in the whole district. In Dhuri block, 10 persons have been able to get 100 days of work in the year 2014–15, but in Lehragaga only single household has been able to get it. The number of scheduled caste people getting work is double in Dhuri in comparison to Lehragaga block in the year 2014–15.

Table 2: Employment Generated in Given Blocks of Sangrur District During the Year 2014–15

Block	Job Cards Issued	Job Cards Issued to SC People	Total Persons Demanded Work	Total Persons Allotted Work	Total Persons Worked	Total Households Reaching 100 Day Limit	Total Person Days Worked by SCs
Dhuri	5,402	4,717	2,591	2,590	2,279	10	36,982
Lehragaga	7,472	5,763	2,709	2,707	1,493	1	17,266
Sangrur District	59,568	47,918	22,070	22,065	17,869	34	2,34,615

Source: www.nrega.nic.in.

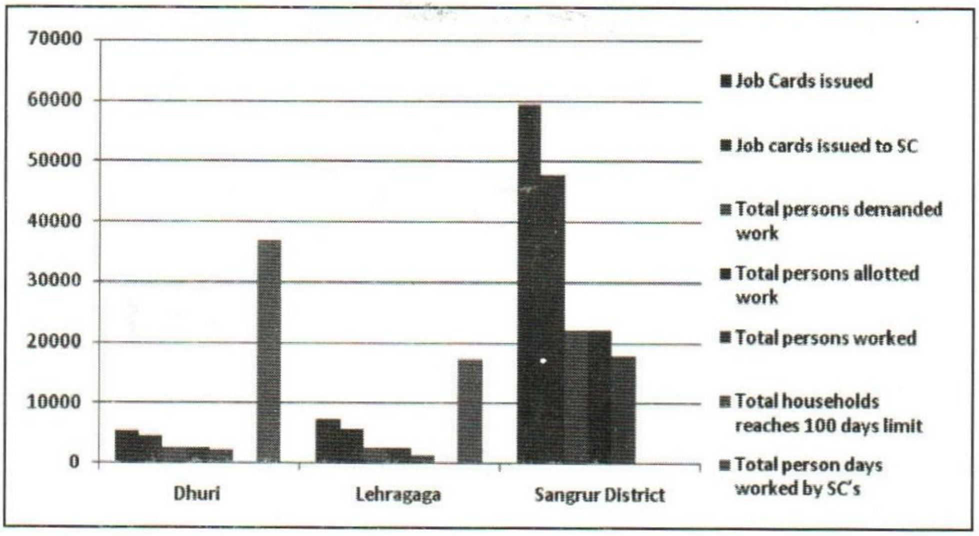

Chart 2: Employment Generated in Given Blocks of Sangrur District During the Year 2014–15

Table 3 and Chart 3 define that Budhlada block has more successfully implemented the scheme in comparison to Bhikhi as Budhlada has issued job cards to almost double the number of persons than Bhikhi and provided work to around to more than three times the number of workers. But in case of providing 100 days of work, both blocks are far behind it in the year 2014–15.

Table 3 : Employment Generated During the Year 2014–15 in Mansa District

Block	Job Cards Issued	Job Cards Issued to SC People	Total Persons Demanded Work	Total Persons Allotted Work	Total Persons Worked	Total Households Reaching 100 Day Limit	Total Person Days Worked by SCs
Budhlada	18,003	14,339	5,990	5,990	3,948	1	42,953
Bhikhi	7,658	5,873	2,682	2,561	1,326	0	16,103
Mansa District	57,230	41,907	17,096	16,974	11,144	7	1,15,539

Source: www.nrega.nic.in.

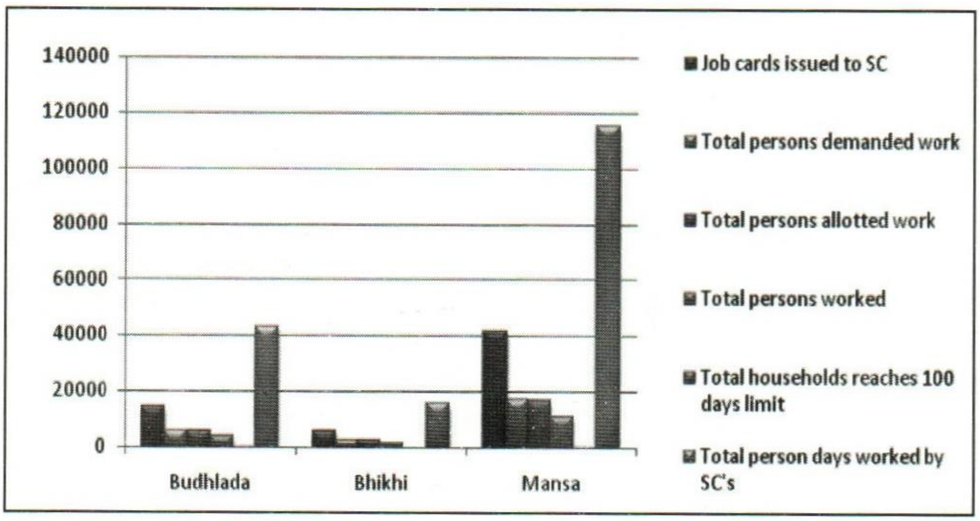

Chart 3: Employment Generated During the Year 2014–15 in Mansa District

Table 4 and Chart 4 show funds allotted under MGNREGA to Sangrur district during past years. Both explain that fund allocation in the year 2008–09 has increased to INR 1,000.67 million, but it continuously decreased from the year 2010–11. It was just INR 5.6 million in 2014–15.

Table 4: Funds Allotted Under MGNREGA to Sangrur District During Past Years

S.No.	Year	Amount
1.	2007–08	6.8
2.	2008–09	1000.671
3.	2009–10	48.850
4.	2010–11	65.319
5.	2011–12	45.556
6.	2012–13	30.341
7.	2013–14	21.222
8.	2014–15	5.834

(Amount in million INR)

Source: Office of Additional Deputy Commissioner (Development), Sangrur.

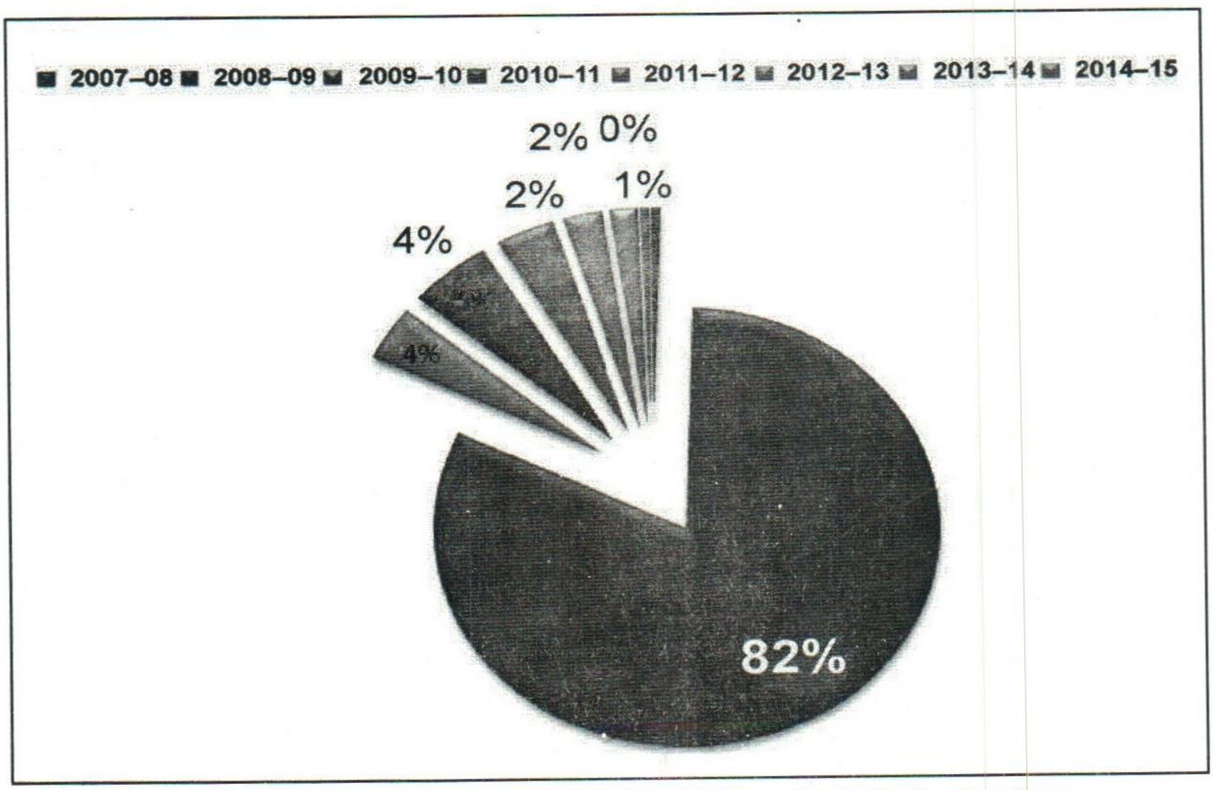

Chart 4: Total Funds Allotted Under MGNREGA to Sangrur District During Past Years

Table 5 and Chart 5 indicate funds allotted under MGNREGA to Mansa district during past years showing that fund allocation to Mansa district was highest in 2013–14, which stood at INR 3,620 million, and in 2014–15 it was 950 million INR. But Mansa district has been allotted more funds as compared with Sangrur district under MGNREGA.

Table 5: Funds Allotted Under MGNREGA to Mansa District During Past Years

S.No.	Year	Amount
1.	2008–09	444
2.	2009–10	614
3.	2010–11	520
4.	2011–12	380
5.	2012–13	1,139
6.	2013–14	3,620
7.	2014–15	950

(Amount in million INR)

Source: Office of Zila Parishad (MGNREGA Cell), Mansa.

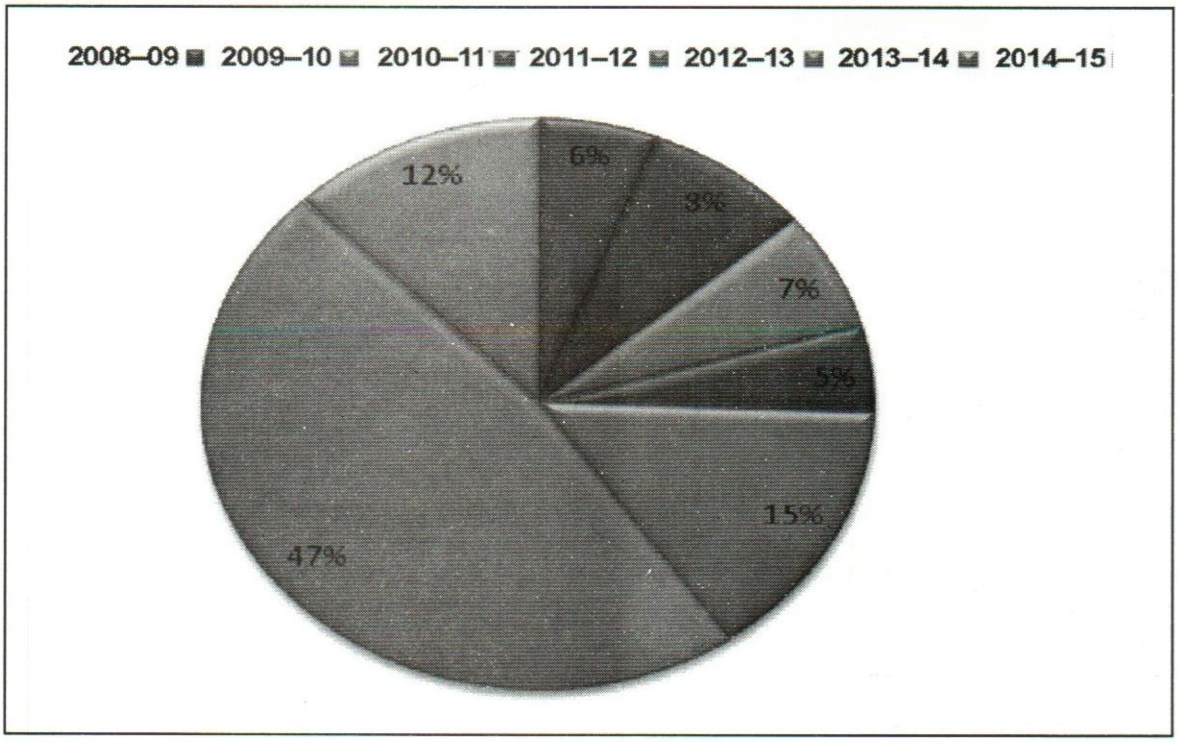

Chart 5: Funds Allotted Under MGNREGA to Mansa District During Past Years

Table 6 and Chart 6 show expenditure made under MGNREGS in Dhuri and Lehragaga blocks during the past years. Lehragaga block has made more expenditure than Dhuri under MGNREGA from the year 2008 to 2011–12.

Table 6: Expenditure Made Under MGNREGS in Dhuri and Lehragaga Block During Past Years

Block Name	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15
Dhuri	3.0	8.305	3.685	4.632	2.381	1.731	0.79	——
Lehragaga	0.03	12.87	4.29	4.72	3.70	0.898	0.39	——

(Amount in million INR)

Source: Office of Additional Deputy Commissioner (Development), Sangrur.

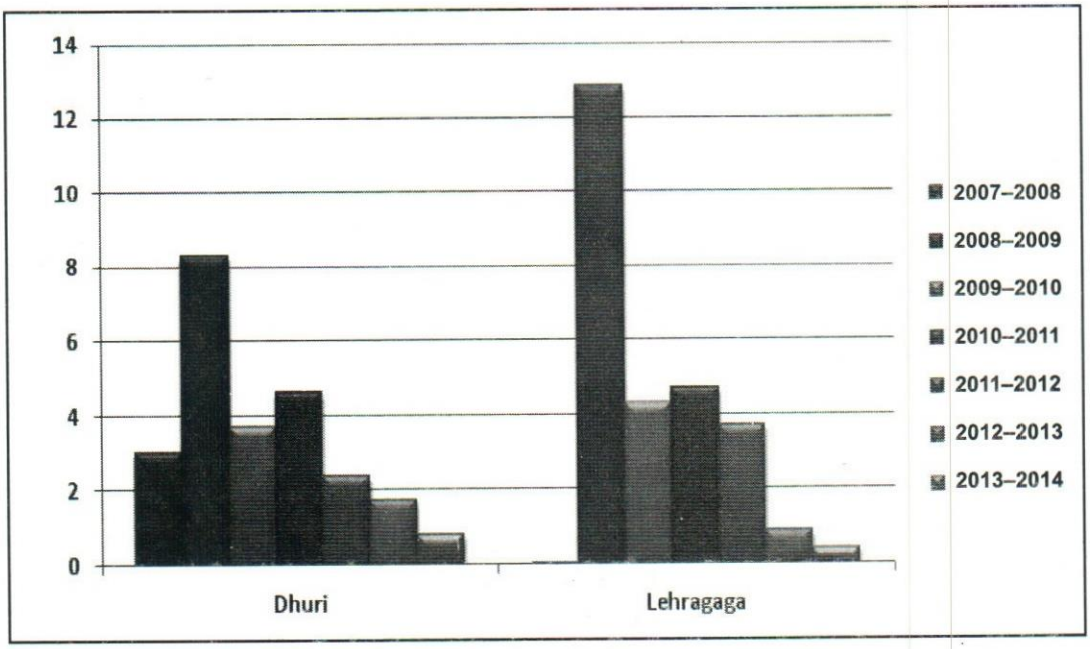

Chart 6: Expenditure Made Under MGNREGS in Dhuri and Lehragaga Block During Past Years

Table 7 and Chart 7 define expenditure made under MGNREGS in Budhlada and Bhikhi blocks during the past years. Both the table and chart illustrate that Budhlada has made more expenditure than Bhikhi under MGNREGA in almost all the years since the inception of the scheme.

8. Analysis of MGNREGA in Selected Villages

Benra village has a total of 504 persons associated with MGNREGA, whereas Dohla village has 81 persons associated with the scheme. Both the villages have very high participation of scheduled caste people in

Table 7: Expenditure Made Under MGNREGS in Budhlada and Bhikhi Blocks During Past Years

Block Name	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15
Budhlada	—	8,51,788	1,453,543.3	1,156,800	16,24,000	22,95,851.8	15,59,851	24,14,100
Bhikhi	—	3,50,729	8,37,099.5	3,44,400	4,71,289.2	13,25,514.7	11,59,300	7,44,400

(Amount in million INR)

Source: Office of Additional Deputy Commissioner (Development), Mansa.

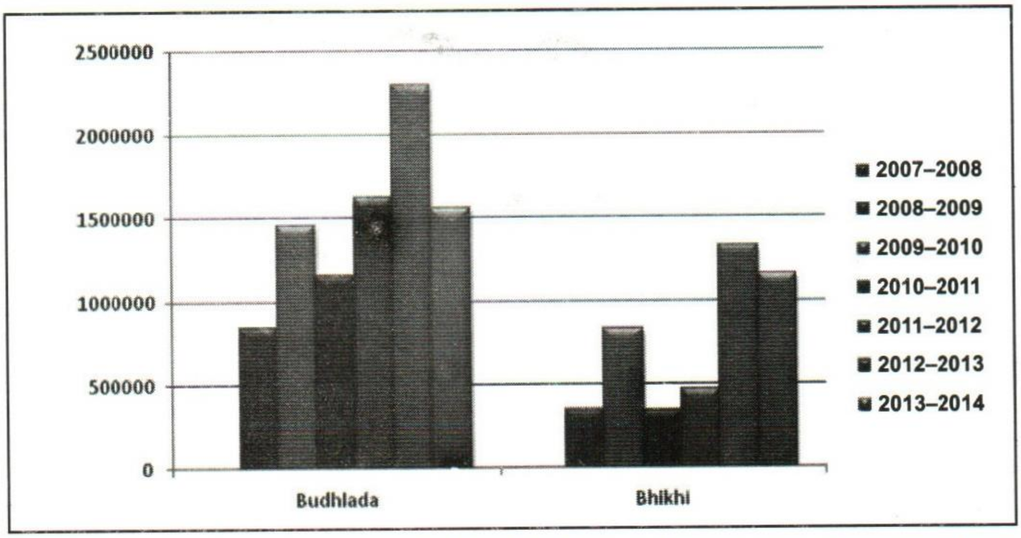

Chart 7: Expenditure Made Under MGNREGS in Budhlada and Bhikhi Blocks During Past Years

MGNREGA as Benra has nearly 469 (93 per cent) and Dohla has 100 per cent of workers belonging to scheduled caste. The women participation is around 52 per cent in both the villages, which shows good participation. But both the villages have failed to provide 100 days of work to even a single worker since its implementation.

Gaga village has 94 persons associated with MGNREGA out of which 75 (79 per cent) of them belong to scheduled caste category, while village Balran has 417 persons associated with MGNREGA out of which 368 (88 per cent) belong to scheduled caste. The participation of women in Gaga is very low as only 28 per cent women are associated, whereras 41 per cent are associated in Balran.

In Mansa, village Kulrian which falls under Budhlada block has 1036 MGNREGA workers, whereas village Bhava has 316 workers associated with the scheme. Both the villages have very impressive participation of scheduled caste people as in both villages their participation is 786 (75 per cent) and 221 (70 per cent), respectively. The participation of women in both villages is 469 (45 per cent) and 119 (37 per cent), respectively.

It is pertinent to mention here that not even a single worker has got 100 days of work in all visited villages of both blocks of Dhuri and Lehragaga of Sangrur district for the study right from the inception of the scheme.

Table 8 indicates the number of workers who have completed 100 days of work in Kulrian and Bhava villages of Budhlada block. It shows that only 2 workers have completed 100 days of work in the year 2011–12 in village Kulrian, whereas only 1 and 5 number of workers have completed 100 days of work in 2010–11 and 2013–14 in village Bhava of Budhlada block, respectively. It clearly defines that in both blocks, government has failed to provide 100 days of work to the MGNREGA workers as promised under the scheme.

Table 8: Number of Workers Completing 100 Days of Work in Kulrian and Bhava Villages of Budhlada Block in the Past Given Years

Year	Village	Block	No. of Workers Completing 100 Days of Work
2011–12	Kulrian	Budhlada	2
2010–11	Bhava	Budhlada	1
2013–14	Bhava	Budhlada	5

Table 9 here shows the number of workers who have completed 100 days of work in Budhlada block. Around 28, 8, 37, 83, 373 and 1 number of workers have completed 100 days of work from the years 2009–10 to 2014–15, respectively, in the different villages of the Budhlada block.

Khiwa Khurd and Phapre Bahike have been selected from Bhikhi block of Mansa district. Khiwa Khurd has 441 MGNREGA workers out of which 413 (93 per cent) are schedules caste. Phapre Bahike has 1094 MGNREGA workers out of which 897 (82 per cent) are schedule caste. The participation of SC/BC people is very impressive in MGNREGS in both the villages. The participation of women in both villages is 42 per cent and 44 per cent respectively.

Table 9: Number of Workers Completing 100 Days of Work in Budhlada Block

Year	No. of Workers Completing 100 Days of Work
2009–10	28
2010–11	8
2011–12	37
2012–13	83
2013–14	373
2014–15	1

Table 10 illustrates the total number of workers who have completed 100 days of work in Khiwa Khurd village of Bhikhi block. Only 4 and 16 number of workers got 100 days of work in the year 2011–12 and 2013–14, respectively. While no worker has got 100 days of work in any year in the village Phapre Bahike.

Table 10: Number of Workers Completing 100 Days of Work in Khiwa Khurd Village of Bhikhi Block in the Past Given Years

Year	Village	Block	No. of Workers Completing 100 Days of Work
2011–12	Khiwa Khurd	Bhikhi	4
2013–14	Khiwa Khurd	Bhikhi	16

Table 11 indicates the total number of workers who have completed 100 days of work in Bhikhi block. Overall 6, 15, 11, 59 and 122 number of workers have completed 100 days of work in the years from 2009–10 to 2013–14, respectively, in different villages of Bhikhi block.

During the study, it has been found that the MGNREGA workers are not satisfied with the implementation of this scheme. Workers in the villages of Gaga and Balran under Lehragaga block complained of not getting work of 100 days in 1 year under MGNREGA as promised in the Act. The workers of Gaga village said that they had got work ranging from 5 days to 80 days in 1 year right from its implementation of the scheme. Balran village workers confirmed of getting work between 5 and 52 days. In case of Benra and Dohla villages under Dhuri block, the workers got 2–58 days and 5–48 days of work,

Table 11: Number of Workers Completing 100 Days of Work in Bhikhi Block in the Past Given Years

Year	No. of Workers Completing 100 Days of Work
2009–10	6
2010–11	15
2011–12	11
2012–13	59
2013–14	122

respectively. On the other hand in Mansa district, the scheme is more properly implemented as 3 of the 4 village workers have confirmed to get 100 days of work in different years. In Kulrian village under Budhlada block, workers have got work from 10 to 102 days, whereas in village Bhava in the same block workers have got 2–104 days of work. While in village, namely, Khiva Khurd under Bhikhi block, MGNREGA workers have got 1–100 days of work and in village, namely, Phapre Bahike, workers got 10–95 days of work right from the implementation of MGNEGA. So after analyzing the implementation of the scheme, it can be concluded that Mansa district has more successfully implemented it in comparison to Sangrur district in providing 100 days of work to the number of workers.

It is cleared from the above data that from the 4 villages studied that not even a single worker has been able to get 100 days of work in Sangrur district right from the starting of the scheme but in 4 villages of Mansa, around 26 workers got more than 100 days of work in the last 5 years. But still both the districts are far away to give 100 days of work to each of the worker attached as promised under the scheme.

A major work has been done to clean the ponds, drains, land leveling, earth filling, land development, irrigation, street drain, maintenance of roads, digging of new pond, cleaning of canals, drainage and plantation in or around the villages.

In village Kulrian, MGNREGA workers constructed the MGNREGA Bhawan in the village premises. Even though the scheme has managed to increase the income level, it has failed to eradicate poverty. Workers claim that if they start getting regular work under MGNRES, then it will surely reduce the poverty level and increase their income. The workers' perception about MGNREGA is good only if they get regular work. But the impact of this scheme failed to convince the youth in these villages. While researching, it has been found that youths are still going towards cities to get work on daily basis. They are not attracted by MGNREGS as the wages under it are quite low as compared with the market rates and also due to non-availability of regular work.

Another limitation is that no skilled labour is available to work in MGNREGA, which sometimes creates hurdles in work at these sites. All the respondents from the 8 villages who have been interviewed are unskilled in nature. Majority of the workers are either doing farm labour or physical labour work. The panchayat members often complain that most of these works are been done by unskilled labour. Maximum of the MGNREGA workers had earlier worked as a labourer in the nearby towns which required no skills. They also complain that the workers are not serious about the work. Majority of the workers are in old age and also they do not prefer work. They are of the thinking that MGNREGA is their right and they will get wages without doing any work. Panchayat members have to face a number of problems while measuring the work.

There is also no availability of First Aid kit at the worksite and even no compensation is given to the workers in case while doing work in areas far more than 5 km from the village in case of village Khiva Khurd.

The other aim of the research was to test whether MGNREGA has affected the wage rate of the labourers or not. Then, it has been analyzed that this scheme has made no or very little effect on the wage rates. There has been an increase in the labour wages not due to MGNREGA rather than due to an increase in inflation. Some of the workers said that the wage rates will only be increased if they get 100 days of work. But they are getting very few days of work in each year. During the research, it has been noticed that majority of the workers are even ready to work in the nearby industries under MGNREGA scheme, but only on the condition that they will be paid for their work at right time.

Table 12 shows the statistical analysis of data collected from 4 villages of both the blocks. It defines the

Table 12: Statistical Analysis of Data Collected from 4 Villages of Both the Blocks

		Sangrur dist.		Mansa dist.			
S. No.	Questions Asked	Yes (%)	No (%)	Yes (%)	No (%)	Total	p-Value
1.	Whether educated?	18 (45)	22 (55)	20 (50)	20 (50)	80	0.654
2.	Whether working as an agriculture labourer?	25 (62.5)	15 (37.5)	24 (60)	16 (40)	80	0.818
3.	Whether doing any other work other than MGNREGA?	29 (72.5)	11 (27.5)	30 (75)	10 (25)	80	0.799
4.	Whether MGNREGA has been able to decrease the human migration to the cities?	14 (35)	26 (65)	19 (47.5)	21 (52.5)	80	0.256
5.	Specify the other areas where the MGNREGA labour can be used?	22 (55)	18(45)	19 (47.5)	21 (52.5)	80	0.502
6.	Whether MGNREGA has affected the trend in wages or not?	27 (67.5)	13 (32.5)	26 (65)	14 (35)	80	0.813
7.	Specify the other areas where the MGNREGA labour can be used	22(55)	18(45)	19(47.5)	21(47.5)	80	0.502
8.	Whether ready to work if MGNREGA is associated with industry?	28 (70)	12 (30)	28 (70)	12 (30)	80	1.00
9.	Whether there is any kind of asset creation due to MGNREGA in the village?	8 (20)	32 (80)	34 (85)	6 (15)	80	0.000*

Source: Information collected through Questionnaires filled by the respondents from 8 villages of both districts.

response of the participants to the questions in Yes/No. It was observed that more number of respondents in the Sangrur district (18/40) were educated in comparison to Mansa district (20/40), but the difference was not statistically significant. The respondents enrolled in this scheme were not solely dependent on MGNREGA. Almost 72.5 per cent (29/40) respondents in Sangrur district and 75 per cent (30/40) respondents in Mansa were doing work other than MGNREGA. In all, 65 per cent (26/40) respondents in Sangrur district and 52.5 per cent (21/40) in Mansa district believed that MGNREGA was not successful in decreasing the migration of people to other cities. When the affect of MGNREGA on trend in wages was studied, it was observed that 67.5 per cent (27/40) respondents in Sangrur district and 65 per cent (26/40) respondents in Mansa district feel that MGNREGA has positively affected their wages. This clearly shows their lack of willingness to do hard work under it. In all, 55 per cent (22/40) respondents in Sangrur and 47.5 per cent (19/40) respondents in Mansa district have suggested that MGNREGA labour can be used in the agricultural sector, while others suggested to attach it with the industrial sector. Consequently, 70 per cent (28/40) of people both in Sangrur and Mansa districts showed their willingness to work if MGNREGA is associated with industry. In all, 85 per cent (34/40) in Mansa district against 20 per cent (8/40) in Sangrur district reported that MGNREGA has helped them in creating asset creation.

The work given under MGNREGA is not affected by any religion or any group as all the respondents replied negatively in this. Around 27.5 per cent respondents do not do any work, whereas 50 per cent respondents work as labourer and 22.5 per cent work as agriculture labourer in Sangrur district. While in Mansa district 25 per cent are not associated with any work, whereas 47.5 per cent work as labour and 27.5 per cent work as agriculture labourer. Around 30 per cent respondents in Sangrur district admitted decrease in poverty due to MGNREGA, whereas 67.5 per cent respondents responded negatively in this. In Mansa district, 57.5 per cent said that the scheme has decreased the poverty level, whereas 42.5 per cent admitted negatively. Around 60 per cent respondents said that MGNREGA has helped in increasing the income level due to the employment scheme, but 37.5 per cent respondents said no regarding this in Sangrur district. While in Mansa district 70 per cent responded positively with an increase in income, and only 30 per cent responded in negative. But all the respondents admitted to getting wages late ranging from 2 to 9 months in both the districts. Not even a single respondent is a skilled worker who is working in this scheme in both the districts. All respondents admitted that wages given under MGNREGA are less than the wages given in the market in both the districts. Not even a single respondent is satisfied with the working conditions at the work sites of MGNREGA in both the districts. Approximately 57 per cent respondents from both the districts prefer to do work of cleaning under the scheme in the villages, while the rest prefer to do land leveling work. Around 50 per cent workers in Sangrur district said that there is usefulness of different assets created under MGNREGA, whereas 42 per cent said no. In Mansa district, 85 per cent respondents responded positively in usefulness of the assets, whereas only 15 per cent responded negatively. But one thing that has been noticed in all the villages is that all the respondents were satisfied with the registration process of MGNREGA. They do not face any problem in the making of job cards. But all were highly disappointed by knowing the fact that the authorities have to provide them work within 15 days after making job cards as not even a single respondent was given work within 15 days of it. One thing is more noticed that no worker is aware about the accidental compensation being given under the scheme and majority of the respondents are not aware about the various clauses. All respondents including women are not satisfied with the facilities provided at the worksite. Even basic facilities such as resting room, drinking water and washrooms are not available at the work places. Only 10 per cent respondents said that funds under the scheme are properly used in district Sangrur, whereas 25 per cent respondents replied the same in Mansa district, which clearly shows the presence of corrupt activities in MGNREGA.

9. Limitations of the Study

The study is based on limited samples of Sangrur and Mansa districts of Punjab. Some limited information has been collected due to illiteracy and ignorance of the workers. Majority of the workers feel hesitated to share their views about the employment scheme as they might be in some fear of not getting the work or their due wages from the competent authorities if they say something about the scheme. Due to lack of trust, all the respondents have given same answers at some places.

10. Conclusion

MGNREGA scheme has become a popular in the rural areas, but due to its lack of implementation people are not inclining towards it. Unawareness among the rural masses regarding the various provisions of the scheme also acts as a hindrance in its proper implementation. But in spite of investing such huge amount, there is no increase in the productivity and other factors, which were earlier expected. For better results, more strict laws have to be made by the government regarding its implementation and to control the corrupt activities. The government can also widen its scope by attaching the scheme with the industries and agriculture by which the majority of workers can get the promised 100 days of work which will further increase productivity.

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Water and air, the two essential fluids on which all life depends, have become global garbage cans.

–Jacques Yves Cousteau

DATA BASE

Water Resources Scenario in India: 2005 and 2015

RAJESH SUND

Introduction

Water, a scarce natural resource is fundamental to life, livelihood, food security and sustainable development. India has more than 18 per cent of the world's population, but has only 4 per cent of world's renewable water resources and 2.4 per cent of world's land area. There are further limits on utilizable quantities of water owing to uneven distribution over time and space. In addition, there are challenges of frequent floods and droughts in one or the other part of the country. With a growing population and rising needs of a fast developing nation as well as the given indications of the impact of climate change, availability of utilizable water will be under further strain in future with the possibility of deepening water conflicts among different user groups. Low consciousness about the scarcity of water and its life sustaining and economic value results in its mismanagement, wastage and inefficient use, as also pollution and reduction of flows below minimum ecological needs. In addition, there are inequities in distribution and lack of a unified perspective in planning, management and use of water resources.

The present scenario of water resources and their management in India has given rise to several concerns, important amongst them are: (a) Large parts of India have already become water stressed. Rapid growth in demand for water due to population growth, urbanization and changing lifestyle pose serious challenges to water security. Development of irrigation to increase agricultural production has been assigned a very high priority in the Five Year Plans, and multipurpose river valleys projects. As can be seen in Table 1, expenditure of major and medium irrigation projects across selected Indian states increased at an average increase of 131.89 per cent.

The inland water resources of the country are classified as rivers and canals; reservoirs; tanks and ponds; beels, oxbow lakes, derelict water and brackish water. Other than rivers and canals, the total water bodies cover

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Table 1: Expenditure on Major and Medium Irrigation Projects during X and XI Plans: Selected States

State	X Plan (2002–07)	XI Plan (2007–12)	% Increase
Andhra Pradesh	20434.2	51525.49	**152.15**
Gujarat	10496.2	25614.81	**144.04**
Maharashtra	10313.3	25397.89	**146.26**
Madhya Pradesh	5429.3	9982.62	**83.87**
Uttar Pradesh	4876.1	9138.35	**87.41**
Orissa	2388.6	6283.78	**163.07**
Bihar	1597.3	3537.35	**121.46**
Haryana	1297.8	3333.98	**156.89**
Average increase			**131.89**

Source: Water & Related Statistics (2013 and 2015).

about 7 million hectares. Of the rivers and canals, Uttar Pradesh occupies the first place. The other states following Uttar Pradesh are Jammu & Kashmir and Madhya Pradesh. Among the remaining forms of the inland water resources, tanks and ponds have a maximum area followed by reservoirs. As far as the reservoirs are concerned, major states like Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan and Uttar Pradesh account for a large portion of the area. Orissa ranks first as regards the total area of brackish water and is followed by Gujarat, Kerala and West Bengal. The total area of inland water resources is, thus, unevenly distributed over the country with Orissa, Andhra Pradesh, Gujarat and Karnataka, West Bengal accounting for about half of the country's inland water bodies.

India's water demand at present is dominated by irrigational needs. The existing status of water resources and increasing demands of water for the rapidly growing population of the country as well as the problems that are likely to arise in future, a holistic, well-planned long-term strategy is needed for sustainable water resources management in India. The water resources management practices may be based on increasing the water supply and managing the water demand under the stressed water availability conditions. Data monitoring, processing, storage, retrieval and dissemination constitute the very important aspects of the water resources management. These data may be utilized not only for management but also for the planning and design of the water resources structures. Also, knowledge sharing, people's participation, mass communication and capacity building are essential for effective water resources management.

Table 2: Inland Water Resources of India

	2005	2015
Inland Water Resources of India Rivers & Canals (length in km) **Other Water Bodies (Lakh ha)**	1,95,567	1,95,095
Reservoirs	21.61	29.26
Tanks & Ponds	25.14	24.33
Flood Plain Lakes	9.98	7.98
Derelict Water Bodies		
Brackish Water	16.86	11.55
Total	73.59	73.12

Source: Water & Related Statistics (2013 and 2015).

Table 3: Inland Water Resources—Rivers & Canals (Length in km)

State	2005	2015
Orissa	7,219	4,500
Andhra Pradesh	13,891	11,514
Karnataka	9,000	9,000
Tamil Nadu	7,420	7,420
West Bengal	2,526	2,526
Kerala	3,092	3,092
Uttar Pradesh	28,500	28,500
Gujarat	3,865	3,865
Maharashtra	16,000	16,000
Arunachal Pradesh	2,000	2,000
Rajasthan	6,802	5,290
Madhya Pradesh	17,088	17,088
Others incl UTs	78,164	84,300
TOTAL	1,95,567	1,95,095

Source : Water & Related Statistics (2013 and 2015).

Table 4: Inland Water Resources—Reservoirs (Lakh ha)

State	2005	2015
Orissa	1.96	2.56
Andhra Pradesh	2.34	2.34
Karnataka	2.11	4.4
Tamil Nadu	0.52	5.7
West Bengal	0.17	0.17
Kerala	0.3	0.3
Uttar Pradesh	1.38	1.38
Gujarat	2.43	2.43
Arunachal Pradesh	2.79	2.99
Rajasthan	1.2	1.2
Madhya Pradesh	2.27	2.27
Others incl UTs	4.14	3.52
TOTAL	**21.61**	**29.26**

Source : Water & Related Statistics (2013 and 2015).

Table 5: Inland Water Resources—Tanks & Ponds (Lakh ha)

State	2005	2015
Orissa	1.16	1.23
Andhra Pradesh	4.63	5.17
Karnataka	2.9	2.9
Tamil Nadu	2.56	0.56
West Bengal	2.76	2.76
Kerala	0.3	0.3
Uttar Pradesh	1.61	0.61
Gujarat	0.71	0.71
Maharashtra	0.59	0.72
Arunachal Pradesh	2.5	2.76
Rajasthan	1.8	1.8
Madhya Pradesh	0.6	0.6
Others incl UTs	3.02	3.21
TOTAL	**25.14**	**24.33**

Source: Water & Related Statistics (2013 and 2015).

Table 6: Annual Replenishable Ground Water Resources (BCM/Year)

State	2005	2015
Assam	24.72 (5.73%)	28.15 (6.59%)
Bihar	33.52 (7.77%)	29.34 (6.78%)
Orissa	20.00 (4.64%)	17.78 (4.11%)
Andhra Pradesh	35.29 (8.18%)	35.89 (8.29%)
Karnataka	16.19 (3.75%)	17.03 (3.94%)
Tamil Nadu	26.39 (6.12%)	21.53 (4.98%)
West Bengal	23.09 (5.35%)	29.25 (6.76%)
Uttar Pradesh	83.82 (19.43%)	77.19 (17.84%)
Gujarat	20.38 (4.72%)	18.57 (4.29%)
Maharashtra	37.87 (8.78%)	33.95 (7.85%)
Rajasthan	12.71 (2.95%)	11.94 (2.76%)
Madhya Pradesh	50.89 (11.79%)	35.04 (8.1%)
Others incl UTs	46.61 (10.80%)	41.74 (9.65%)
TOTAL	**431.48**	**432.72**

Source: Water & Related Statistics (2013 and 2015).

Table 7: Major & Medium Surface Water Irrigation Potential ('000 ha)

State	2005	2015
Andhra Pradesh	5,000	5,000
Orissa	3,600	3,600
Karnataka	2,500	2,500
Tamil Nadu	1,500	1,500
West Bengal	2,300	2,300
Kerala	1,000	1,000
Uttar Pradesh	12,500	12,154
Gujarat	3,000	3,000
Maharashtra	4,100	4,100
Rajasthan	2,750	2,750
Madhya Pradesh	6,000	4,853
Assam	970	970
Bihar	6,500	5,224
Haryana	3,000	3,000
TOTAL	**431.48**	**432.72**

Source: Water & Related Statistics (2013 and 2015).

Table 8: Minor irrigation (Surface and Ground) ('000 ha)

State	2005	2015
Andhra Pradesh	6,260	6,260
Orissa	5,203	5,203
Karnataka	3,474	3,474
Tamil Nadu	4,032	4,032
West Bengal	4,618	4,618
Kerala	1,679	1,679
Uttar Pradesh	17,999	17,481
Gujarat	3,103	3,103
Maharashtra	4,852	4,852
Arunachal Pradesh	168	168
Rajasthan	2,378	2,378
Madhya Pradesh	11,932	11,361
Assam	1,900	1,900
Bihar	6,847	5,664
Haryana	1,512	1,512
Punjab	2,967	2,967
Others	2,468	4,131
TOTAL	**431.48**	**432.72**

Source: Water & Related Statistics (2013 and 2015).

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