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Climate Change and Agricultural Sustainability

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Climate Change and Agricultural Sustainability in India: Issues and Policy Options

DEEPAK SHAH

India faces a major threat from changes in climate since its economy is closely tied to natural-resource-base and climate-sensitive sectors such as agriculture, water and forestry that happen to be the most vulnerable sectors. India is poorly equipped to cope effectively with the adversities of climate change due to low capabilities, weak institutional mechanisms, and lack of access to adequate resources. Wheat production in the country may decline after 2020 and rice production may be adversely impacted in the eastern states. The eastern region would witness increased temperatures and decreased radiation, resulting in fewer grains and shorter grain filling durations. On the other hand, the potential decline in yields owing to increased temperatures in northern India will be offset by higher radiation, resulting in lower impacts of climate change. There is a possibility of a loss of 4–5 million tonnes in annual wheat production with every 1°C rise in temperature even after considering the carbon fertilisation effect. The climate change will affect various crops during the entire growing period owing to extreme whether events. The adaptability of crops-to-climate variability would acquire significant dimension as frequent occurrence of extreme weather conditions may dictate as to how to cope up with the situation.

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1. Introduction

The major challenge posed before the entire world today is climate change or global warming. Several countries have initiated various measures to counter global warming. It has been estimated that due to continued human modification of the atmosphere the rate of future global warming over the period 1990–2100 would be about 0.20°C per decade, which stands some five times the mean rate of warming over the past hundred years (Chattopadhyay, 2008). During the early 90s, the Intergovernmental Panel on Climate Change (IPCC) had forecasted a worldwide negative impact of climate change[1] on agriculture sector with less adverse effects on crop yields in mid and high latitude regions than such effects in low latitude regions. The warmer areas would witness decline in potential yields due to shortening of crop growing period, decrease in water availability owing to higher rate of evapotranspiration,[2] and poor vernalisation of temperate cereal crops. Among various nations, India, with 15 per cent of world's total population, is one of the most drought prone countries in the world and most vulnerable to changes in climate. Despite significant progress in industrialisation process in recent years, the economic growth of India still largely depends on agriculture mainly owing to burgeoning population where food and nutritional security is a constant challenge.

The impact of climate change on Indian agriculture and water resources are of great concern to the policymakers and development experts. Agriculture, in India, to a greater extent is dependent on south-west monsoon. A large part of the net sown area is rainfed,[3] thereby making the agricultural sector in India very sensitive to any change in the pattern of rainfall (Agarwal

et al., 2010). Among various foodgrain crops produced in India, rice and wheat occupy a major share, and any discernible positive or negative change in rice and wheat yields may have a significant impact on food security of the country. The productivity levels of these crops in the coming decades will chiefly depend on changes with respect to sensitive weather parameters, viz., temperature, rainfall and solar radiation. In view of the fact that about 65 per cent of the country's population depends on agriculture sector for their livelihood and that the change in climate would have a direct bearing on the food production, an analysis into the changes, which could impact crop yields and subsequently lead to an instable food security situation, is essential. Since the change in climate has a bearing on food security of the nation, the magnitude of the change and its consequence will be of matter of concern for the scientists, planners and policymakers, especially in view of regulating the food supply and maintaining its reserves for the future. The present study, therefore, not only assesses the impact of climate change on agriculture sector of India but also determines future strategies for sustainable development, adaptation and other policy decisions since it is essential to have integrated assessment of climate.

2. Climate Change: A Review

The impact of climate change on agricultural sector assumes greater significance since climate is a direct input into the agricultural production (Guiteras, 2008). There has been spate of studies assessing the impact of climate change on agricultural sector of India. Simulations using dynamic crop models indicate a decrease in yield of crops as temperature increases in different parts of India. For example, studies carried out by Sinha and Swaminathan (1991) and Aggarwal and Kalra (1994), showed that with 2°C increase in mean air temperature, rice yields could decrease by about 0.75 ton/ hectare in the high yield areas and by about 0.06 ton/ hectare in the low yield coastal regions. This is offset by an increase in CO_2 at moderate rise in temperature and at higher warming; negative impact on crop productivity is projected due to reduced crop durations. In the agriculture sector, the major impacts of climate change will be on rainfed or unirrigated crops, which are cultivated in nearly 60 per cent of cropland area. In India, it is the poorest, most vulnerable farmers who practice rainfed agriculture. A temperature rise by 0.5°C in winter temperature is projected to reduce rain fed wheat yield by 0.45 tons per hectare in India (Lal *et al.*, 1998). Rao and Sinha (1994) showed that wheat yields could decrease between 28 to 68 per cent without considering the CO_2 fertilisation effects and would range between +4 to -34 per cent after considering CO_2 fertilisation effects. Using WTGROWS model, Aggarwal and Sinha (1993) showed that a 2°C temperature rise would decrease wheat yields in most places. Saseendran *et al.* (2000) showed that for every 1°rise in temperature the decline in rice yield would be about 6 per cent.

The direct hazards to crops are the extreme weather conditions viz., floods, droughts, heat and cold waves, flash floods, cyclones and hailstorm, etc. More subtle fluctuation in weather during critical phases of crop development can also have substantial impact on yields. Climate may have indirect and possibly lagged influences on harvested areas. For instance, shortfalls in rainfall can reduce irrigation water supplies, leading to reduce areas under irrigated crops and potentially increased areas under rain-fed crops in the subsequent season (Kumar *et* al., 2004). Mall and Singh (2000) observed that small changes in the growing season temperature over the years appeared to be the key aspect of weather affecting yearly wheat yield fluctuations. The negative trends in solar radiation and an increase in minimum temperature resulted in declining trends of potential yields of rice and wheat in the Indo-Gangetic plains of India. This trend clearly indicates the reduced factor of productivity in case of the rice-wheat cropping systems. These variations in trends of productivity indicate the effects of other biophysical and socio-economic components, which needs to be eliminated before embarking on assessing the impacts of climate change and its variability on growth and yield of crops (Mall *et al.*, 2006).

There have also been studies in India which aimed at understanding the nature and magnitude of yield gains or losses of crops at selected sites under elevated atmospheric CO_2 and associated climatic change (Abrol *et al.*, 1991; Mathauda and Mavi, 1994; Lal *et al.*, 1998; Francis, 1999; Saseendran *et al.*, 2000; Aggarwal, 2003; Attri and Rathore, 2003, Mall *et al.*, 2004). Rao and Sinha (1994) studied the impact of climate change on wheat performance of India and showed that wheat yields decreased due to the adverse effects of temperature during grain filling and maturity stages of the growth. The results of this study indicate that crop characteristics such as sensitivity of grain filling duration to temperature, play a major role in determining the effects of climate change on crop productivity.

During the past fifty years, there have been around fifteen major droughts, due to which the productivity of rain-fed crops in drought years was adversely affected. Food security of India may be at risk in the future due to the threat of climate change leading to an increase in the frequency and intensity of droughts and floods, thereby affecting production of small and marginal farms. With higher magnitude of temperature increases, western India may show some negative impact on productivity due to reduced crop durations.

3. Impact of Climate Change on Indian Agriculture

India is one of the fastest growing economies of the world, which is under the threat of climate change and its impact. With about 30 per cent of Indian population living below the poverty line, the consequences of climate change, especially in agriculture, could worsen the living conditions since agriculture sector has been a major source of livelihood to a significant section of poor people. The poorest of the poor and the marginalised sections of Indian population will be the major victims of the consequences of climate change. The studies in the past have shown potential threat of climate change on the overall food productivity. Studies conducted by the Indian Agricultural Research Institute (IARI) indicate the possibility of a loss of 4–5 million tonnes in annual wheat production with every 1°C rise in temperature despite considering the carbon fertilisation effect. Studies have also shown that an increase in temperature may also effect the nutritional quality of cereals and pulses, though moderately.

It is to be noted that the brunt of environmental changes is expected to be very high in India due to greater dependence on agriculture, limited natural resources, alarming increase in human and livestock population, changing pattern in land use and socio-economic factors that pose a great threat in meeting the food, fibre, fuel and fodder requirement. There is a likelihood of a considerable impact on agricultural land-use due to snow melt, availability of irrigation, frequency and intensity of inter- and intra- seasonal droughts and floods, soil organic transformation matters, soil erosion and availability of energy as a consequence of global warming, impacting agricultural production and hence, the nations' food security. Climate change may have beneficial as well as detrimental consequences for agriculture. A warming climate and decreasing soil moisture can also result in increasing need for irrigation. It is to be further noted that seasonal changes in rainfall and temperature could not only impact agro-climatic conditions but may alter growing seasons, planting and harvesting calendars, water availability, etc.

Although considerable studies have been carried out to investigate how farming might be affected in different regions due to climate change, these studies either pin their attention to the degree of temperature increase and its geographic distribution or focus on the concomitant changes that are likely to occur in the precipitation patterns which determine the water supply to the crops, and the evaporative demand imposed on the crops in carbon dioxide enriched atmosphere. The problems of predicting the future course of agriculture in the changing world are compounded by the fundamental complexity of natural agricultural systems, and socio-economic systems governing the world food supply and demand (Khan *et al.*, 2009). Climate change will also have an economic impact on agriculture, including changes in farm profitability, prices, supply, demand, trade and regional comparative advantages. The magnitude and geographical distribution of such climate-induced changes may affect our ability to expand the food production area as required to feed the burgeoning population. Further, increasing climatic variability associated with global warming will result in considerable seasonal/annual fluctuations in food production. All agricultural commodities even today are sensitive to such variability. Droughts, floods, tropical cyclones, heavy precipitation events and heat waves are known to negatively impact agricultural production, and farmers' livelihood. The projected increase in these events will result in greater instability in food production and threaten livelihood security of farmers.

Given the fact that the impact of climate change on India agriculture varies greatly by region, there is every possibility that climate change would influence agricultural productivity, resulting in change in cropping pattern. It has been shown by Saseendran *et al.* (2000) that for every one-degree rise in temperature the decline in rice yield would be about 6 per cent. For instance, a 2°C increase in mean air temperature would decrease rice yields by about 0.75 ton/hectare in the high yield areas and by about 0.06 ton/hectare in the low yield coastal regions. However, the climate change would have major impact on rain fed crops that occupy about 60 per cent of cropped area. The worst sufferers would be poor sections of the farming community as they mainly depend on rain fed agriculture. The resultant effect would be on farm level net revenue that will decrease in the range of 9–25 per cent for a temperature rise of 2–

3.5°C. Interestingly, the major impact is likely to be on eastern regions that would witness increased temperatures and decreased radiation, resulting in relatively fewer grains and shorter grain filling durations. On the other hand, the potential decline in yields owing to increased temperatures in northern India will be offset by higher radiation, resulting in lower impacts of climate change.[4]

4. Rice and Wheat Yields

A number of crop-weather models and regression-based yield prediction models for rice and wheat for the Indian region have been developed during the past few decades. The WIGROWS model, developed by IARI, shows that a mean temperature increase of 3°C during the post-anthesis period would have an adverse effect on grain yield in India mainly owing to shorter duration of the growing season. Similarly, the International Rice Research Institute (IRRI) has developed regression equations for the productivity of rice on the basis of trials conducted worldwide. Using this for India, it was established that the coastal areas, which have the lowest productivity, would be affected least, while the productive areas, particularly Punjab, Haryana and Uttar Pradesh, would be most adversely affected. The results from climate change studies in northern India suggest a declining trend in wheat production in these areas. A rise in mean temperature of about 2°C, as predicted by a group of scientists in the Climate Research Unit, University of East Anglia, UK, in Punjab and Haryana, would mean a substantial decrease in rice yields in these states. Though increased carbon dioxide enhances the productivity of C_3 plants in the arid region of India, the increase in temperature may offset such beneficial effects of carbon dioxide (Chattopadhyay, 2008).

The study conducted by Mathauda *et al.* (2000) has evaluated the impact of projected climate change on rice production in Punjab using simulation technique (CERES RICE model). The crop performance under five climatic scenarios showed that under normal weather scenario the forty-five days old seedlings transplanted on 15th of June took 153 days to complete its life span. The crop attained maximum Leaf Area Index (LAI) of 6.2 with total biomass of 10.22 t ha^{-1}. Under this scenario the potential grain yield simulated by the CERES RICE model will be 6.13 t ha^{-1} by attaining 494 grains per ear and 18846 grains m^{-2} (Table 1). Under the slight warming scenario the rise in temperature by 0.5°C over the normal will cut short the life span of the crop by two days only. It will reduce the maximum LAI, biomass, grains per ear, grains m^{-2} and grain yield by 1.1, 1.3, 2.4, 3.2 and 3.2 per cent, respectively, while the increase in the straw yield will be a fraction of one per cent (0.7) only.

TABLE 1: Rice Crop Response to Variation in Temperature

Climate scenario	Temperature change	Yield and yield attributes						
		Crop duration (Days)	Grain yield (kg ha^{-1})	Grains (m^{-2})	Grains (Ear^{-1})	Max (LAI)	Biomass (kg ha^{-1})	Straw (kg ha^{-1})
		(% deviation over normal scenario)						
Extreme warm	+ 2.0°C	-3.3	-8.4	-8.4	-12.4	-3.9	-7.4	-6.4
Greater warm	+ 1.5°C	-2.6	-8.2	-8.2	-8.3	-3.9	-6.5	-4.7
Moderate warm	+ 1.0°C	-2.3	-4.9	-4.9	-6.1	-2.4	-3.6	-2.2
Slight warm	+ 0.5°C	-1.3	-3.2	-.32	-2.4	-1.1	-1.3	-0.7
Normal weather	Normal	153	6136	18846	494	6.2	10220	4943

Source: Mathauda (2000).

In case of moderate warming scenario the average temperature rise of 1°C is expected around the year 2020. This will reduce the crop duration by three days over the normal and it will have negative effect on yield contributing characters of the crop. Maximum reduction (6.1 per cent) will be observed in case of grains per year, followed by a reduction of about 5 per cent in grains m^{-2} and grain yield. Greater warming scenario may occur around 2035 when the expected rise in temperature will be by 1.5°C. This change will have considerable negative effect on the crop performance. The crop duration will be shortened by four days over normal. The grains per year will reduce by 8.3

per cent. The grains m^{-2} and grain yield will be reduced by 8.2 per cent. Under extreme warming scenario the average rise in temperature by 2°C over the normal is expected by the middle of next century with almost doubling of CO_2 in comparison to 1990 level. This change in temperature will enhance the maturity of five days over the normal.

The mean temperature in India is projected to increase by 0.1–0.3°C in kharif and 0.3–0.7°C during rabi by 2010 and by 0.4–2.0°C during kharif and to 1.1–4.5°C in rabi by 2070. Similarly, mean rainfall is projected not to change by 2010, but to increase by up to 10 per cent during kharif and rabi by 2070. At the same time, there is an increased possibility of climate extremes, such as the timing of onset of monsoon, intensities and frequencies of drought and floods (Khan *et al.*, 2009). It is to be noted that Wheat growth simulator (WTGROWS), developed at IARI, New Delhi, has been extensively tested for different agro-environments (Aggarwal and Kalra, 1994). In past, it has been successfully used for the resource management, forecasting of wheat yields and climate variability related studies. Using WTGROWS, a strong linear decline in wheat yield was noticed with the increase in January temperature. For every degree increase in mean temperature, grain yield decreased by 428 kg/ha. Inter-seasonal climatic variability analysis carried out through yield response of wheat indicated that impact of the variability was lowest for Kota and highest for Solapur.

TABLE 2: Temperature Increases (°C) Canceling Positive Effect of CO_2 across Regions in India at Two Levels of Management – Rice Crop

Management	CO_2 concentration		
	450 ppm	550 ppm	650 ppm
North India			
- Improved	1.7	3.2	5.0
- Current	1.9	2.7	4.8
East India			
- Improved	1.2	3.5	5.0
- Current	2.0	4.4	5.0
West India			
- Improved	0.9	1.8	2.8
- Current	1.0	2.1	3.4
South India			
- Improved	1.0	2.3	4.4
- Current	0.9	2.0	3.4

Source: Khan *et al.* (2009).

As for rice yield, it is to be noted that though additional CO_2 can benefit crops, this effect would be nullified by an increase of temperatures. This is concomitant from the fact that increase in CO_2 from 450 ppm to 650 ppm is nullified by rise in temperature from 0.9°C to 5.0°C across various regions of India (Table 2).

In eastern and northern regions of India, the beneficial effect of 450, 550 and 650 ppm CO_2 was nullified by an increase in temperature from 1.2 - 1.7°C, 3.2 - 3.5°C and 4.8 - 5.0°C, respectively. In southern and western regions, positive CO2 effects were nullified at temperatures lower than these (Khan *et al.*, 2009). Thus, under improved management conditions, the regions, such as southern and western parts of India, which currently have relatively lower temperatures, are likely to show less increase in rice yields under climate change compared to northern and eastern regions. The study conducted by Khan *et al.* (2009) also shows that a 0.5°C increase in winter temperature would reduce wheat crop duration by seven days and reduce yield by 0.45 t/ha. An increase in winter temperature of 0.5°C would thereby translate into a 10 per cent reduction in wheat production in the high yield states of Punjab, Haryana and Uttar Pradesh.

5. Pulses Yields

The IPCC has projected that after 2050 temperatures would rise by 3–4° over current levels with major impacts of climate change on rainfed crops. Since pulses occupy

major share in rainfed agriculture, reduction in yields as a result of climate change are predicted to be more pronounced for these crops, especially in indo-gangetic plains under limited water supply situations since there are no coping mechanisms for rainfall variability. The predicted changes in temperature and their associated impacts water availability, pests, disease, and extreme whether events are likely to affect potential of pulse production. Major pulses such as chickpea, pigeonpea, lentil grown under rainfed conditions are subjected to multiple stresses viz., drought, high and low temperatures, high solar radiation, salinity and water logging. If present trend in climate change continues as projected through various weather prediction models, the adverse situation will more pronounce for pulses crops. However, in order to cope up with these adverse abiotic factors, pulses have wide adaptive mechanisms such as very deep rooting system in pigeonpea and chickpea, high degree of dehydration tolerance, phenotypic plasticity, wide ranging sensitivity towards photothermoperiods and higher moisture retention capacity.

6. Adaptation to Climate Change

The adaptability of crops to climate variability would acquire significant dimension as frequent occurrence of extreme weather conditions may dictate as to how to cope up with the situation. Although global integrated impact assessment models provide a framework with respect to adaptation to climate change, these models are inadequate for regional policy planning, especially for countries with varied weather conditions as noticed in India. India needs an integrated assessment simulation model that encompasses cropping systems, water use and socio-economic parameters. The model shown by Mall *et al.* (2006) not only includes environmental and biophysical factors but also socio-economic parameters with respect to adaptation to climate change in agricultural production system, and, therefore, is an all encompassing (Figure 1).

The assessment of climate change on Indian agriculture can be more precise and provide sound basis for regional policy planning when uncertainties and certain limitations have been considered in the crop simulation modeling. On the basis of earlier studies, it is observed that the impacts of climate change on agricultural sector of India are uncertain. However, the total average impact may be positive or negative depending upon the climate scenario, i.e., temperature rising in 2°C, 3°C, 4°C, increase in CO_2 and interaction of increase in temperature and CO_2. Impacts also vary both quantitatively and qualitatively by crop, level of agronomic management, region and season. As for seasonal impact, though the rabi agriculture in central and southern India will be more risky, most scenarios show that climate change will have an overall positive impact or not affect significantly on India's agriculture until 2050. However, when temperature increases are very large, the India agriculture will suffer the most.

The adaptation measures that the agricultural sector can undertake to cope with future climate change may include (a) changing planting dates; (b) planting different varieties or crop species; (c) development and promotion of alternative crops; (d) developing new drought and heat-resistant varieties; (e) improved crop residue and weed management; (f) more use of water harvesting techniques; (g) better pest and disease control for crops; (h) implementing new or improving existing irrigation systems; (i) developing watersheds in rainfed areas; (j) promoting crop diversification; (k) promoting on-farm water-efficient technologies; (l) introducing a system of credits and loans to farmers; (m) promoting the National Agricultural Insurance Scheme; and (n) encouraging RCTs (resource conserving technologies) for crop production. In fact, developing adaptation strategies exclusively for minimising the negative impact of climate change may be risky considering the number of uncertainties associated with its spatial and temporal magnitude (Agarwal *et al.*, 2010). There is, therefore, a need to follow adaptation strategies that may be needed for sustainable development of agriculture in the region, which could be at the level of individual farmer, farm, society, village, region, state or at a national level.

7. Mitigation of Climate Change in Agriculture

Sustainable practices such as organic farming, natural farming can help farmers adapt to the changing climate. Integrated farming systems based on locally available resources by including trees, livestock, water management can help mitigate climate change to a large extent and improve the quality of life of the farmers. Although India continues to emit greater and greater amounts of greenhouse gases (GHGs) due to accelerated industrialisation process, almost 20 per cent of its GHG emissions actually come from agriculture. Methane (CH_4) emissions from irrigated rice production, nitrous oxide (N_2O) from the use of nitrogenous fertilisers, and the

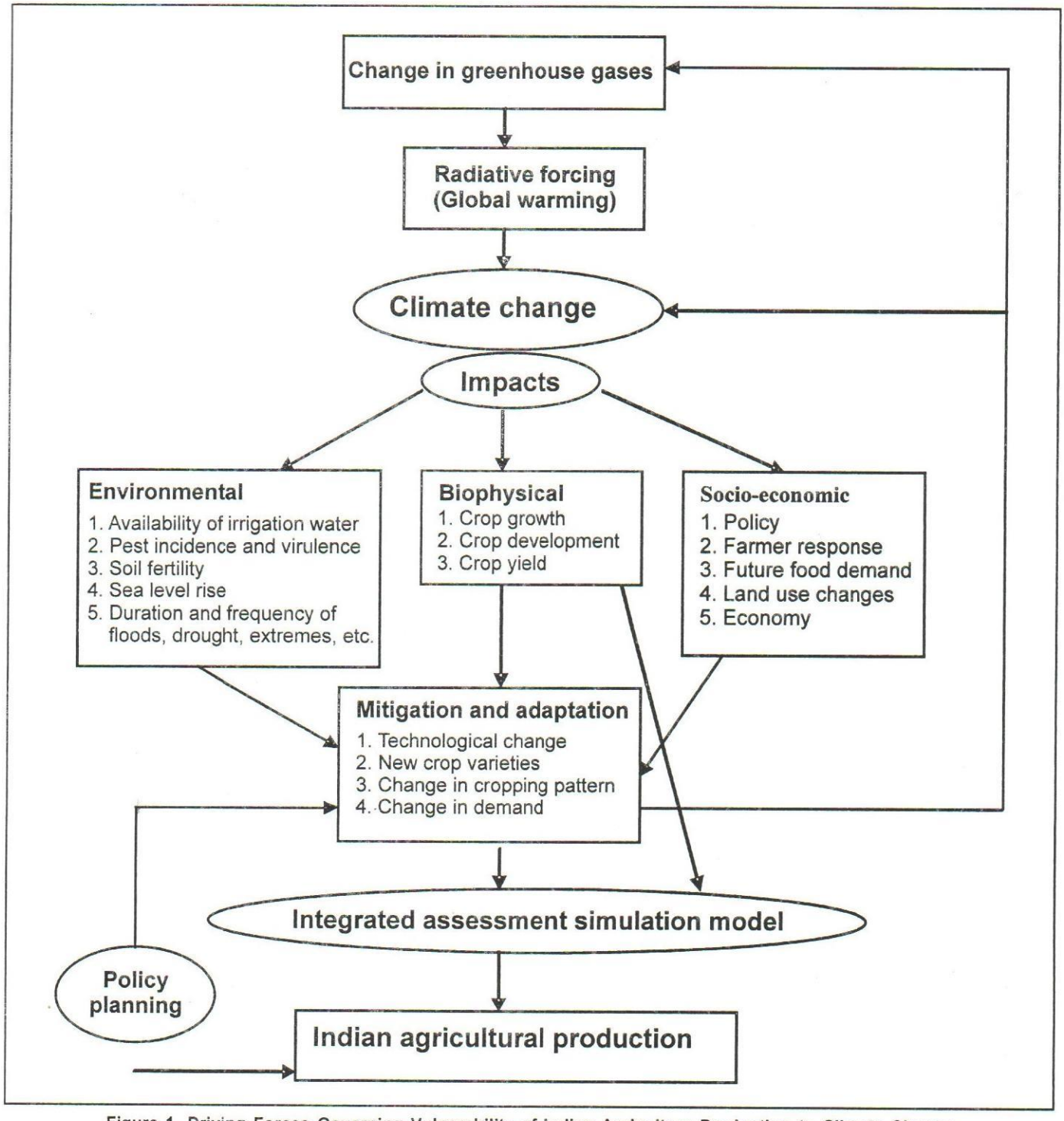

Figure 1. Driving Forces Governing Vulnerability of Indian Agriculture Production to Climate Change

release of carbon dioxide (CO_2) from energy sources used to pump groundwater for irrigation are the primary culprits. Generally, mitigation includes reducing emissions of carbon dioxides, methane and nitrous oxides, sequestering carbon, clean development mechanism, etc. Emissions of carbon dioxide from changes in agricultural land use can be reduced by slowing deforestation. The other appropriate approaches of mitigation include changes in agricultural land management viz. conservation tillage, agro-forestry, and rehabilitation of degraded crop and pasture land, overall improvement of nutrition and genetics of ruminant livestock, storage and capture technologies

for manure, and conversions of emissions into biogas. Most of these approaches have positive outcomes in terms of higher productivity, better management of natural resources, or the production of valuable by-products, such as bioenergy.

8. Conclusions

India faces a major threat from changes in climate since its economy is closely tied to natural-resource-base and climate-sensitive sectors such as agriculture, water and forestry that happen to be the most vulnerable sectors. India is poorly equipped to cope effectively with the adversities of climate change due to low capabilities, weak institutional mechanisms and lack of access to adequate resources. An index of sustainability that included economic and environmental indicators clearly shows that the agricultural production is under threat and needs immediate attention (Joshi *et al.*, 2003). The climate change will affect various crops during the entire growing period owing to extreme weather events. The adaptability of crops to climate variability would acquire significant dimension as frequent occurrence of extreme weather conditions may dictate as to how to cope up with the situation. The climate change will include extreme heat as well as cold waves, increased variability with respect to rabi and kharif crop production, increased extreme weather events in general, erratic onset as well as advances of monsoon, etc. Since farm production is likely to be adversely affected, the climate change will result in increased water management practices, improving land, soil and nutrition management practices, reduction in inefficiency in water use, preservation and enhancement of plant and animal genetic resources, adjustment to the pattern of food consumption, promotion of eco-friendly use adaptation, adaptation to ecosystem based approaches of risk management, shift in cropping pattern, adaptation to integrated farming system and integrated agro forestry systems, etc. There are areas where adaptation programme have already been developed and these include crop improvement, risk financing, draught proofing, disaster management, etc. The adaptation of climate change will lead to adoption of new draught and heat resistant varieties of crops, new farm management practices, land use pattern and watershed management, agricultural insurance, etc. Adapting agricultural systems to climate change is urgent because its impact is already evident and the trends will continue even if emissions of GHG emissions are stabilised at current levels. Adaptation can substantially reduce the adverse economic impact.

Notes

[1] Climate change can manifest itself in gradual changes in temperature, precipitation and a rise in sea level, resulting in changes in frequency, intensity and duration of extreme events. Global warming means earth getting warmer and resulting in an ecological imbalance. Climate change can affect agriculture in a variety of ways. Beyond a certain range of temperatures, warming tends to reduce yields because crops speed up their development, producing less grain in the process.

[2] Evaporation from the soil accelerates when temperatures rise and plants increase transpiration—that is, lose more moisture from their leaves. The combined effect is called 'evapotranspiration'. Because global warming is likely to increase rainfall, the net impact of higher temperatures on water availability is a race between higher evapotranspiration and higher precipitation. Typically, that race is won by higher evapotranspiration.

[3] In India, out of the total net sown area of 140.3 million hectares, 60.9 million hectares is the net irrigated area. Over 75 per cent of the cropped area is in the semi-arid tropics in the country. Ninety nine districts across fourteen states in India have been declared as drought prone districts by the Central Water Commission (2002). Most of these districts are concentrated in Andhra Pradesh, Maharashtra, Tamil Nadu, Karnataka and Rajasthan. Low and erratic rainfall coupled with extreme temperatures and intense solar radiation makes these regions the most vulnerable regions in India.

[4] Though the yield levels of wheat, mustard, barley and chickpea are likely to show stagnation or decrease leading to rise in temperature at all the four major northern states, the extent of decline may be different for crops as well as their locations. This will lead to examination of effects of rising temperature on yield of crops in different agro-ecologies and agricultural production environments.

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"The quest for food security can be the common thread that links the different challenges we face and helps build a sustainable future"

– José Graziano da Silva

Indian Agrarian Economy or Suicide Economy: Is There Any Way Out?

PRIYANKA MURRIA

During the past two decades, a major public policy issue that has been receiving a lot of media attention is a spate of suicide death among the Indian farmers. The staggering incidents of suicide death among farmers are pointing the strong tentacles of agrarian crisis hampering the Indian Agrarian Economy. The farmers of certain states particularly Andhra Pradesh, Maharashtra, Madhya Pradesh, Karnataka, Kerala and West Bengal are causing distress deaths ending in elevation of suicide deaths. The problem is so grave that it needs to be addressed on urgent basis and in an integrated manner. Unless and until this problem is addressed, despite achieving the GDP of 2.3 trillion dollars, the India's macro development objective remains discolored. This is because of the fact that farmers who are responsible for growth of primary sector are ending their lives year by year portraying the grey picture of suicide economic structure in India.

This paper is an attempt to understand and analyze the extent and incidence of farmer's suicides across major suicide prone states in India. For this purpose, data has been considered on various aspects such as total number of farmer's suicides in India, gender composition of farmers' suicides, and state-specific suicide death rates of male farmer suicides in major suicide prone states in India. This research paper focuses on the farmers suicides in India for the period of 1995-2014. In addition, the comprehensive review of literature has been attempted in order to explore the stressors that are behind the mounting farmer suicides. Lastly, the suggestions have been made in order to mitigate or curb the practice of farmers' suicides.

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1. Introduction

Agricultural sector occupies a vital position in the overall socio-economic development of India. Nearly 58 per cent of the rural households depend on agriculture for their living (India Brand Equity Foundation, 2016). However, it has now become a buzzword and a part of media reports because of farmers' suicide. The incidence of farmers deliberately killing themselves is pointing towards the major agrarian crises. Keeping in mind the gravity of the problem, the current study unfolds certain dimensions in order to quantify the impact of farmer's suicide in terms of number figures.

The seeds of farmers' crisis lie in the scientific application of crop management techniques, lack of availability of timely credit (Pavuluri N., 2013), inadequate and poorly distributed rainfall (Ashalatha K.V. and Das C., 2016), inadequate irrigation facility, non-remunerative prices (Gaur M, 2014) , and dominance of middlemen in Agricultural Marketing Structure. In wake of strengthening the agricultural sector, the measures such as green revolution and LPG reforms have also added to the problem of the farmers. The 1960's revolution in agriculture aimed at making the primary sector self-reliant but it had major repercussions on the lives of the farmers (Sadashiv K.R., 2015). The aftermaths of implementation of the policy were a major source of disappointment among the farmers. As it leads to the rise in prices of crops, expensive inputs, infertility of soil due to overuse of chemical fertilizers. The farmers with limited money income and funds had to depend on borrowed money to purchase inputs such as seeds and other inputs like seed, fertilizers, and pesticides, which further dragged them towards 'debt-trap' (Guha J, 2012).

In addition, because of economic reforms, these farmers and their products faced competition with the international market, making them difficult to stand and

survive. As a result, farmers have earmarked last decade as high degree of agrarian distress in India providing a stark evidence of suicides across the country.

2. Statement of Problem

In the recent years, the incidents of farmers killing themselves are mounting. This is evident from one of the estimates of National Crime Records Bureau report on 'Accidental Deaths and Suicides in India (2007) which reflects that 46 farmers commit suicide every day in India. A year later, further the bureau reports reflected 1,99,132 farmers losing their lives by committing suicide since 1997 to 2008.

Recently a study carried out by Mishra S. (2014) pointed out that Global Burden of Disease (GBD) estimates related to the year 2010 reflect that India accounts for 35.6 percent of the global Years of Life Lost (YLL) because of suicides, which is more than double its global population share of 17.2 percent. It was further added that as per the reports of National Crime Records Bureau (NCRB), the farmer suicides were reported at 134,599 which is less than half that of the GBD estimates. This clearly points out that there is the understatement of the figures that are being reported to reveal farmers' suicide data (Rukmini S., 2015). Hence, for any economy, this reflects a grave situation, which needs to be addressed at the earliest.

Moreover, 'there may be under-reporting in case of deaths in rural areas as they are certified by village headmen (*panchyatdars*) in all cases are investigated by the police. Only about 25% of deaths are registered and only about 10% are medically certified. Death by suicide is frequently reported as due to illness or accident to avoid police investigation. Thus, at times the families of suicide victims usually do not want postmortems further lowering the suicide count' (Radhakrishnan and Andrade, 2012).

In addition, farmers suicide is in growing numbers throughout the states of Maharashtra, Karnataka, Andhra Pradesh, and West Bengal is the most crucial problem and calls for the topmost priority in the agenda of rulers & policymakers. For this purpose, five suicide-prone states have been considered. In this regard, NCRB is the only source of disaggregated data at the state level and provides information that can allow us to delineate suicides for farmers and non-farmers.

3. Objectives of the Study

The broad objectives of the study are as follows:

- To identify the stressors leading to suicidal death by the farmers by attempting a comprehensive review of literature.
- To analyze the extent of farmer suicides with respect to total suicides in India from 1995-2012.
- To find out the gender-wise proportion of male farmer and female farmer suicidal trends in India from 1995-2012.
- To study the state-specific suicide death rates of male farmer suicides in major suicide-prone states in India.
- To suggest policy measures.

4. Research Methodology

For the purpose of this research paper, the data has been collected by using secondary sources like Data & records available with several NCRB Reports, Journals, data published in various National and Vernacular newspapers, Government websites. The reference period of the study is 1995-2014.

5. Scope of Research

The research paper justifies its scope by studying various causes of farmer's suicide in India by carrying out an extensive review of literature. Further, the analysis has been attempted using the data pertaining to farmers' suicides from a reasonable period of 18 years i.e. from 1995-2012. For this purpose, the farmer's suicides have been considered in percentage terms over total suicides in India. Thereafter, gender compositions of farmer's suicides have been calculated by calculating male farmer percentage over total farmers' suicides.

In addition, in order to ascertain the state-specific suicide death rates of male farmer suicides in India, farmers suicides of six states i.e. Maharashtra, Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh and West Bengal is shown as they are on top in farmers suicides in India and contributed near about two-thirds of total farmers suicides in India. Lastly, the latest data for 2013 and 2014 has complied in order to ascertain the total numbers of farmer suicides and gender composition. Thereafter, proportions of farmer suicides to total suicides have also been calculated.

6. Limitations of Research

The current paper concentrates on farmers suicides in India. However, the following points reflect the limitation of the study:

a) The research paper is based on the estimates of NRCB report. However, there may be underreporting of data by households. This is because of following reasons:

   i. Avoiding the police investigation in case of suicide as committing suicide is punishable as a criminal offense.

   ii. Inconvenience caused to existing family members. This may lead to artificially lowering their number.

   iii. Avoidance of shame leads to poor quality of data (Mishra S. 2014).

b) The definition of farmers may not include those without a clear land title, which is likely to understate the number figures.

c) The study has been carried out in India but has considered only six states, which contribute to 2/3rd of total farmer suicides in India.

The majority of the studies identify indebtedness of farmers as the main cause of committing suicide (ADSI, 2014; Ashalatha K.V. and Das C., 2016; Behere P. B. and Behere A. P, 2008; Guha J., 2012; Gaur M., 2014; Kale et.al., 2014; Mishra S., 2006; Parvathamma G. L., 2016; Pierre B., 2010; Sangalad P. N., 2012; Seck B. P., 2010; Thakare R.M. and Thakare K.R., 2016; Center for Human Rights and Global Justice, 2011). Apart from this the second cause as per the studies is repeated crop failures (ADSI, 2014; Ashalatha K.V. and Das C., 2016; Guha J., 2012; Gaur M., 2014; Mishra S., 2006; Parvathamma G.L, 2016; Pavuluri, 2013; Sangalad P. N. 2012; Seck B. P., 2010).

The literature further identifies the following stressors leading to framer's suicide:

- Lack of farm credit (Ashalatha K.V. and Das C., 2016; Guha J., 2012; Parvathamma G.L, 2016)
- Inability to Get Remunerative Price (Guha J., 2012; Gaur M., 2014)
- Deterioration of economic status (Mishra S., 2006)
- Family Problem (Sangalad P. N.2012; ADSI, 2014)
- Health Ailments (Guha J., 2012; ADSI, 2014)
- Inadequate and poorly distributed rainfall(Ashalatha K.V. and Das C., 2016)
- Drug Abuse/Alcoholic Addiction (Sangalad P. N., 2012; ADSI, 2014)
- Higher rate of interest in the cooperative credit system (Ashalatha K.V. and Das C., 2016)
- Rising cost of cultivation (Ashalatha K.V. and Das C., 2016)
- Worsening Agricultural Conditions (Guha J., 2012)
- Increasing Price of Inputs (Guha J., 2012)
- Malnutrition (Parvathamma G.L, 2016)
- Green Revolution Changing technology (Pavuluri, 2013; Sadashiv K.R., 2015)
- Increasing cost of agriculture inputs like seeds (Sadashiv K.R., 2015), fertilizers, pesticides (Shiva V. and Jalees K.)
- Global reasons such as Liberalization, Privatization and Globalization (LPG) policy (Sadashiv K.R., 2015)

8. Data Analysis and Discussion

Poor farm income and lack of non-farm income resources is increasing incidence of farmers' suicides (Mishra S., 2007). "On average, one farmer commits suicide every 30 minutes in India," (Center for Human Rights and Global Justice, 2011). In this regard, the task of compilation of data on suicides at all India level has been entrusted to the National Crime Records Bureau (NRCB); Ministry of Home Affairs. The NCRB has its annual publication namely 'Accidental Deaths & Suicides in India (ADSI)' for suicide related data. The ADSI Report contains data on suicides in the country, disaggregated by states and major cities, and other parameters since 1967. However, the data disaggregated by professions is added in ADSI publications from 1995.

In ADSI, the data related to farmer's suicide has been mentioned under the head "profession-wise suicides by sex" and among those professions, "self-employed in farming/agriculture" has been mentioned, wherein owner-or tenant-cultivators have been included, but not agricultural labourers (Accidental Deaths & Suicides in India Report, NRCB, 2014). Hence, the definition of farmers as per NRCB data excludes the agricultural labourers. Moreover, it collects data based on figures reported in police records. Thus, only the figures reported in as police records suicide has been considered for the purpose of the study.

7. Review of Literature

Author	Year of study	Identified Stressors Leading to Suicides
Accidents, Deaths and Suicides in India Report	2014	During 2014 the main causes were: • Bankruptcy or Indebtedness (20.6%) • Family Problem (201.%) • Failure of Crop (16.8%) • Illness' (13.2%) and • Drug Abuse/Alcoholic Addiction (4.9%).
Ashalatha K.V. and Das C.	2016	• Fall in crop production, • Inadequate and poorly distributed rainfall. • Borrowing from formal and informal sources, • Higher rate of interest in the cooperative credit system e.g. up to 12.5% to 14%
Behere P. B. and Behere A. P.	2008	• Pressure by money lenders, • Indebtedness, • Rising cost of cultivation, • Lack of farm credit, • Repeated Crop failures
Center for Human Rights and Global Justice	2011	Indebtedness
Guha J.	2012	• Debt • Crop Failure • Inability to Get Remunerative Price • Health Ailments • Absence of Safety Net/Insurance • Social Worsening Agricultural Conditions • Poor Agricultural Credit • Increasing Price of Inputs
Gaur M.	2014	• Failure of crops • Droughts and floods, • Lack of remunerative prices • Indebtedness- the main causes
Kale N. M., Mankar D. M. & Wankhade P.P.	2014	Indebtedness
Mishra S.	2006	• Indebtedness (87 per cent), • Deterioration of economic status (74 per cent), • Conflict with other members in the family (55 per cent), • Crop failure (41 per cent), • Burden of daughter's/sister's marriage (34 per cent). • 91 per cent farmers were males, 71 per cent were below 50 years of age, 80 per cent were currently married, 39 per cent completed their matriculation or higher education, 58 per cent had more than 10 years of experience in farming, and in 79 per cent of the cases the method of committing suicide was by consumption of insecticide/pesticide

Mishra S.	2014	• Neurobiological disorders, stress or depression
Parvathamma G.L.	2016	• Family problems and ill-health, • Economic failures, • Bankruptcies • Malnutrition • Failure of crops • Debt burden • Chronic illness
Pavuluri N.	2013	• Reliance on informal sources with higher interest burden • Consistent decline in the size of holding • Green Revolution • Changing technology and market conditions • Lack of availability of timely credit, • Unpaid debt, • Massive drop in price of produce leading to less revenue, • Lack of irrigation, • Crop failures occur mainly due to lack of water, • Over utilization of pesticides & insecticides
Pierre B.	2010	• Debt cycle of farmers • Crop failures
Sadashiv K.R.	2015	• Financial reasons-requirement of capital and Payment to moneylenders • Natural Calamities • Increase in cost of production due to hybrid seeds • Political reasons • Global reasons such as Liberalization, Privatization and Globalization (LPG) policy • Illiteracy, Traditions & Culture • New changes: After the green revolution and innovation of new technologies new hybrid seeds, • insecticides, pesticides and farm cultivation technologies
Sangalad P. N.	2012	• Failure of Crops • Debt Burden • Loss in Agriculture Activities • Family Problems • Price Crash • Various habits like alcohol, gambling, etc.
Seck B. P.	2010	Identified two types of causes: • Primary Causes: rooted in the very structure and functioning of the Indian market for agricultural products. It includes indebtedness leading to debt cycle caused by three main factors: introduction of Genetically Modified Organisms (GMOs), weak education and information, international competition. • Secondary causes: rooted form punctual events requiring money, or unrelated ones. Bifurcated under two heads:

		i) social ones including poor social background, with limited amount of land ii) Climatic ones like the climate change.
Shiva V. and Jalees K.	Not Mentioned	• Failure of Institutional Delivery of Credit to Farmers • Indebtedness • Economic reforms • Withdrawal of government intervention from Safety nets such as fair price shops (FPS) • The exclusion of poor and indebted from the food distribution system. • Increasing cost of agriculture inputs like seeds, fertilizers, pesticides, etc. • Reduced price of agriculture produces. • Increasing dependence of small farmers on moneylenders, at rates of interest from 24 to 60 percent per annum • Cumulative Crop Loss.
Thakare R.M. and Thakare K.R.	2016	Indebtedness leading to disappointment and frustration

Table 1 clearly reveals the gravity of problem of farmer suicides as the figures in percentages reflect the percentage of farmer committing suicides viz- a-viz. total suicides in India. It reflects that the percentage share of farmer suicide is 12 percent in 1995, which rose to 15.6 percent in the year 1996. A mixed picture of decline as well as rise further followed this until it recorded its maximum at 16.3 percent. Thereafter, it represented a

Table 1: Number of farmer's Suicide in India: 1995-2012

Sr. No.	Year	No. of farmers suicides in India	All suicides in India	Farmers suicides as % of all suicides in India [(Col.3/ Col.4)* 100]		Sr. No.	Year	No. of farmers suicides in India	All suicides in India	Farmers suicides as % of all suicides in India [(Col.3/ Col.4)* 100]
1	1995	10720	89178	12.0		11	2005	17131	113914	15.0
2	1996	13729	88241	15.6		12	2006	17060	118112	14.4
3	1997	13622	95829	14.2		13	2007	16632	122637	13.6
4	1998	16015	104713	15.3		14	2008	16196	125017	13.0
5	1999	16082	110587	14.5		15	2009	17368	127151	13.7
6	2000	16603	108506	15.3		16	2010	15964	134599	11.9
7	2001	16415	108506	15.1		17	2011	14027	136585	10.3
8	2002	17971	110417	16.3		18	2012	13754	135445	10.2
9	2003	17143	110579	15.5		19	TOTAL	284673	2052800	13.9
10	2004	18241	113697	16.0						

Source: Data Compiled from the reports of National Crime Records Bureau (NRCB) (1995-2012)

Table 2: Gender Composition of Farmer's Suicides in India from 1995-2012

Year	Male farmer Suicides	Female Farmer Suicides	Total farmer Suicides	Proportion of Male Farmers to total farmers suicides [(Col.2/Col.4)*100]
1995	8295	2425	10720	77.4
1996	10897	2832	13729	79.4
1997	11229	2393	13622	82.4
1998	12986	3029	16015	81.1
1999	13278	2804	16082	82.6
2000	13501	3102	16603	81.3
2001	13829	2586	16415	84.3
2002	15308	2663	17971	85.2
2003	14680	2463	17143	85.6
2004	15929	2312	18241	87.3
2005	14973	2158	17131	87.4
2006	14664	2396	17060	86.0
2007	14509	2123	16632	87.2
2008	14145	2051	16196	87.3
2009	14951	2417	17368	86.1
2010	13592	2372	15964	85.1
2011	12071	1956	14027	86.1
2012	11951	1803	13754	86.9
TOTAL	240788	43885	284673	84.6

Source: Reports of National Crime Records Bureau (NRCB) (1995-2012)

decline until 2012 when nearly 10 percent of the farmers committed suicide out of the total population. Hence, though the number of farmer's suicides out of the total suicide rate is declining but still significant.

In all, nearly 2. 8 lakh farmers killed themselves since 1995-2012, constituting 14 percent of all reported suicide deaths in the country. Table 1 makes it explicitly clear that the suicidal deaths among the farmers are following an increasing trend as 13729 farmers were recorded to have committed suicide in the year 1996 against the earlier number figure of 10720 in year 1995.

Thereafter, the incidents of farmer suicides were rampant and increased during 1997-2004. The highest figure of 18241 was recorded in the year 2004, when around 18000 farmers committed suicide.

More recent figures, however, reveal a different picture. The rate of suicide showed a decline from 2005 to 2008 and a mixed trend during 2009-2012. In the year 2012, about 14000 farmers were reported to commit suicide. However shocking and disappointing is the fact that the suicide figures which were nearing about 11000 in the year 1995 rose to near about 14000 in the year 2012, even

then the policy measures to curb or at least to mitigate their level have it seems not proven effective.

The reported data in table 2 reflected that the highest farmers' suicides were recorded in the year 2004 when 18,241 farmers killed themselves. However, the suicide deaths are more for male farmers as compared to female farmers. The proportion of male farmers in total farmer suicide is nearly 85 percent. This may be due to the reason that in India, male are considered to be bread earners in rural areas where literacy rate is not much high. The females are entrusted the task of caretakers of house and children. However, the table clearly reveals that they have come forward and helping their spouses.

At all India level, the suicide deaths for male farmers reach to a peak in 2004 followed by a second spike in 2009, which was a drought year. Thereafter, it is following a declining trend until 2012. The suicide trend among female farmers, however, shows a mixed trend until 2009, after which it has started declining. Still the number figures of suicide data reveals that since 1995 to 2012, nearly 2.4 lakhs male farmers have ended their lives, however during the same period; nearly 44000 women killed themselves constituting 15.4 percent of total farmer suicides in the country (Table 2).

The state wise shares of suicide deaths among the male farmers clearly reflect that the share is maximum in Maharashtra which account for about one-fourth of the total suicide death rates in India. This is a matter of great concern as the percentage share on three year average has risen by nearly 11 percent by the year ended 2012 against the proportionate share of 13.6 percent during 1995-1997. The reason for this could be its water-starved regions and failure to adapt to suitable cropping patterns. Further, the 'suicidal current' is flowing to other states but is more affecting the states of Andhra Pardesh and Karnataka in the recent years.

The second most suicide affected reported state is Andhra Pradesh with 16 percent percentage share followed by Karnataka with 14 percent male suicide death proportion. Though the states like Kerala and West Bengal which had high suicide deaths initially from 1995-1997, however, reveal a different picture. More recent data reflects that the states are now following a declining trend. The rate of suicide shows a declining trend from 11.06 percent

Table 3: Three-year average State-specific shares of Male Farmer Suicides in Major suicide prone states in India, 1995-2012

	Male farmers (Percent)					
States	1995-1997	1998-2000	2001-2003	2004-2006	2007-2009	2010-2012
Andhra Pradesh	10.07	10.97	10.05	13.68	12.09	16.09
Karnataka	15.18	13.98	14.80	10.58	11.76	14.19
Kerala	11.06	9.61	8.96	6.50	6.30	6.68
Madhya Pradesh	13.29	14.74	14.45	15.81	17.27	10.43
Maharashtra	13.64	16.30	21.64	25.34	23.47	25.32
West Bengal	11.94	7.45	6.84	5.73	5.66	3.89

Source: Relevant Data from Mishra (2014)

Table 4: Incidence of Farmers' Suicides and Percentage: 2013-2014

Sl. No.	Year	Total Number of farmer's Suicides	Total number of Suicides	Percentage Share of Farmers' Suicides to Total Suicides [(Col.3/Col. 6)x100]
1	2013	11,772	1,34,799	8.73
2	2014	12,360	1,31,666	4.3

Source: The Hindu (2014) and Business Standard (2014)

to 6.68 percent in the state of Maharashtra and from 11.94 percent to 3.89 percent in West Bengal (Table 4).

However, the actual percentages may be larger as the NCRB defines 'farmers' as men (but not women) who work in agriculture. Thus, these percentages exclude the female farmers who are also a component of agricultural scenario.

The recent figures of farmers' suicide reflect that at all India level, the proportion of farmers' suicide to total suicides has reduced to almost half between 2013 and 2014. The reason for the proportionate decline may be because of increase in suicide rate apart from farmer suicides. Thus, this is not indicative of decline in farmers' suicide trends. It can be clearly noticed from table 4 that 588 cultivators have killed themselves since 2013, raising the number figures to 12,360 in 2014. Thus, an increase of about 5 percent in the number of officially recorded farm suicides has been recorded between 2013 and 2014.

9. Conclusion

The higher incidence of farmers' suicides is demanding the urgent attention of authorities as it is leading to public policy concerns regarding masses dependent on agriculture. In order to ensure the prosperity at macroeconomic level, the in-depth study and appraisal of all the strata constituting economy is needed. Thus, the agricultural population assumes its importance. If these masses are not elevated in economic and social terms, there will be spatial growth of the economy. The disequilibrium in agrarian economy has not only affected the lives of farmers but has ever-lasting impact on their spouses and families.

The study reflects that the farmers are ending their lives because of various stressors. The majority of the studies ranked indebtedness and repeated crop failures as the major stressors. Apart from this, lack of farm credit, less price of produce, deterioration of economic status, high rate of interest, rising cost of cultivation, etc. were also stated as one of the reasons of farmers' suicides. In nutshell, the practice of farmers deliberately ending their lives needs to be checked and monitored.

The study reflects that though the number of farmer's suicides out of the total suicide rate is declining since 2004 but still significant as nearly 2.8 lakhs of farmers lost their lives by committing suicides between 1995-2012. However, state-specific analysis, while showing mixed pattern, reflects that the practice of farmers' suicide is more prominent in the states of large cotton-growing areas of Maharashtra, Andhra Pradesh and Karnataka. Of all suicide prone states in India, these three states alone contribute to 65 percent of total farmer suicides between three years 2010-12. Thus, a major public policy concern is that appropriate measures should be taken focusing on farm suicides in these three states so that the practice of this unnatural death is curbed or at least mitigated.

In nutshell, the number of farmers killing themselves is significant and needs to be addressed at the earliest. There is a need to work on the following parameters. First, there is need to improvise the quality of data related to suicides in India. It should be seen that by whatever reasons, there is no possibility of understatement of data in any official record. Second, the state and district authorities need to come forward and ensure timely availability of any grant or credit and minimum possible rates of interest. There should be fixation of amount of compensation in case of crop-failure or crop damage, which should be enhanced, considered the extent of loss. Third, efforts should be undertaken to motivate farmers to undertake alternate occupations like poultry, animal husbandry, etc. and vocational training programs should be promoted. Working on these parameters may be helpful but is not enough. Thus, there is need to expand horizon and work harder on the issue so that the quality of life of the farmer and their families can be enhanced.

10. Suggestions

Promoting the welfare of the farming population is not the task of one single agency. It require the joint initiatives at various levels. However, some of the suggestions are being forwarded in order to ensure self-sufficiency in agricultural scenario thereby strengthening the plight of Indian Farmer:

11. At the Level of State and District

There is a need to take the following initiatives in this regard:

a) The literature has identified indebtedness as the major cause of farmers' suicides in India. The indebtedness generates a separate class of landless labourers and bonded labourers. This further leads

to depression and frustration leading to suicides. Hence, Microfinance cells should be created at district level with the responsibility of dispensing cash to the farmers. These cells should be given funds by state and should periodically submit their reports to an authority appointed for monitoring the same.

b) An apex regulatory authority must be formulated to address the following key areas:

i) Monitor the availability of inputs like seeds, fertilizers and pesticides at subsidized rates to farmers.

ii) Arrangements of marketing and forward linkages so sell their produce at remunerative prices

iii) Provision of minimum support prices to farmers to protect interest of farmers.

c) The majority of the studies have reflected repeated crop failure or crop damage as one of the reasons of farmers suicide. There should be fixation of amount of compensation, which should be fixed in light of the extent of loss.

d) Free vocational training centres should be established where farmers can educate themselves vocationally and become more independent as far as occupation is concerned.

12. At the Level of Banks and Financial Institutions

a) To establish linkages by promoting Self-help groups (SHGs) and thereby promoting Bank-SHG model or Bank- MFI-SHG linkage model of micro-credit.

b) Banks/ financial institutions should set aside a fixed sum of money for exclusive lending to the farmers or other priority sectors in order to ensure adequate dispersal of funds.

c) To promote the issuance of Kisan Credit Cards to all the eligible farmers.

d) Timely and adequate financial support by way of credit to farmers should be provided.

e) There is a need to lessen the period of grant of loan and avoiding procedural delays.

f) Subsidized rate of Interest with focus on small and marginalized farmers.

13. At the Level of Farmers

a) Farmers should be self-motivated for adoption of allied activities like dairy, fishery, poultry etc. in addition to farming activities.

b) They should attend any vocational or training program if any, conducted for them.

c) They should go for crop rotation in agricultural production to increase productivity.

d) A resolution and understanding at the end of the farmers that ending their life is not a solution, rather it aggravates problems of their family members.

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"I feel it is an obligation to help people understand the relation of food to agriculture and the relationship of food to culture."

– Alice Waters

Fifty years of Punjab Agriculture: An Appraisal

M. S. SIDHU AND VARINDER PAL SINGH

Punjab with just 1.53 per cent of the geographical area of the country accounted for about 40-45 per cent of wheat and about 25-30 per cent of rice procured for the central pool of food grains during the last 50years or so. The State agriculture, which was growing fast earlier, has now reached a sort of plateau in terms of productivity and production. In the wake declining land – man ratio, it is not able to generate gainful employment and sufficient income for the growing population. There is almost stagnation in the net farm income. The farming alone is not able to generate sufficient income for small and marginal farmers. Due to economic distress, 6926 farmers and agricultural labourers had committed suicides between 2000 and 2010. At present, the farm indebtedness is to the extent of about Rs.80,000, which work out at Rs.7.60 lakh per farming household. Unless the state make rational use of its irrigation resources, it would be difficult to maintain even the present type of cropping pattern in the long run. In the overall interest of rural economy, the employment opportunities in the non-farm sector may be created for the unemployed/ under-employed youth. Future of the state is in the hands of present young generation.

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1. Introduction

Punjab witnessed a major breakthrough in the farm production starting in the late 1960s. The increase in wheat and paddy production improved the economic status of the peasantry bringing about an all round change. A number of factors have made this possible. These include the introduction of high yielding varieties (HYVs) particularly of wheat and paddy, assured price policy and supporting infrastructure for supply of different inputs and dissemination of the technical know how. However, the prime movers in this growth process were the farmers themselves who were quick enough to exploit the new production possibilities (Sidhu, Joshi and Kaur, 2006). The result is that the state with 1.53 per cent of the geographical area of the country accounted for about 40-45 per cent of wheat and about 25-30 per cent of rice procured for the central pool of foodgrains during the last 50 years or so.

The Punjab agriculture, which was growing fast earlier, has now reached a sort of plateau in terms of productivity and production. In the wake of a declining land-man ratio, it is not able to generate gainful employment and sufficient income for the growing population. Farm profitability has witnessed a decline in the recent years due to cost price squeeze. There is almost stagnation in the net farm income. The farming alone is not able to generate sufficient income for small and marginal farmers. Due to economic distress, 6926 farmers and agricultural labourers had committed suicides between 2000 and 2010 (Bharti, 2017). As per press reports, around 7000 suicides have been reported during the last five years (Ibid). At present, the farm indebtedness is to the extent of about Rs 80,000 crore that work out Rs 7.60 lakh per farming household. About 69 per cent and about 31 per cent of the debt is of institutional and non-institutional sources respectively. There are some good aspects of

the agricultural sector in the state but there are big challenges also. Keeping in view all this, the present study has been undertaken to examine scenario of Punjab agriculture during the last 50 years and its prospects in future.

2. Data base

The secondary data used in this paper have been mainly taken from the published sources. Notable among these are Statistical Abstract of Punjab, Agricultural Statistics At A Glance, etc. The data published in reputed English newspapers have also been used. The information has also been taken from Department of Economics & Sociology, PAU, Ludhiana. The data about state-wise monthly farm income have been taken from the NSSO.

3. Results and Discussion

Land use pattern

The information about land use pattern have been presented in table 1. A perusal of the table shows that the net area sown in the state was 4145 thousand hectares during the year 2013-14 out of a total reporting area of 5033 thousand hectares, which means that about 82 per cent of the reporting area was already under cultivation which was the highest in the country. There was only negligible area available under current fallows and other uncultivated land. The net area sown increased from 3870 thousand hectares in 1966-67 to 4145 thousand hectares in 2013-14, which means an average increase of about six thousand hectares per annum. On the other hand, the total cropped area increased by 2677 thousand hectares during this period which gives an average increase of about 56 thousand hectares per year. It may be mentioned here that net area sown increased from 3870 thousand hectares in 1966-67 to about 4200 thousand hectares in 1980-81. After that, there has been no significant increase in net area sown in the state. On the other hand, the net area sown has declined in the recent years due to urbanisation, industrialisation and other uses of agrilcultural land in the rural areas of Punjab. It happened mainly because of the fact that size of the land is fixed and increase in area came mainly from increase in the total cropped area.

Table 1: Land utilization pattern in Punjab, 1966-67 to 2013-14

(000 ha)

Parameters	1966-67	1980-81	1990-91	2000-01	2010-11	2013-14
Geographical area	5036	5036	5036	5036	5036	5036
Forests	78	216	222	280	295	258
Land not available for cultivation	641	532	426	438	528	549
Cultivable waste land	1248	41	35	15	2	6
Fallow land	262	45	110	43	37	61
Net sown area	3870	4191	4218	4250	4158	4145
Area sown more than once	1301	2572	3284	3691	3724	3703
Total cropped area	5171	6763	7502	7941	7882	7848
Net irrigated area	2276	3382	3909	4038	4070	4141
Gross irrigated area	3366	5781	7055	7664	7724	7728
Per cent area irrigated	58.81	81	93	95	98	99.9
Area under cultivation (net area sown as % of geographical area)	76.85	83.22	83.76	84.39	82.57	82.31
Cropping Intensity (%)	134	161	178	187	190	189

Source: Statistical Abstract of Punjab, various issues

Due to increase in the cropping intensity, the total cropped area increased from 5171 thousand hectares in 1966-67 to 7941 thousand hectares in 2000-01. Cropping intensity increased from 134 during 1966-67 to 189 during 2013-14. After that, it has almost become constant because there is limit to increase the cropping intensity also. Therefore, there is little scope to increase cropping intensity in near future and the total cropped area will remain constant around 79 thousand hectares. On the other hand, there is possibility of further decline in net area sown in the state due to use of land for non-agricultural purposes. This will have adverse effect on the total cropped area also. The irrigated area has increased tremendously since 1966-67. At present, almost all the the area is irrigated as 99.9 per cent net sown area is reported to be irrigated.

Number of operational holdings

The information about number of operational holdings in Punjab is given in Table 2. There were 10.27 lakh operational holdings in 1980-81. Their number increased to 11.17 lakh in 1990-91, but in the year 2000-01, this number sharply declined to 9.97 lakh and increased to 10.53 lakh during 2010-11. The maximum decline was observed in case of marginal holdings. Their number was 1.97 lakh in 1980-81, which plummeted to 1.64 lakh in 2010-11. During the above period, the number of smallholdings declined marginally from 1.99 lakh to 1.95 lakh. These figures reveal that agriculture is becoming un-remunerative particularly for marginal and small farmers, therefore, they were forced to lease out their tiny holdings. In many cases, they also sold their land to clear their debts and to meet other social obligations.

Another phenomenon about the operational holdings in the state is regarding the number of large farmers. Although their number was just six to seven per cent during the last three decades but they operated about 26 to 29 per cent of the area during this period. Therefore, we can say that modern farming is more favourable to the large farmers as compared to their fellow marginal and small farmers. The average size of operational holding was 3.79 ha, 3.61 ha, 4.03 ha and 3.77 ha during the years 1980-81, 1990-91, 2000-01 and 2010-11 respectively. At the national level, it is just 1.15 hectares. Therefore, the Punjab scenario is comparatively better than other states.

It is worthwhile to mention here that in the pre-green revolution period in the state, the bachelor farmer used to donate their share of land to their nephews (bhatijas). This prevented the land from being further divided. It was known as the Draupati system after the wife shared by the Pandavas princes in the Mahabharta and there was no stigma attached to it (Mishra, 1999). Due to spread of education and awareness among the farming households, this practice has almost disappeared from the rural Punjab during the post- revolution period.

Increase in the number of workers

The information regarding the number of agricultural workers as cultivators and agricultural workers is given in Table 3. The number of cultivators has increased from about 16 lakh in 1961 to 20.65 lakh in 2001 but thereafter declined to 19.34 lakh during 2011. The number of agricultural workers jumped from 3.35 lakh to 15.88 lakh in during the period 1961 to 2011. The trend of sub-division of land holdings is reflected more evidently in the land operated per cultivator and agricultural worker (taken together) which has declined gradually form1.94 hectares of net area sown in 1961 to 1.18 hectares in 2011. In terms of gross cropped area, this figure has declined from 2.44 hectares to 2.23 hectares during the same period. The facts given above are not mere statistical figures but rather have wider social, economic and political implications for the state as well as the country.

A perusal of Table 3 further revealed that net area sown per cultivator has declined from 2.34 hectares in 1961 to 2.14 hectares in 2011. This figure for the agricultural worker was 11.23 hectares and 2.61 hectares in the corresponding period. Due to increase in cropping intensity, the gross cropped area per cultivator has increased from 2.95 hectares in 1961 to 4.06 hectares in 2011. As already discussed, there has been fast increase in the number of agricultural workers during the last five decades i.e. from 1961 to 2011. Their number was 3.35 lakh in 1961, which increased to 15.88 lakh in 2011. It had adverse impact on the gross cropped area available to each agricultural worker. The gross cropped area per agricultural worker declined from 14.14 hectares in 1961 to 4.94 hectares in 2011. The fast mechanism of agriculture in this state has also narrowed down the employment opportunities for the agricultural labourers. A study has shown that use of each harvest combine eroded an estimated 24000 person days of work in a year (Mander, 2004). Moreover, the increased use of weedicides for control of weeds in the major crops i.e. wheat and paddy, has obviated the need for human labour for inter-culture operations. The excessive use of weedicides has not only replaced the human labour but has adversely affected the soil health too.

Table 2: No. of operational holdings, area operated and average size of operational holdings in Punjab, 1980-81 to 2014-15

Farm category	1980-81			1990-91			2000-01			2010-11		
	Number	Area operated	Av. size of operational holdings	Number	Area operated	Av. size of operational holdings	Number	Area operated	Av. size of operational holdings	Number	Area operated	Av.size of operational holdings
Marginal (Below 1 ha)	197.32 (19.21)	118.33 (3.04)	0.60	295.67 (26.47)	164.13 (4.07)	0.56	123.00 (12.34)	77.00 (1.91)	0.63	164.43 (15.62)	101.01 (2.55)	0.61
Small (1-2 ha)	199.37 (19.41)	281.04 (7.22)	1.41	203.84 (18.25)	328.26 (8.14)	1.61	173.00 (17.35)	242.00 (6.02)	1.40	195.44 (18.57)	269.08 (6.78)	1.38
Semi-medium (2-4 ha)	287.42 (27.99)	790.95 (20.32)	2.75	288.78 (25.86)	841.62 (20.87)	2.91	328.00 (32.90)	876.00 (21.78)	2.67	324.52 (30.83)	855.11 (21.56)	2.64
Medium (4-10 ha)	269.07 (26.20)	1565.55 (40.22)	5.82	261.48 (23.41)	1621.95 (40.22)	6.20	301.00 (30.19)	1731.00 (43.04)	5.75 (28.36)	298.45 (43.18)	1712.86 5.74	5.74
Large (10 ha & above)	73.94 (7.19)	1136.60 (29.20)	15.37	67.17 (6.01)	1076.73 (26.70)	16.03	72.00 (7.22)	1096.00 (27.25)	15.22	69.72 (6.62)	1028.58 (25.93)	14.75
All holdings	1027.13 (100.00)	3892.46 (100.00)	3.79	1116.95 (100.00)	4032.69 (100.00)	3.61	997.00 (100.00)	4022.00 (100.00)	4.03	1052.55 (100.00)	3966.63 (100.00)	3.77

Note: i) Figures in parentheses indicate percentages to the total
ii) Number of operational holdings is in thousands and area operated in thousand hectares.
iii) The average size of operational holdings is in hectares.

Table 3: Net and gross cropped area available to the cultivators and agricultural workers in Punjab, 1961 to 2011

Year	As cultivators No.	As agri. workers No.	Net sown area per cultivator (ha)	Net area sown per agri. worker (ha)	Gross cropped area sown per agri. cultivator (ha)	Gross cropped area sown per agri. worker (ha)
1961	1602666	334610	2.34	11.23	2.95	14.14
1971	1665153	786705	2.43	5.15	3.41	7.22
1981	1767286	1092225	2.37	3.84	3.82	6.19
1991	1917210	1452828	2.20	2.90	3.91	5.16
2001	2065067	1489861	2.06	2.85	3.85	5.33
2011	1934511	1588455	2.14	2.61	4.06	4.94

Year	Net area sown per cultivator and agri. worker (ha)	Gross cropped area per cultivator and agri. worker (ha))
1961	1.94	2.44
1971	1.65	2.32
1981	1.47	2.36
1991	1.25	2.23
2001	1.20	2.23
2011	1.18	2.23

Source: Statistical Abstract of Punjab, various issues

Shifts in cropping pattern

The cropping pattern in the state is shown in Table 4. The figures show that during the year 2014-15, about 83.5 per cent of the total cropped area was under foodgrains, 8.24 per cent under cash crops, i.e. cotton, sugarcane, oilseeds and potatoes. It may be stated here that about nine per cent of the total cropped area was under rabi and kharif fodder crops and about two per cent under fruits and vegetables. Wheat is the principal crop of Punjab, which alone had 44.66 per cent of the cropped area followed by rice, which had 36.88 per cent area. In this way, these two crops taken together occupied about 81.50 per cent of the area.

Rice is not a traditional crop of Punjab. The area under rice was just 227 thousand hectares in 1960-61, which increased to 390 thousand hectares in 1970-71, 567 thousand hectares in 1980-81, 1183 thousand hectares in 1985-86 and 2015 thousand hectares in 1990-91. It reached to the level of 2612 thousand hectares in 2000-01, which further increased to 2894 thousand hectares in 2014-15. The major factors responsible for increase in its area are high and stable yield as compared to other kharif crops, assured price and public procurement. We can say that net returns to the farmers from paddy crop are high vis-à-vis other competing kharif crops. Paddy has replaced kharif pulses and oilseeds on a large scale in the last three decades. The area under wheat was 1400 thousand hectares in 1960-61 which increased to about 2300 thousand hectares in 1970-71, 2812 thousand hectares in 1980-81, 3273 thousand hectares in 1990-91, 3408 thousand hectares in 2000-01 which further increased to 3505 thousand hectares in 2014-15. Wheat crop has also replaced rabi pulses particularly gram and oilseed crops. This crop has also high and stable yield as compared to other rabi crops. Moreover, it is procured by the public procurement agencies at the minimum support price (MSP). It is also a staple food of the Punjabis. The farmers to feed dairy animals also use wheat bhusa, the by-product of wheat on a very large scale. Therefore, we can say that wheat is a natural crop of Punjab. Moreover, its irrigation requirements are not high as in case of paddy.

Table 4: Shifts in cropping pattern in Punjab, 1960-61 to 2014-15

(Area 000' ha)

Years/crop	Wheat	Rice	Maize	Total cereals	Total pulses	Rapeseed & mustard	Total oilseeds	Cotton	Sugarcane	Potato
1960-61	1400	227	327	2160	903	107	185	447	133	9
	(29.58)	(4.80)	(6.91)	(45.65)	(19.08)	(2.26)	(3.91)	(9.45)	(2.81)	(0.19)
1970-71	2299	390	555	3514	414	103	295	397	128	17
	(40.48)	(6.87)	(9.77)	(61.89)	(7.29)	(1.81)	(5.19)	(6.99))	(2.25)	(0.29)
1975-76	2439	567	577	3891	441	122	315	580	114	27
	(38.99)	9.06)	(9.22)	(62.21)	(7.05)	(1.95)	(5.03)	(9.27)	(1.82)	(0.43)
1980-81	2812	1183	382	4513	341	136	238	649	71	40
	(41.58)	(17.49)	(5.65)	(66.73)	(5.04)	(2.01)	(3.52)	(9.59)	(1.05)	(0.59)
1985-86	3112	1714	260	5169	225	151	211	559	78	43
	(43.47)	(23.95)	(3.63)	(72.21)	(3.14)	(2.11)	(2.95)	(7.81)	(1.09)	(0.60)
1990-91	3273	2015	188	5525	143	69	104	701	101	23
	(43.63)	(26.86)	(2.51)	(73.65)	(1.91)	(0.92)	(1.39)	(9.34)	(1.35)	(0.31)
1995-96	3221	2185	171	5625	95	101	237	742	136	39
	(41.77)	(28.33)	(2.22)	(72.94)	(1.23)	(1.31)	(3.07)	(9.62)	(1.76)	(0.51)
2000-01	3408	2612	164	6222	55	55	86	473	121	64
	(42.95)	(32.92)	(2.07)	(78.41)	(0.69)	(0.69)	(1.08)	(5.96)	(1.52)	(0.81)
2005-06	3464	2647	149	6290	29	47	80	557	85	71
	(44.03)	(33.64)	(1.89)	(79.94)	(0.37)	(0.60)	(1.02)	(7.08)	(1.08)	(0.90)
2010-11	3510	2826	133	6484	20	32	56	483	70	64
	(44.53)	(35.85)	(1.69)	(82.26)	(0.25)	(0.41)	(0.71)	(6.13)	(0.89)	(0.81)
2011-12	3527	2814	130	6487	20	30	52	515	80	70
	(44.63)	(35.61)	(1.65)	(82.09)	(0.25)	(0.38)	(0.66)	(6.52)	(1.01)	(0.89)
2012-13	3517	2849	131	6513	20	29	51	481	82	80
	(44.69)	(36.20)	(1.66)	(82.76)	(0.25)	(0.37)	(0.65)	(6.11)	(1.04)	(1.02)
2013-14	3510	2849	131	6503	19	30	47	445	89	79
	(44.72)	(36.30)	(1.67)	(82.86)	(0.24)	(0.38)	(0.60)	(5.67)	(1.13)	(1.01)
2014-15	3505	2894	126	6536	13	31	46	420	94	86
	(44.66)	(36.88)	(1.61)	(83.28)	(0.17)	(0.40)	(0.59)	(5.35)	(1.20)	(1.10)

Note: Figures in parentheses indicate percentages to the total cropped area

Maize was an important crop of the state in the pre-green revolution period. The area under maize was 327 thousand hectares in 1960-61 which declined to 188 thousand hectares in 1990-91, 164 thousand hectares in 2000-01. Further, it plummeted to 126 thousand hectares in 2014-15. In percentage terms, the maize area declined from about seven per cent of the cropped area in 1960-61 to less than two in 2014-15. As already discussed, with the fast increase in paddy area, the maize area declined significantly. Although MSP is announced for maize crop every year but there is no effective public procurement. Therefore, to avoid price risk, the Punjab farmers particularly in the central zone has shifted from maize to paddy on a large scale in the kharif season.

The area under potato crop has also increased during the last three decades. Its area was 17 thousand hectares in 1970-71 which increased to 64 thousand hectares in 2000-01 and it further increased to 86 thousand hectares despite inter year fluctuations in market prices. Price of potato is a major factor for the increase or decrease of potato area. Generally, its market price is fixed according to the forces of demand and supply. This crop is also not covered effectively under the public procurement programme.

All this reveals that cereals particularly wheat and paddy have come to dominate the cropping pattern in the state in the wake of new farm technology and axe has fallen mainly on pulses and oilseeds. As already discussed, this outcome is the consequence of higher profitability of wheat and paddy cropping system. There is another dimension of this problem. Pulses and oilseeds are legumes and their cultivation was an important natural source of restoring the soil fertility. The decline in their area has resulted in reduced availability of natural sources of fertilization of soils.

There is also concern over the long range effect of cereals dominated cropping pattern particularly the rice cultivation and also overall exploitative agriculture which could have deleterious effect on the soil health. The indiscriminate and uncontrolled use of underground water may not also be desirable in several areas of the state from the long-run point of view of sustained use of this scarce and precious resource.

Irrigated area

The expansion of irrigated area played a major role in the development of agricultural sector in Punjab. Irrigation is complementary to the other inputs like HYV seeds, fertilizers, pesticides etc. in boosting agricultural production. Table 5 shows the irrigated area by different sources in Punjab. It may be noted from the table that proportion of irrigated area to total cropped area increased from 3382 thousand hectares (81 per cent) during 1980-81 to 4141 thousand hectares (99.9 per cent) during 2013-14. The share of tube well irrigation area has been increased from 1939 to 2981 thousand hectares, whereas the share of canal irrigation has been declined from 1430 thousand hectares to 1160 thousand hectares during the same period. At present, about 72 per cent of the irrigation is through tube-wells and the rest about 28 per cent by canals. The major reason for higher use of ground water in Punjab is presence of huge subsidies on electricity for tube wells and better quality of ground water (Bhullar and Sidhu, 2006). Due to larger irrigated area in Punjab (99.9%), the consumption of other inputs like fertilizers and chemicals is comparatively high which led to higher productivity of crops in Punjab.

Over-exploitation of ground water

In the post-green revolution period, the number of tube-wells for irrigation purpose has increased very fast. There were only 1973 tube-wells in the state in 1950-51.This number increased to about 12000 in 1960-61, 1.92 lakh in 1970-71, 6.00 lakh in 1980-81, 7.73 lakh in 1990-91, 10.73 lakh in 2000-01 and 14.06 lakh in 2014-15. At present, about 72 per cent of the irrigation is through tube-wells and the rest about 28 per cent by canals. This phenomenon resulted in over-exploitation of ground water. Paddy is a water intensive crop. The over-exploitation of ground water is also linked mainly with the paddy crop. During the year 1984, there were only about 45 per cent over developed blocks in the state (Table 6). This number increased to about 79 per cent during the year 2011. The number of white blocks was about 31 per cent in 1984, which declined to about 16 per cent in 2011. Similarly, the share of grey blocks declined from about 19 per cent in 1984 to only 1.46 per cent in 2011.

In the districts of kandi zone, draft as percentage of recharge has increased from 49 during 1984 to 103 during 2011. The year 2011 witnessed sharp increase in water draft, which can be attributed to the fact that paddy area in this zone increased from 311 thousand hectares in 2004-05 to 345 thousand hectares in 2011-12 (Table 7). In south western zone, the water over draft increased from 32 to 138 per cent during above period. The central zone

Table 5: Irrigated area by different sources in Punjab

(000 ha)

Year	Canals	Tube wells	Other	Total	Per cent area irrigated
1980-81	1430 (42.28)	1939 (57.34)	13 (0.38)	3382 (100.00)	81.00
1990-91	1559 (39.87)	2339 (59.83)	12 (0.30)	3910 (100.00)	93.00
2000-01	962 (23.83)	3074 (76.13)	2 (0.04)	4038 (100.00)	95.00
2010-11	1116 (27.42)	2954 (72.59)	-	4070 (100.00)	98.00
2012-13	1133 (27.53)	2982 (72.47)	-	4115 (100.00)	99.16
2013-14	1160 (28.01)	2981 (71.99)	-	4141 (100.00)	99.90

Source: Sharma et al (2014), Statistical Abstract of Punjab, various issues.

showed the highest percentage overdraft of 142 to 197 per cent over time. Increase in paddy area and decrease in rainfall over time are two main reasons for such drastic increase in ground water balance in central districts.

Already due to decline in water table, more than one lakh tube-wells have been replaced with submersible pumps and around 3.9 lakh centrifugal pumps will have to be replaced by submersible pumps in the next few years, costing crores of rupees and increasing the energy requirements three-fold to pump out the same quantity of water (Aulakh, 2004). At present, about five lakh submersible pumps are there in the state. The PAU experts always advise the farmers not to transplant paddy before 10th June because transplantation of paddy before PAU recommendation results in fall of water table. It may be stated here that paddy transplanted on May 1 result in 70 cms decline in water table, 60 cms in case of May 10, 50 cms on May 20, 28 cms on May 30 and 10 cms on June 10. For the last two decades, the PAU advice to the farmers did not have significant impact in this regard. According to the press reports, some farmers of Moonak block (Sangrur district) transplanted paddy as early as on April 20, 2006 (Sharma, 2006). In the central Punjab, the water table is declining very fast which would have wide implications in the years to come. From the years 1982-87, the water table in the central Punjab declined by 18 cms per year. This figure increased to 25 cms in the years 1992-97, 42 cms in 1997-2002, 69 cms in 2003-04 and 74 cms in 2004-05 (Govt. of Punjab, 2006). Keeping in view these facts, the State Government has put a ban on transplantation of paddy before 10th June every year.

Keeping in view the problem of declining water table and other related issues, the Punjab Government constituted the Committee in the year 2002 under the Chairmanship of Dr S.S.Johl an eminent agricultural economist to suggest various measures for the diversification of agriculture in Punjab. The Committee suggested that one million hectares area each under paddy and wheat may be replaced with other crops particularly oilseeds and pulses. According to the existing water resources of the state, we can sustain paddy in about 16 lakh hectares only. But due to various reasons, the recommendations of this Committee have not been implemented as such by the Government of India. The severe drought in the year 2002-03 resulted in fall of foodgrain production by about 38 million tones in a year. The buffer stocks also declined considerably. Rather, India has been forced to import about seven million tonnes of wheat in the year 2006 to 2008. Since food security of the country is in the hands of the Punjab farmers, therefore, shifting of one million hectare area each under wheat and paddy to other crops in near future will be a very difficult task. Again during the year 2016-17, India has become a net importer of wheat. The policy framework and market infrastructure are in favour of wheat and paddy crops.

Table 6: Groundwater exploitation in Punjab, 1984 to 2011

Water blocks/year	1984	1989	1991	1997	2004	2011
Overdeveloped	53	62	62	73	104	109
	(44.92)	(52.54)	(52.54)	(52.90)	(75.91)	(78.98)
Developed	7	7	8	11	9	5
	(5.93)	(5.93)	(6.78)	(7.97)	(6.57)	(3.62)
Grey	22	20	15	16	8	2
	(18.64)	(16.95)	(12.71)	(11.59)	(5.84)	(1.46)
White	36	29	33	38	16	22
	(30.51)	(24.58)	(27.97)	(27.54)	(11.68)	(15.94)
Total number of water blocks	118	118	118	138	137	138
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Note: i) Figures in parentheses indicate percentages to the total number of water blocks
ii) Overdeveloped blocks are those where withdrawal of groundwater was more than 100 per cent of the recharge of water. In dark blocks, the withdrawal of groundwater was between 85 per cent and 100 per cent of the recharge of water. In grey block, the withdrawal of Groundwater was between 60 per cent and 85 per cent of recharge of water. In whole blocks, the withdrawal of groundwater was less than 60 per cent of the recharge of water.

Source: Water Resources Directorate, Punjab, Chandigarh and Kaur et al (2015)

Table 7: Zone wise comparison of ground water development in Punjab. 1984 to 2011

(draft as percentage of recharge)

Zone/year	1984	1989	1991	1997	2004	2011
Kandi zone	49	60	56	57	86	103
Central zone	142	149	149	156	172	197
South-western zone	32	45	40	48	108	138

Source: Water Resources Directorate, Punjab, Chandigarh and Kaur et al (2015)

Compound growth rates of area, production and yield

The compound growth rates of area, production and yield for important crops of the state are shown in Table 8. A perusal of the figures shows that rice production recorded the higher growth, i.e. 18.41 per cent per annum from the years 1966-67 to 1980-81. The contribution of area and yield was 11.00 per cent and 6.67 per cent respectively. Among the cereals, wheat was the next crop to record a high production growth rate (6.48 per cent per annum) during this period. The contribution of area in this was 3.34 per cent and yield contributed 3.05 per cent. Potato and American cotton also recorded significant production growth rates of 13.30 per cent and 8.09 per cent respectively in this period. In case of potatoes, the contribution of area was 9.38 per cent and that of yield 3.66 per cent. In case of cotton (A), the increase in production mainly occurred as a result of increase in area (7.37 per cent) and contribution of yield was (-) 0.11 per cent. Sugarcane witnessed a negligible growth rate of 0.23 per cent. The other crops like maize, barley, bajra, pulses, oilseeds and cotton (D) had negative growth rates for production during this period. This happened primarily on account of decrease in area. Area released from maize crop in kharif season was largely replaced by the paddy crop and that from pulses and oilseeds to wheat in the rabi season. The area under cotton (D) has mainly been replaced by cotton (A).

The compound growth rates of area, production and yield of important crops in the state for the period 1981-82 to 1990-91 revealed that rice crop again recorded the highest production growth rate. It was 5.61 per cent per annum. The contribution of area was 4.85 per cent and that of yield 0.72 per cent. Among the cereals, wheat was the next crop to record 3.70 per cent per annum production growth rate. The contribution of area was 0.97 per cent and that of yield 2.70 per cent. The cotton

Table 8: Compound growth rate of area, production and yield of important crops in Punjab

(per cent per annum)

Sr. No.	Crop	Area	Production	Yield
		1966-67 to 1980-81		
I	Rice	11.00***	18.41***	6.67***
II	Wheat	3.34***	6.48***	3.05***
III	Maize	-1.33*	-0.90NS	0.42NS
IV	Barley	-4.44*	-0.30NS	4.21***
V	Bajra	-7.92***	-7.27***	0.71NS
Vi	Pulses	-3.36***	-4.05***	-0.72NS
VII	Oilseeds	-2.91***	-2.91***	-0.0009NS
VIII	Sugarcane	-4.15***	0.23NS	4.55***
IX	Potato	9.38***	13.30***	3.66***
X	Cotton (A)	7.37***	8.09***	-0.11NS
XI	Cotton (D)	-1.77*	-2.91**	-1.65***
		1981-82 to 1990-91		
I	Rice	4.85***	5.61***	0.72NS
II	Wheat	0.97***	3.70***	2.70***
III	Maize	-5.72***	-7.08***	-1.40NS
IV	Barley	-8.79***	-3.32NS	6.08***
V	Bajra	-18.46***	-19.66***	-1.63NS
Vi	Pulses	-7.15***	-4.39*	2.97*
VII	Oilseeds	-6.01***	-4.16NS	2.21*
VIII	Sugarcane	0.95NS	0.77NS	-0.80NS
IX	Potato	-2.77NS	-2.01NS	-0.08NS
X	Cotton (A)	2.79NS	11.16***	8.15**
XI	Cotton (D)	-9.07***	-3.52NS	6.09*
		1991-92 to 2000-01		
I	Rice	2.72***	2.86***	0.12NS
II	Wheat	0.36*	2.48***	2.13***
III	Maize	8.23 NS	1.54NS	3.42**
IV	Barley	-4.60***	-2.36*	2.48***
V	Bajra	-7.92**	-5.80NS	-2.80*
Vi	Pulses	-5.62***	-7.97***	-2.50**
VII	Oilseeds	-7.41**	-9.64***	-2.40***
VIII	Sugarcane	2.29 NS	2.07NS	0.23NS
IX	Potato	14.59***	14.56***	0.18NS
X	Cotton (A)	-5.21***	-13.29***	-8.53**
XI	Cotton (D)	6.23 NS	5.57NS	-0.62NS

Contd...

2001-02 to 2014-15				
I	Rice	1.11***	1.73***	0.61**
II	Wheat	0.25***	1.20**	0.95**
III	Maize	-1.71***	1.88**	3.86***
IV	Barley	-6.46***	-5.40***	1.15***
V	Bajra	-19.27***	-18.82***	-22.63*
Vi	Pulses	-8.50***	-8.78***	-0.54^{NS}
VII	Oilseeds	-5.67***	-3.36***	2.83***
VIII	Sugarcane	-3.94**	-2.58*	0.14^{NS}
IX	Potato	2.00**	4.53***	2.84***
X	Cotton (A)	0.13^{NS}	1.17^{NS}	1.04^{NS}
XI	Cotton (D)	-19.34***	-18.16***	1.58^{NS}
1966-67 to 2014-15				
I	Rice	4.78***	6.75***	1.89***
II	Wheat	1.19***	3.20***	1.98***
III	Maize	-3.26***	-1.39***	2.15***
IV	Barley	-4.29***	-1.10**	3.34***
V	Bajra	-10.51***	-10.59***	-2.31*
Vi	Pulses	-7.61***	-7.68***	-0.06^{NS}
VII	Oilseeds	-4.14***	-2.93***	1.21***
VIII	Sugarcane	-0.63**	0.24^{NS}	0.81***
IX	Potato	3.43***	4.57***	1.04***
X	Cotton (A)	1.33***	2.52***	1.14***
XI	Cotton (D)	-5.71***	-4.52***	1.21***

Note: NS, ***, **, * indicate non-significant and significant at 1 per cent, 5 per cent and 10 per cent respectively.

(A) recorded 11.16 per cent production growth rate. In this, the contribution of area and yield was 2.79 per cent and 8.15 per cent respectively. The sugarcane also did not show a high growth rate in this period. The crops like maize, barley, bajra, pulses, oilseeds, potato and cotton (A) showed the negative production growth rates. It happened mainly due to decrease in area under these crops.

During the period 1991-92 to 2000-01, the production growth rates of rice and wheat were low as compared to the earlier periods, i.e. 1966-67 to 1980-81 and 1981-82 to 1990-91. Among the cereals crops, the production growth rate of rice was 2.86 per cent per annum from the years 1991-92 to 2000-01. The increase in production was mainly due to increase in area, i.e. 2.72 per cent per annum. The contribution of yield was non-significant, i.e. 0.12 per cent per annum. The major reason for increase in rice area during this period was replacement of cotton (A) by the farmers with rice. Due to attack of American bollworm on the cotton (A) crop on a large scale during this period, the farmers had no option but to shift to paddy crop in the kharif season. In the cotton belt, the ground water is brackish and unfit for water intensive crop like paddy. However, economic hardships faced by the farmers due to failure of cotton (A) crop forced them to shift to rice cultivation.

Wheat crop recorded the production growth rate of 2.48 per cent per annum during the period 1991-92 to 2000-01. The contribution of area and yield was 0.36 per cent and 2.13 per cent respectively. Potato crop witnessed significant production growth rate, i.e. 14.56 per cent per annum during this period. The contribution of area and yield was 14.59 per cent and 0.18 per cent respectively. Sugarcane production also witnessed the growth rate of 2.07 per cent per annum but it was not significant. The

cotton (D) showed 5.57 per cent production growth rate which was not found to be significant whereas cotton (A) production declined by 13.29 per cent per annum. The other crops like barley, bajra, pulses and oilseeds showed negative production growth rates. Maize crop witnessed non-significant 1.54 per cent production growth rate.

During the period 2001-02 to 2014-15, among the cereals crops, the production growth rate of rice was 1.73 per cent per annum. The increase in production was due to increase in area, i.e. 1.11 per cent per annum and yield i.e. 0.61 per cent per annum. Wheat crop recorded the production growth rate of 1.20 per cent per annum during the period 2001-02 to 2010-11. The contribution of area and yield was 0.25 per cent and 0.95 per cent respectively. Maize crop witnessed 1.88 per cent production growth rate which was mainly due to increase in yield i.e. 3.86 per cent per annum. Potato crop witnessed significant production growth rate, i.e. 4.53 per cent per annum during this period. The contribution of area and yield was 2.00 per cent and 2.84 per cent respectively. The cotton (A) showed non-significant growth of 1.17 per cent in production whereas cotton (D) production declined by 17.34 per cent per annum. The other crops like barley, bajra, pulses, oilseeds and sugarcane showed negative production growth rates.

The overall growth rate of area, production and yield of important crops for the period 1966-67 to 2014-15 indicated that rice crop was at number one having the highest production growth rate, i.e. 6.75 per cent per annum. The contribution of area and yield was 4.78 per cent and 1.89 per cent respectively for the increase in rice production. Among the cereal crops, wheat was next important crop having 3.20 per cent growth rate in production. The contribution of area was 1.19 per cent and yield 1.98 per cent. The growth rate of production of cotton (A) was 2.52. The contribution of area was 1.33 per cent and that of yield was 1.14 per cent. Potato was another important crop which showed the growth rate of production, i.e. 4.57 per cent per annum. The contribution of area and yield was 3.43 per cent and 1.04 per cent respectively. Sugarcane recorded negligible production growth rate of 0.44 per cent per annum. This increase was mainly due to increase in productivity. The other crops like maize, bajra, pulses, oilseeds and cotton (D) recorded negative growth rates in production.

The overall comparison of growth rates of different periods show that Punjab agriculture is facing the problem of stagnation in production particularly in the last one and half decade. The slow down in the growth rates of different crops had negative impact on the employment and income of the farmers as well as agricultural labourers. The area under different crops has almost reached to the maximum possible level. Any increase in area of particular crop will result in decline of another crop. In this way, the overall picture of Punjab agriculture may not change significantly.

Growth in net sown area and irrigated area

Since 1966-67, the net sown area has increased at annual compound growth rate of 0.14 per cent whereas the real increase was during 1966-67 to 1980-81 @ 0.51 per cent (Table 9). After 1980-81, no significant increase was witnessed in net sown area. Total cropped area increased at annual compound growth rate of 1.00 per cent since 1966-67. The highest increase was during 1966-67 to 1980-81 @ 1.86 per cent per annum. There was no increase in the total cropped area after 2000-01. Net irrigated area increased at 1.28 per cent annual compound growth rate since 1966-67. The highest growth was witnessed during 1966-67 to 1980-81 i.e. 2.79 per cent per annum. The growth rate kept on declining and was lowest (0.17 per cent) during the period 2001-02 to 2013-14. Similar trends were found in the growth rate of gross irrigated area which grew at 1.99 per cent annual compound growth rate since 1966-67. The highest growth was witnessed during 1966-67 to 1980-81 i.e. 3.78 per cent per annum. The growth rate kept on declining and was lowest (0.12 per cent) during the period 2001-02 to 2013-14.

Area, production and yield of wheat and paddy in Punjab vis-à-vis India

The data given in table 10a shows the information regarding area, production and yield of wheat in Punjab vis-à-vis India since 1966-67. A perusal of the table showed that wheat area has increased over time in Punjab as well as India. The proportion of wheat area in Punjab to total wheat area in India increased up to 1990-91 and after that it declined as the growth in wheat area in Punjab was slow as compared to national average after 1990-91. Regarding the production, it is interesting to note that the share of Punjab to wheat production is quite higher than its share of wheat area in India. The proportion of wheat production to national wheat production increased up to 2000-01, thereafter, it declined due to decline in share of area to national average. The reason

Table 9: Compound growth rates of net sown area, total cropped area, net irrigated area and gross irrigated area

Sr. No.	Period	NSA	TCA	NIA	GIA
1	1966-67 to 1980-81	0.51***	1.86***	2.79***	3.78***
2	1981-82 to 1990-91	-0.02^{NS}	0.98***	1.40***	1.79***
3	1991-92 to 2000-01	0.17^{NS}	0.56***	0.41**	0.79***
4	2001-02 to 2013-14	-0.20***	-0.03^{NS}	0.17***	0.12***
5	1966-67 to 2013-14	0.14***	1.00***	1.28***	1.99***

Note: NS, ***, **, * indicate non-significant and significant at 1 per cent, 5 per cent and 10 per cent respectively.

NSA: Net sown area TCA: Total cropped area

NIA: Net irrigated area GIA: Gross irrigated area

Table 10a: Area, Production and yield of wheat in Punjab vis-à-vis India, 1966-67 to 2014-15

Year	Area (Mill ha)			Production (Mill ton)			Yield (kgs/ha)		
	India	Punjab	% share of Punjab	India	Punjab	% share of Punjab	India	Punjab	Difference*
1966-67	12.84	1.61	12.54	11.39	2.45	21.51	887	1524	+71.82
1970-71	18.24	2.30	12.61	23.83	5.15	21.61	1307	2238	+71.23
1980-81	22.28	2.81	12.61	36.31	7.68	21.15	1630	2730	+67.48
1990-91	24.17	3.27	13.53	55.14	12.16	22.05	2281	3715	+62.87
2000-01	25.73	3.41	13.25	69.68	15.55	22.32	2708	4563	+68.50
2010-11	29.07	3.51	12.07	86.87	16.47	18.96	2988	4693	+57.06
2014-15	30.47	3.51	11.52	86.53	15.09	17.44	2840	4304	+51.55

*Per cent difference between Punjab and India's yield

Table 10b: Area, Production and yield of rice in Punjab vis-à-vis India, 1966-67 to 2014-15

Year	Area (Mill ha)			Production (Mill ton)			Yield (kgs/ha)		
	India	Punjab	% share of Punjab	India	Punjab	% share of Punjab	India	Punjab	Difference*
1966-67	35.3	0.29	0.82	30.4	0.34	1.12	863	1185	+37.31
1970-71	37.6	0.39	1.04	42.2	0.69	1.64	1123	1765	+57.17
1980-81	40.2	1.18	2.94	53.6	3.23	6.03	1336	2733	+104.57
1990-91	42.7	2.02	4.73	74.3	6.51	8.76	1740	3229	+85.57
2000-01	44.7	2.61	5.84	85.0	9.16	10.78	1900	3506	+84.53
2010-11	42.9	2.83	6.60	96.0	10.82	11.27	2239	3828	+70.97
2014-15	44.1	2.89	6.55	105.5	11.11	10.53	2391	3838	+60.52

*Per cent difference between Punjab and India's yield

for higher contribution of Punjab in wheat production compared to share in area is higher yield levels in Punjab. Over the time, the gap in wheat yield in Punjab and national average is narrowing down, but still it is more than 50 per cent during 2014-15.

It is evident from Table 10b that rice area has increased over time in Punjab as well as India. The proportion of rice area in Punjab to total rice area in India increased from just 0.82 per cent during 1966-67 to 6.55 per cent during 2014-15. Rice area has almost stagnated in the state after 2010-11. Regarding the production, it is again interesting to note that the share of Punjab to rice production is quite higher than its share of rice area in India. The proportion of rice production to national rice production increased up to 2010-11, thereafter it declined due to stagnation in rice area in the state. The reason for higher contribution of Punjab in rice production compared to share in area is higher yield levels in Punjab. The gap in rice yield in Punjab and national average increased up to 1980-81 and thereafter, it declined, but still it is more than 60 per cent during 2014-15.

Comparative economics of different crops

The information regarding economics of various rabi and kharif crops is shown in Table 11. A perusal of the table reveals that among the kharif crops, gross returns were highest from the sugarcane planted crop (Rs 101625) followed by sugarcane ratoon (Rs 85675), Bt cotton (Rs 47475), paddy (Rs 40600), basmati (Rs 37375) and cotton desi (Rs 37495). The respective variable costs of these crops were Rs 61641, Rs 41976, Rs 23688, Rs 16337, Rs 18158 and Rs 18496 per acre. The returns over variable cost were the maximum (Rs 43699) for sugarcane ratoon followed by sugarcane planted (Rs 39994), paddy (Rs 24263), Bt cotton (Rs 23787) and basmati (Rs 21217). Although the returns over variable cost were the highest in sugarcane ratoon and sugarcane planted but being an annual crop, the actual returns were lower in comparison to the lesser duration crops like paddy, cotton etc.

In case of the rabi crops, gross returns were the highest from the winter maize (Rs 46600) followed by wheat (Rs 34000), sunflower (Rs 29625), gram (Rs 23485) and summer moong (Rs 22440). The respective variable costs of these crops were Rs 20163, Rs 13966, Rs 14263, Rs 14719, and Rs 11567 per acre. The returns over variable cost were the maximum (Rs 26437) for winter maize followed by wheat (Rs 20034), sunflower (Rs 15362), barley (Rs 11742) and summer moong (Rs 10873).

Income of Agricultural Households in India

The information pertaining to monthly income of agricultural households in various states of India is presented in Table 12. A perusal of the table showed that the average monthly income of agricultural households is highest in Punjab state (Rs 18,059) followed by Haryana (Rs 14,434), J&K (12,683), Kerala (Rs 11,888), Meghalaya (11,792). Hence, the Punjab state is at a better position regarding average monthly income compared to other states. The average monthly income in some states like Bihar, West Bengal, Uttarakhand, Jharkhand, UP and Odisha, which account for 43 % of India's total agricultural households, is below Rs 5,000 per month. At the national level, the monthly income is Rs 6426 which is just about 36 per cent of income of Punjab farmers.

Future possibilities

It is often talked that Punjab may not be able to add much to its agricultural production since it is already near the saturation point so far as exploitation of new areas is concerned. Besides water is going to become the most limiting resource in further intensification of agriculture. We are of the view that unless the states make rational use of its irrigation resource, it would be difficult to maintain even the present type of cropping pattern in the long run. Already the state is facing the problem of depleting water table over vast areas in the central Punjab. This is coupled with water logging problem in some parts of south western districts where underground water is brackish. This does not, however, mean that there is no scope to increase agricultural production. Even with the known level of technology, it is possible to enhance agricultural production by bridging the adoption gaps.

There are sizeable productivity differentials among districts which are otherwise more or less homogenous with respect to availability of irrigation facilities and soil type. It should be possible to increase the productivity levels in these districts by giving due attention to the limiting factors in these districts. As far as diversification of crops is concerned, we are of the view that alternative crops should provide net returns almost equal to wheat and paddy crops. Only then, the farmers will shift to those crops. In this regard, production technology and marketing will have to play a crucial role. At present, the farmers face problems related with these issues. Besides, the

Table 11: Comparative economics of different crops, 2015-16

(Based on PAU Recommendations) (Rs/acre)

Sr. No.	Crop	GR	TVC	ROVC
Kharif crops				
1	Paddy	40600	16337	**24263**
2	Basmati	39375	18158	**21217**
3	Maize	28200	19040	9160
4	Bt cotton	47475	23688	**23787**
5	Cotton (Desi)	37495	18496	18999
6	Sugarcane planted	101635	61641	**39994**
	Sugarcane Ratoon	85675	41976	**43699**
7	Mash	19000	11909	7091
8	Moong	21000	12045	8955
9	Arhar	29350	12573	16777
10	Bajra	20200	12455	7745
11	Groundnut	37000	18450	18550
12	Soybean	16560	12594	3966
Rabi crops				
1	Wheat	34000	13966	20034
2	Barley	21400	9658	11742
3	Winter maize	46600	20163	26437
4	Gram	23485	14719	8766
5	Lentil	16635	11004	5631
6	Field Pea	21375	12851	8524
7	Gobhi Sarson	22400	12694	9706
8	Toria	15750	11553	4197
9	Linseed	16345	13854	2491
10	Sunflower	29625	14263	15362
11	Summer moong	22440	11567	10873
12	Summer mash	20856	12383	8473

GR= Gross returns, TVC= Total variable costs, ROVC= Returns over variable costs

Source: Deptt. of Economics & Sociology, PAU, Ludhiana

Table 12: Income of Agricultural Households in various states of India, 2012-13#

State	Monthly Income (Rs)*	% Agricultural households**	State	Monthly Income (Rs)*	Agricultural households %
Punjab	18,059	51.1	Bihar	3,558	50.5
Haryana	14,434	60.7	West Bengal	3,980	45.0
Jammu & Kashmir	12,683	82.1	Uttarakhand	4,701	64.3
Kerala	11,888	27.3	Jharkhand	4,721	59.5
Meghalaya	11,792	75.1	Uttar Pradesh	4,923	74.8
Arunachal Pradesh	10,869	65.1	Odisha	4,976	57.5
Nagaland	10,048	63.5	Chhattisgarh	5,177	68.3
Mizoram	9,099	81.0	Tripura	5,429	36.9
Manipur	8,842	68.2	Andhra Pradesh	5,979	41.5
Karnataka	8,832	54.8	Madhya Pradesh	6,210	70.8
			All India	6,426	57.8

*Income includes income from salary wages, net receipt from cultivation, net receipt from farming of animals and net receipts from non-farm business.

** Of rural households

July 2012 to June 2013.

Source: The Economic Times dated 30-11-2016, p-2

employment opportunities in the non-farm sector may be created in the rural areas for the unemployed/under-employed youth. Future of the state is in the hands of present young generation.

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"In a world of plenty, no one, not a single person, should go hungry. But almost 1 billion still do not have enough to eat. I want to see an end to hunger everywhere within my lifetime."

– Ban Ki-moon

Productivity and Farm Income differences of Ginger Cultivation in Sikkim

YOGRAJ SHARMA AND PRADYUT GUHA

The analysis of the data of 200 ginger farming households initiating cultivation in different agro-climatic regions of East and South district of Sikkim at disaggregate level reveals that significant difference of total factor productivity in different agro-climatic regions with average productivity has been found to be maximum in the tropical region and was least in temperate agro-climatic region. Considerable differences in farm business income were also noticed with the change in agro-climatic regions. The expenditure incurred for hired labour, manure, and disease (rhizome rot) seems to have a negative and significant impact on farmer's income.

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1. Introduction

Ginger is one of the important crops in the list of diverse horticultural and cash crops being grown in Sikkim. Sikkim is an important producer of ginger, contributing nearly 5 percent of the country's production during 2010-2011 (Yadev et al., 2014, pp.129-138). As per the Database on Horticulture & Cash Crops Development Department (2016) production and productivity of ginger was largest and second position in terms of area under cultivation during 2001-2014 amongst major cash crops of Sikkim. Ginger cultivation practices have prevalent in almost all districts of Sikkim. During 2010-2014 the production, productivity as well as area under ginger cultivation was highest in South districts of Sikkim while North district was lagging behind the rest of the districts in all three respects. Healthy productivity of a crop is important for the fate of farmers. Productivity analysis in agriculture has been attempted in the works of (Shaw, 1967, pp.670-683; Dayal, 1984, pp.98-123; Kumar and Mittal, 2006, pp.71-88; Pujari, 2005, pp.1-35; Hamid and Ahmad, 2009, pp.49-78) while (Singh and Dhillion, 2015, pp.35-42) have examined the productivity of ginger in Himachal Pradesh. While studying the association of plant spacing with incidence of disease (Tabin et al., 2014, pp.49-51) found decreasing plant spacing increase the disease incidence which gives less productivity of rhizome. The earthling up ginger at 4 month after planting using flat bed give the higher productivity of rhizome in Pune mentioned in (Sheikh et al., 2005, pp.216-217). Despite its cost ineffectiveness the drip irrigation technique being preferred by the ginger cultivators against conventional method for its productivity benefit (Kalkyankar et al., 2011, pp.359-370). The association of non-chemical method of production higher productivity ginger in NE states of India found in (Dheroo

et al., 2012, pp.1-22). While examining the importance of mulch and tillage practices on productivity and growth of ginger (Zaman et al., 2002, pp.121-123) found zero tillage with mulch found as best production technique in Bangladesh. The use of new technology seems to be directly linked with the productivity and income of Malaysian ginger grower (Suhaimi et al., 2014, pp.421-427). (Kumar et al., 2012, pp.121-123) recommended implementation of technology with fertilizer could be helpful in attaining higher productivity in Sikkim while positive association of productivity and quality of ginger with the increased use of fertilizer observed in (Seyie et al., 2013, .pp.65-70) similar observation was made for ginger grower of Meghalaya (Majumdar et al., 2005, pp.809-811) for the combined application of farmyard manure and potassium (K). (Rana and Karlo, 2010, pp.250-253) argued organic manure in combination with inorganic fertilizers enhances the quality and productivity of ginger in Nauni Solan. The organic manures[1] being indifferent in improvement of growth and productivity of ginger plant and fresh weight of ginger in Central Java felt in (Samanhudi et al., 2014, pp.1-5).

Alongside productivity, the earning of remunerative farm business income (FBI) is also important for the farmer is initiating cultivation at commercial basis for their livelihood. The FBI of any crop may be influenced by factors, which are external and internal to agriculture. Externally the marketing condition, price, cost of production, public support price policy can be important determinant while internally area under cultivation, output quality and quantity can also be important predictor of FBI. FBI as a measure of profitability in agriculture was popularized in the work of various researchers. (Singh and Dhillion, 2015, pp.35-42) have attempted to examine the FBI of ginger in Arunachal Pradesh while FBI across different farm size in Bihar (Pandey, 2015, pp.90-110). (Goswami, 2016, pp.1-14) made an attempt to evaluate the FBI differences across the different farm size across different agro-climatic regions of Assam and the FBI of major Kharif crops in Madhya Pradesh (Sharma et al., 2015, pp.67-77).

The analysis of productivity and FBI from crops cultivation has important implications. The knowledge about differential levels of productivity and FBI from cultivation of a crop at different agro-climatic regions may help the farmers to utilize their resources more efficiently and helps them to identify the potential location for initiating the cultivation of the crop. The measurement of productivity and FBI in agriculture being initiated in the works of several researchers, but efforts to examine the productivity and FBI differences of ginger cultivation across different agro-climatic regions of Sikkim is limited. Present study is an attempt in that direction. In addition, the study seeks to examine the factors determining FBI of ginger farmer across different agro-climatic regions of the study area.

2. Data and Methodology

Present study is based on primary data collected using multi-stage random sampling method during April-August 2016. The universe of the study was all the ginger cultivator of Sikkim. Given the vastness of the universe of the study and time and resource constraints on the part of individual researcher present study was concentrated only in two districts (East and West) of Sikkim for undertaking the field survey. The reasons for selection of these two districts were being their importance of ginger cultivation in terms of area, and output. The multi staged random sampling method was used for selection of villages where the survey has been administered. Three agro-climatic regions were selected for present study. However, the altitude range of one village does not lie on same heights because of hilly slopes and terrain, the altitude of a village varies from place to place. Hence, for research convenience and to nullify such variations the present study has rearranged the agro-climatic regions by classifying the regions as tropical (100 meter < R_3 < 700 meter), sub-tropical (700 meter < R_2 < 1400 meter), and temperate (1400 meter < R_1 < 2100 meter) regions. The plan of sample selection of ginger farming household being presented in Table 1.

Initially, two blocks were selected from East district and three blocks were being selected from South district for having importance in terms of coverage of areas under ginger cultivation in different agro-climatic regions. Sum total of 200 framing household were selected by taking minimum of 33 household from sampled villages of the study area.

3. Line of Analysis

Productivity Analysis:

The literature of productivity suggests two ways for measurement: partial factor productivity (PFP) and total factor productivity (TFP). Given the biasness and problem of underestimation associated with PFP many studies in agriculture attempted TFP such as (Shaw, 1967, pp.670-683; Dayal, 1984, pp.98-123; Kumar and Mittal, 2006, pp.71-88; Pujari, 2005, pp. 1-35; Hamid and Ahmad, 2009,

Table 1: Selection of the sampled household from Agro-climatic regions

Districts	Agricultural Development Officer (ADO) Circle	Village Name	Sampled Households	Classification of Agro-climatic Regions (R) (in Meter)	R
East	Pakyong	Pakyong	34	$1400 < R_1 < 2100$	R_1
South	Namchi	Maniram	33		
East	Pakyong	Pacheykhani	33	$700 < R_2 < 1400$	R_2
South	Timi	Tarku	33		
East	Rhenock	Rorathang	33	$0 < R_3 < 700$	R_3
South	Jorethang	Salghari	34		

Source: (i) Handbook of Organic Production in Sikkim, 2014
(ii) Agro biodiversity of Sikkim-Sikkim Forest Gov.

pp.49-78) while (Singh and Dhillion, 2015, pp.35-42) on ginger. Following Rao (2008); the TFP has been calculated using following equation

$$TFP = \frac{Vg}{P_1x_1+p_2x_2+.....+p_nx_n} = \frac{Vg}{\sum p_j x_j} \quad (i)$$

$$TPP = \frac{Vg}{\sum_{j=1}^{n} p_j x_j}$$

Or,

Where, V_g stands for value of ginger output (in Rs.)

p_j stands for price of j^{th} inputs

x_j stand for quantity of j^{th} inputs

Cost concepts:

The guidelines of Commission for Agricultural Costs and Prices (CACP) have specified nine different types of cost concepts as used in agriculture. With the regional differences in agriculture the CACP specific cost functions were used in the studies of (Narayanmoorthy, 2013, pp.107-120; Singh and Dhillion, 2015, pp.35-42) and specific cost function (in Goswami, 2016, pp.1-14). The cost functions specified by CACP are as follows:

Cost A1 = Includes all actual expenses in cash and kind incurred in production by owners

Cost A2 = Cost A1+ rent paid for leased in land

Cost A2+FL = Cost A2+ imputed value of family labour

There are six more types of cost concepts[2] given by CACP such as B1, B2, C1, C2, C2* and C3 but given the limitation of data as farmers were not able to provide the costs information on interest value of owned capital assets (excluding land) and also because being marginal farmer and disadvantage geographical specification, farmers in the study area were not using the capital like tillers, tractors etc., and were found using only simple tools such as sickle, trowel, plough axe, hoes, rake, etc. Therefore, reporting interest on such tools being not viable for farmers and estimation for the researcher. Thus, with the constraints of capturing the information on depreciation of capital goods the present research used only two cost concepts: A1 and A2.

Farm Business Income:

Taking FBI as a measure of profitability, the present study estimated the two variants of FBI namely FBI1 and FBI2 following (Singh and Dhillion, 2015, pp.35-42; Goswami, 2016, pp.1-14). Where, FBI1 denotes returns over variables costs of ginger farming households without considering imputed value of family labour and FBI2 denotes returns over variable cost of ginger farming households and imputed value of family labour.

FBI1 = Gross Income – Cost A2

FBI2 = Gross Income – Cost A2 + FL

Where FL stands for imputed value of family labour

It was assumed that farmers were rational and given his experience in farming, he would use inputs until the level where contribution of the inputs to income is positive. The explanatory variables used in the studies are farmer's characteristics, cost of cultivation, disease and locational dummies. The farmer's characteristics include experience (Exp) and education (Edu) and land tenure system (leased in land). The age of the farmers and education can be

Table 2: Descriptions of Explanatory variables impact on FBI

Variables	Description	Expected Sign
Exp	Experience of farmer (in years)	+
Edu	= 1 if the farmer is literate, = 0 if illiterate	+
PL	Labour cost per day hours (in Rs.)	+/-
FL	Imputed Family Labour per day hours (in Rs.)	+
AL	Animal labour cost per day hours in Rs.	+/-
Mnr	Manure cost per kg in Rs.	+/-
Seed	Seed cost per kg in Rs.	+/-
RL	Rent for leased in land in Rs.	+/-
Dis	Loss from disease in Rs.	-
Msl	Miscellaneous cost in Rs.	-
Temperate region (R_1)	=1 if the region is falling in temperate=0 otherwise	+/-
Sub- tropical region (R_{2i})	=1 if the region is falling in sub-tropical,= 0 otherwise	+/-

Note: The Tropical region (R_3) was assumed as the base region for comparison in the study

expected to be contributing positively to FBI of ginger farmers and land tenure system as if rent for leased in land (RL) may have negative impact on FBI. Cost of production such as value of paid labour (PL), value of seeds (Seed), Value of manure (Mnr), value of animal labour (AL) and miscellaneous expenses (Mscl) can be expected to be negatively as well as positively influencing FBI except imputed value of family labour (FL). The disease caused from rhizome rot (Dis) also can be expected to have negative relation with FBI of ginger. Since, study has been carried out in three location on the basis on agro-climatic regions (i.e. tropical, sub-tropical and temperate agro-climatic regions) of Sikkim, hence two locational dummies were used in order for understanding whether the FBI changes as we move to temperate or tropical agro-climatic regions of study area. It was considered that R_1=1 if the region was falling in the range (1400 meter < R_1 < 2100 meter) that is temperate agro-climatic region and R_2=1 if the region was falling in the range (700 meter < R_2 < 1400 meter) that is sub-tropical agro-climatic regions. The tropical region was assumed as the base region for comparison in the study. It is less predictable to know the sign the coefficient of these locational dummies were anticipated to be sign indifferent. Having considering the listed variables two multivariable linear regression model were estimated by dropping FL in one model and incorporating it in another model. The description of the explanatory variables and their likely impact on FBI is specified in Table 2.

Having considered the listed variables the following two linear multiple regression equations were fitted for understanding the factors determining the FBI of ginger farmers in the two sampled districts of Sikkim.

$$FBI1_i = \beta_0 + \beta_1 Exp_i + \beta_2 Edu_i + \beta_3 PL_i + \beta_4 AL_i + \beta_5 Mnr_i + \beta_6 Seed_i + \beta_7 RL_i + \beta_8 Dis_i + \beta_9 Mscl_i + \beta_{10} R_{1i} + \beta_{11} R_{2i} + U_i \quad (ii)$$

$$FBI2_i = \beta_0 + \beta_1 Exp_i + \beta_2 Edu_i + \beta_3 PL_i + \beta_4 FL_i + \beta_5 AL_i + \beta_6 Mnr_i + \beta_7 Seed_i + \beta_8 RL_i + \beta_9 Dis_i + \beta_{10} Mscl_i + \beta_{11} R_{1i} + \beta_{12} R_{2i} + U_i \quad (iii)$$

Where, i= 1, 2, 3,....., 200th sampled ginger farming households

$$U_i \sim IIND\ (0, \sigma^2)$$

β_0 is the positive intercept of the regression model

$\beta_1, \beta_2, \beta_3, \ldots\ldots\ldots\ldots, \beta_{12}$ are the positive slope coefficients

Since the data used in this exercise came from a cross-section of farmers, before estimating the model, the Breusch-Pagan/Cook-Weisberg test was applied to check the presence of heteroscedasticity in the data set. The result of the test showed the presence of heteroscedasticity and consequently, heteroscedasticity robust standard error was estimated.

4. Productivity of Ginger

In an attempt to examine if the productivity of ginger differs significantly among the ginger farming household in the

study area the total factor productivity (TFP) were estimated. The independent sample t test results reveals that productivity of ginger differs significantly across the farming household cultivating in different agro-climatic regions of the study area. Significant difference in TFP being found between temperate and sub-tropical regions and also between temperate and tropical regions in study area (as in Table 3).

The mean TFP value among the ginger farming household in temperate regions has been found as Rs.1.11 and in sub-tropical regions, it was Rs.1.21 whereas it was Rs.1.27 in tropical regions. Such difference in ginger productivity indicates that productivity will decline as the farmer moves to temperate regions. Some of the reasons for low or declining TFP in temperate regions may be climatic conditions, animal[3] attacks as reported by farmers.

Table: 3 TPF of Ginger in different Agro-Climatic regions of Sikkim

Descriptive Statistics	R_1	R_2	R_3
Mean	1.11	1.21	1.27
Standard Deviation	0.23	0.22	0.28
Number of Observation	67	66	67
Regions	R_1 with R_2	R_1 with R_3	R_2 with R_3
Independent Sample t-test	2.51**	3.59***	1.38
	(0.03)	(0.04)	(0.04)

Source: Self estimates based on field survey during April-August, 2016
Note: *** significant at 0.01 percent level, ** significant at 0.05 percent level
Figures in the parenthesis are the Standard Error of the respective estimates

Apart from such problem faced by ginger cultivators in temperate regions, rhizome rot disease and occurrence of nematode were found to be a primary cause for falling TFP in the study area.

5. Differences on FBI of Ginger

Refers to Table 4 it has been found that there was significant difference in FBI1 between sub-tropical and tropical regions with highest average value of Rs. 6303.16 in tropical regions where as it was least Rs. 4437.47 in sub-tropical regions of the study area. Again taking the case of FBI2 significant difference was found between temperate and tropical regions, also between sub-tropical and tropical regions. The average value of FBI was found to be highest in tropical regions and was lowest in temperate regions of the study area (as in Table 4).

To enquire the factors determining the FBI1 and FBI2 of ginger in three different agro-climatic regions of Sikkim

Table: 4 Differences in FBI across different agro-climatic regions of Sikkim

Descriptive Statistics	FBI1			FBI2		
	R_1	R_2	R_3	R_1	R_2	R_3
Mean	5286.24	4437.47	6303.16	1614.60	2120.05	3655.40
Standard Deviation	4371.83	3598.71	5400.21	1497.20	1353.02	3033.20
Number of Observation	67	66	67	67	66	67
Regions	$R_1$with R_2	$R_1$with R_3	$R_2$with R_3	$R_1$with R_2	$R_1$with R_3	$R_2$with R_3
Independent Sample t-test	0.84	0.85	2.07**	0.62	1.98*	1.84*
	(1008.77)	(1192.68)	(902.21)	(821.80)	(1030.70)	(836.62)

Source: Self estimates based on field survey during April-August, 2016
Note: *** significant at 0.01 percent level, ** significant at 0.05 percent level
* significant at 0.10 percent level
Figures in the parenthesis are the Standard Error of the respective estimates

the regression analysis was carried out. Refer to Table 5; it has been found that the coefficients of, manure, disease, miscellaneous expenditure and the locational dummy (R_1) were negative and significant in regressing equation of FBI1. Whereas, the coefficients of imputed family labour has been found to be positively significant in regression equation of FBI2. In addition, coefficient of manure, disease and locational dummy (R_2) found to be negatively significant in regression equation of FBI2. Thus, these results imply that if the paid labour increased by a unit the household would have relatively lower farm business income (FBI1). The result for lower income on paid labour may be the increasing wage rate consuming a substantial payment as factor price to the hired labour in the wake of increasing labour scarcity in agriculture. The other variables such as manure also found to be significant at 1 percent level indicating a unit increased in the expenditure of manure has significantly reduced the FBI1 by 1.26 units in the study area. Interesting to observe that the coefficient of disease was negatively significant, implying a unit increased in disease would have lowered the FBI in the study area by 0.17 units in FBI1.

Likewise, the coefficient of miscellaneous expenditure has also been remarked to be negatively significant implying higher miscellaneous expenditure were responsible for lower FBI1 in the study area. Important to note that the coefficient of locational dummy (R_1) has been found to be negatively significant at 5 percent level, however, the locational dummy (R_2) has not been observed to be significant. Since the intercept, (constant) being positively significant at 5 percent level implies the minimum FBI1 in the tropical agro-climatic regions was Rs. 2410.14. Again, locational dummy (R_1) being negatively significant implies the minimum FBI1 in the temperate agro-climatic region is negative taking a value of Rs. 40.22. The overall significance for regression equation of FBI1 found to be highly significant and is established.

Again taking into account the regression equation of FBI2 reveals that the coefficient of imputed family labour being highly positively significant. Thus, a unit increase in imputed family labour in the study area would have held to increase the FBI2 by 1.11 units. However, the coefficient of manure being negatively highly significant implies that a unit increased in the expenditure on manure would have reduced the FBI2 amongst the farming households by 1.27 units. The threat of disease found to be negatively significant at 5 percent level indicating a unit increased in disease in the study area would have reduced the FBI2 by 0.21 units. The coefficient of locational dummy (R_1) has been found to be negatively highly significant which implies the farmers in the temperate agro-climatic regions must be the victim of low and negative FBI2. However, the coefficient of locational dummy of sub-tropical regions and intercepts representing tropical regions were not found to be statistically significant.

6. Conclusion

The TFP of ginger has been observed considerably different across the different agro-climatic regions of present study. The difference in TFP was found to be significant between temperate and sub-temperate regions, and also between temperate and tropical regions. The temperate region found to be subject of lowest productivity while it was recorded highest in the tropical region of the study area. The loss incurred in the wake of rhizome rot disease, occurrence of nematode and less favorable climatic condition for ginger cultivation may be to some extent responsible for low productivity in temperate regions. Significance difference in FBI of ginger was observed across different agro-climatic regions of the study area of Sikkim. The average FBI was found to be largest amongst the framers in tropical region while it was lowest amongst the ginger-farming households in temperate regions of the study area. Any increased expenditure on hired labour, manure, miscellaneous expenditure and disease observed to be responsible for lower FBI of the farming household in the study area. The farmers' initiating cultivation with self-labour (imputed labour) found to enjoy increased FBI while increased cost of paid labour in cultivation attributed to lower FBI amongst the farming households in the study area. Locational advantage and disadvantage seemed to be prominent in the present study as the farm business income recorded low as we move to temperate regions. Factors such as loss incurred because of rhizome rot disease, occurrence of nematode and high expenditure on paid labour in wake of labour scarcity in agriculture in recent years may be the reason for lower values of farm business income in the temperate regions of the study area. Interestingly, significant section of farmer reported eco-system externality in the form of threat of animal attack was another serious problem in temperate ago-climatic region of the study area of Sikkim.

Table 5: Renaults of regression analysis for FBI1 and FBI2

Test of Heteroskedasticity	BP/CW test $Chi^2(11)=163.31$ Prob=0.000	BP/CW test $Chi^2(12)=190.11$ Prob=0.000
Dependent Variables	FBI1	FBI2
Independent variables/constant	Estimates of coefficients/values	Estimates of coefficients/values
Experience	10.58 (39.57)	32.45 (36.64)
Education	1201.64 (1248.37)	1659.17 (1178.42)
Paid labour	-1.15** (0.47)	0.61 (0.43)
Imputed family labour	-	1.11** *(0.42)
Animal labour	-0.64 (1.09)	-0.73 (0.92)
Manure	-1.26*** (0.41)	-1.27*** (0.42)
Seeds	0.22 (0.18)	0.17 (0.18
Rent in leased in land	1.53 (1.99)	0.32 (1.54)
Disease	-0.17* (0.09)	-0.21** (0.09)
Miscellaneous	-0.89** (0.35)	-0.44 (0.51)
R_1	-2450.36** (947.07)	-2712.20*** (860.60)
R_2	-788.81 (761.75)	-396.05 (693.33)
Constant	2410.14** (1422.25)	-159.93 (1311.76)
R^2	0.34	0.23
F	4.00*** (11,188)	3.10*** (12, 187)
N	200	200

Source: Self estimates based on field survey during April-August, 2016

Note: *** significant at 0.01 percent level, ** significant at 0.05 percent level
* significant at 0.10 percent level,

Figures in the parenthesis are the heteroskedasticity consistent Robust Standard Error of the respective estimates

Public and private initiative on extension activities through training and ancillary activities in the form of measures for disease control and initiating preventive measures for the threat of eco-system externalities may help the ginger farmers to reduce the problem of low productivity especially in the temperate agro-climatic region of the study area.

Notes

[1] chicken manure, goat manure and cow manure

[2] Where Cost concept B1 is the aggregate of Cost A1 and interest on value of owned capital asset (excluding land); while B2 is the aggregate of B1, rental value of own land (net of land revenue) and rent paid for leased-in land; the cost concept C1 is the aggregate of B1 and imputed value of family labour; while C2 is the aggregate of B2 and imputed value of family labour; the C2* is the aggregate of C2 estimated by taking into account statutory minimum or actual wage whichever is higher; finally C3 is the aggregate of Cost C2* and 10% of cost of C2* on account of managerial functions performed by farmers.

[3] Animals like monkey, rabbit, peacock etc.

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"The ultimate goal of farming is not the growing of crops, but the cultivation and perfection of human beings."

– Masanobu Fukuoka

Productivity and Profit from Bt Cotton Cultivation: An Analysis of Farm Level Data from Tamil Nadu

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Cotton crop has been cultivated predominantly in many parts of India, but its productivity is one of the lowest in the world mainly due to severe pests attack. Farmers are unable to control the bollworm attack, which is the key pest in cotton destroying up to 80 percent of crop output. Bt (Bacillus Thuringiensis) cotton introduced during March 2002 for commercial cultivation in India is considered to be an important variety in protecting the crop from bollworm attack. Many studies have been carried out since the introduction of Bt seed focusing on various aspects, but the controversies about the benefits of the new seed variety have been continuing. In this paper, an attempt has been made to study the productivity and profitability of Bt cotton by comparing with non-Bt cotton using farm level data collected from sample farmers in Tamil Nadu State. This study shows that while reducing the consumption of pesticides, Bt cotton helps to increase its productivity and profitability considerably as compared to non-Bt cotton.

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1. Introduction

Cotton, an important commercial crop of the country, occupies a significant place in both agricultural and industrial (textile) economy. Estimate suggests that about 15 million farmers spread out in over 10 States are dependent on cotton cultivation for their livelihood (Sharma, 1998). At the end of 2016, the total area under cotton crop of the country was about 12.82 million hectares (mha), which accounts for about eleven percent in the net cropped area (GOI, 2016). While accounting for about 33 percent of the world's total acreage, India has only 23 percent of world production (GOI, 2017; ISAAA, 2014). Although India is one the largest cotton producers in the world, its yield is one of the lowest because of severe pest attack.

Cotton is cultivated across different states in India and the major cotton producing states are Maharashtra, Gujarat, Andhra Pradesh and Tamil Nadu. Unlike the other commercial crops, almost 67 percent of area under cotton was cultivated under rainfed condition as late as during 2013-14 (GOI, 2016). Farmers cultivating cotton crop have been facing several problems in India, which are totally different from other crops. The predominant cultivation of cotton under rainfed condition increases the uncertainty in yield, different kinds of pests attack significantly hammer the yield of crop. Controlling bollworms is a major problem standing before the farmers throughout different regions in the country. Some estimates suggest that out of the total pesticides consumption of Rs. 2800 crore in Indian agriculture, about Rs. 1600 crore were spent on cotton alone, of which Rs. 1100 crore were spent only to control bollworms (Alagh, 1988; Mayee, et al., 2002). The indiscriminate use of pesticides not only increases the financial burden of the farmers and reduces the profit margins due to increased cost of cultivation.

The Bt (stands for *Bacillus Thuringiensis*) cotton introduced during early 2000s for commercial cultivation considered to be an important variety that can overcome the problems of bollworms in cotton (Mayee, et al., 2002; Gandhi and Namboodiri, 2006). Results from different studies indicate that Bt cotton can increase the yield of crop significantly as compared to hybrid cotton, apart from reducing bollworms attack and cost of cultivation significantly (Mayee, et al., 2002). Since the introduction of Bt cotton seed, it has emerged as an effective alternative to traditional cotton varieties by controlling bollworm attack, thereby improving yield and income. This has resulted in fast adoption of Bt cotton over conventional cotton. Cotton production in India has accelerated more than 4 times and reached a peak of 359 lakh bales during 2013-14 as compared to 86 lakh bales in 2002-03 (GOI, 2017). Despite some controversies about its environmental problems, Bt cotton cultivation has been steadily increasing all over the world including India. The total area under Bt cotton in India has increased from mere 0.29 lakh hectares in 2002-03 to 106.82 lakh hectares in 2015-16, which accounts for about 90 percent of India's total cotton area (GOI, 2017).

Bt cotton has been allowed to cultivate since April 2002 in India, but the controversies on the benefits of this new seed variety has been continuing. It would be useful to understand the overall findings of the existing studies as well as the controversies revolving around the cultivation of Bt cotton. Though information is available on various aspects of Bt cotton cultivation, we particularly looked at the impact of Bt cotton on the use of pesticides, cost of cultivation and productivity. On the impact of Bt cotton on pesticides use, studies carried out in Maharashtra and Andhra Pradesh show no reduction in the use of pesticides due to Bt cotton (see, Sahai and Rahman, 2003; Siva, et al., 1999; Qayum and Sakkhari, 2003). But, contrary to the results of these studies, quite a few studies have found some reduction in the use of pesticides due to the adoption of Bt cotton (see, Mayee, et al., 2002; Sharma, 2001; Pray et al., 2001; Huang, 2002; Ismael, et al., 2002; Qaim, 2006; Subramanian and Qaim, 2009; Ashok, et al., 2012). The other issue associated with Bt cotton crop is whether it reduces the cost of cultivation or otherwise. Most of the studies in this regard show that the cost of cultivation required for cultivating Bt cotton is higher than that of non-Bt varieties (Shiva et al., 1999; Pray et al., 2001; Iyengar and Lalitha, 2002; Yamaguchi and Harris, 2003; Narayanamoorthy and Kalamkar, 2006; Gandhi and Nambodiri, 2006). Since Bt cotton requires relatively more amount of yield increasing inputs, the cost of cultivation is found to be higher in all the studies that we reviewed.

As Bt cotton is expected to increase the yield of crop by reducing the bollworm attack, a number of studies have specifically attempted to find out its impact on yield. While the results of large number studies seem to indicate that the yield of Bt cotton is higher than that of the non-Bt cotton (see, Chaturvdei, 2002; Pray, et al., 2001; Ismael, et al., 2002; Huang, et al., 2002; Dong, et al., 2004; Bennet et al., 2006; Dev and Rao, 2007; Narayanamoorthy and Kalamkar, 2006; Ashok, et al., 2012), some studies have found reduction in yield of Bt cotton or insignificant increase in yield of Bt cotton (Shiva et al., 1999; Sahai, 2002; Sahai, 2002a).

It is clear from the above that the impact of the Bt cotton on different parameters is not uniform. Apart from varying results from different studies, most of the studies one way or the other appears to have the following methodological deficiencies. First, the availability of irrigation is an important factor, which determines the productivity of cotton, be it Bt or non-Bt cotton. However, the studies that we reviewed have not specified whether the sample farmers are drawn from irrigated area or rainfed area. Second, most of the existing studies either carried out without following any sample design or not specified the method that was used for selecting sample farmers. In fact, a large number of studies we reviewed for this study are looking like field notes. Therefore, keeping this in view, an attempt is made in this study to find out the impact of Bt cotton cultivated under irrigated condition on different parameters using sample survey data collected from Salem district of Tamil Nadu State. The major objectives of the study are:

1. To study the input use pattern of Bt and non-Bt cotton crop cultivated under irrigated condition.
2. To study the cost of cultivation of Bt and non-Bt cotton crop.
3. To estimate the impact of adoption of Bt cotton seed on its productivity.
4. To study the difference in farm profitability between Bt and non-Bt cotton.

2. Study Area and Method

The study has been carried out mainly by using field survey data collected from Salem district of Tamil Nadu, which is

an important State in cultivating cotton crop. As per the data of 2014-15, Tamil Nadu State has cultivated about 0.19 million hectares of cotton (GOI, 2016). Tamil Nadu has been selected purposively for this study as it is one of the earlier adopters of Bt technology and has large area under Bt cotton as well. One of the main reasons for selecting Salem district is that both Bt and non-Bt cotton crops are cultivated under irrigated condition in this district which is the main focus of the study.

A total of 100 sample farmers consisting of 50 Bt cotton growing farmers and 50 non-Bt cotton growing farmers have been selected from Salem district for the study. Farmers cultivating Bt cotton as well as non-Bt cotton under irrigated condition have only been selected for this study to avoid the impact of irrigation on productivity of crop and other parameters. Purposive sampling method has been followed to select the sample farmers cultivating Bt cotton. Farmers who cultivated non-Bt cotton nearest to the field of Bt cotton farmers have been selected purposively as non-Bt cotton sample farmers. This is done specifically to reduce the differences in soil quality and other agro-economic factors between the two groups of farmers. Comparison has been made between Bt cotton and non-Bt cotton farmers on different parameters to understand the benefits of Bt cotton. The field level information on Bt and non-Bt cotton cultivation have been collected from the sample farmers who have cultivated cotton crop during kharif season 2016.

One of the objectives of the study is to find out the impact Bt cotton on its productivity. To accomplish this, the following linear regression model is estimated to find out the contribution of each factor on productivity:

$$Yield = a+b_1EDU+b_2LHS+b_3FIE+b_4FER+b_5 PES+b_6 IRR+b_7 VAD \quad \ldots\ldots\ldots\ldots \quad (1)$$

Where,

Yield - Productivity of cotton (quintal/acre)

EDU - Average education of the farmers involved in agriculture (in years)

LHS - Land holding size (acre)

FIE - Farm improvement expenditures (Rs/acre)

FER - Expenditures on fertilisers (Rs/acre)

PES - Expenditures on pesticides (Rs/acre)

IRR - Expenditures on irrigation (Rs/acre)

VAD - Variety dummy (1 for Bt cotton, 0 for non-Bt cotton)

All the variables mentioned in the equation (1) one way or the other are expected to influence the productivity of cotton. Since the main aim of this analysis is to find out the impact of variety (Bt or non-Bt) on productivity cotton, variety dummy is used to differentiate Bt farmers from non-Bt farmers. A human resource variable such as education (ED U) is essential for adopting any new technological components and therefore, the same is used in our model. Inputs such as fertilisers, pesticides, irrigation, farm improvement expenditures (FIE) are needed for any crop to increase the productivity and therefore, these variables are used in the model. Size of land holding (LHS), which is proved to be an important factor in determining the productivity of any crop, is used to reflect the resource position of the farmers. It is expected that among the variables included in the regression model, the variety dummy will have significant influence on the productivity of cotton.

3. Salient Features of Sample Farmers:

A long held view is that socio-economic characteristics of the farmers such as community/caste, farming experience, etc., play a critical role in adopting any new technology in agriculture (see, Schultz, 1964; Lockheed, et al., 1980; Azhar, 1991). Since Bt cotton is a new technology introduced only recently in Indian agriculture, we have studied the socio-economic characteristics of Bt and non-Bt cotton growers. It is clear from Table 1 that the personal characteristics of both Bt and non-Bt farmers are by and large are same, except farming experience. As the young farmers generally tend to adopt any new technology relatively earlier than old farmers, it was expected that the farming experience of the Bt cotton growers would be less than the non-Bt cotton growers, which is borne out by the study. The average farming experience of the household's cultivating Bt cotton comes to 20.64, whereas the same comes to 33.46 years for non-Bt counterpart.

Land quality, landholding size, irrigation availability including source of irrigation, etc., also determine the adoption of any modern technology in agriculture. Since the seed price of Bt cotton is very high as compared to non-Bt cotton seed, it was expected that the average landholding size of the Bt cotton growers must be higher than the non-Bt counterpart. This is turned out to be true in our survey. Since the study selected only those farmers who cultivated Bt and non-Bt variety of cotton under irrigation, we could observe no difference in the percent of irrigated area between the two groups of farmers. The

Table 1: Characteristics of Bt and non-Bt cotton cultivating sample households

S. No.	Characteristics	Bt Households	Non-Bt Households
1	Number of sample households	50	50
2	Average size of family	5.02	5.04
3	Average farming experience (years)	20.64	33.46
4	Average education (years)	9.05	8.61
5	Percent of household with agriculture as main occupation	100.00	100.00
6	Average land size (acre)	6.42	4.13
7	Per cent of irrigated area	100.00	100.00
8	Foodgrains area to GCA	14.35	27.62
9	Non Foodgrains area to GCA	20.93	41.71
10	Cotton area to GCA	62.08	31.49
11	Cropping intensity (per cent)	154.04	180.00

Note: GCA – Gross cropped area

Source: Calculated using field survey data.

share of irrigated area to gross cropped area (GCA) comes to 100 percent for Bt as well as for non-Bt cotton farmers. The main source of irrigation used by both the groups of sample farmers in the district is groundwater. Since the seed price of Bt cotton variety is substantially higher (Rs. 1152 per acre) than that of the conventional hybrid variety (Rs. 615 per acre), farmers do not want to take risk in cultivating Bt variety under rainfed condition, where output is not assured.

4. Input Use Pattern by Bt and non-Bt Cotton Farmers:

Whether or not any difference exists in the input use pattern between Bt and non-Bt cotton growers is one of the objectives of the study. This is done specifically for two reasons. First, the Bt cotton is not only a new crop but also a cost-intensive crop as compared to conventional hybrid variety. Second, it is claimed by the seed company that Bt cotton reduces pest attack (especially bollworm) and therefore, it reduces the use of pesticides substantially. The data presented in Table 2 shows that except, seed and pesticides all other inputs used by Bt cotton cultivators are considerably higher than that of non-Bt cotton cultivators. Bt cotton farmers have used substantially higher amount of yield-increasing inputs such as fertilisers and farm yard manures than non-Bt counterpart group in the district. For instance, while the average use of NPK is 275 kg/acre among Bt cotton growers, whereas it comes to 190 kg/acre among non-Bt cotton growers, a difference of over 44 percent. Similarly, the difference in the use of FYM between Bt and non-Bt cotton growers comes to about 92 percent. Since most of the Bt cotton cultivators are progressive farmers, the use of yield-increasing inputs is found to be higher among them.

Farmers belonging to both Bt and non-Bt groups have followed the recommended rate of seed. While the seed rate used by the Bt cotton cultivators was around 588 gram/acre in the selected district, the same used by the non-Bt cultivators was around 2600 gram/acre. The variation in seed use in both the varieties of cotton occurs mainly because of fraction in the holding size of the cotton cultivators and different spacing followed by the cultivators. However, quite a few farmers mainly belonging to marginal and small groups have not planted the refuge variety of cotton, partly because of availability of limited land resource and partly due to awareness problem. Bt cotton farmers are very much satisfied with the germination of seed. The germination percent of non-Bt seed varieties is also found to be equally good. As both the groups of farmers have cultivated cotton under irrigated condition where moisture stress is very less, the germination percent of seed is found to be higher.

Pesticides are considered to be very important input in cotton cultivation. Bt cotton requires less amount of pesticides as compared to non-Bt cotton varieties, as this

Table 2: Pattern of inputs application for Bt and non-Bt cotton

(Units/acre)

S. No.	Inputs	Bt cotton	Non-Bt cotton	% over Non-Bt cotton
1	Manual labours (days)	126.94	108.30	17.21
2	Tractor (hours)	4.58	3.71	23.45
3	Seed (gram)	588	2600.00	-55.77
4	Fertilisers (kg)			
	Nitrogen (N)	108.50	78.94	37.44
	Phosphate (P)	98.70	60.60	62.87
	Potash (K)	67.50	51.00	32.35
	Total NPK (kg)	274.70	190.54	44.17
5	FYM (cart load)	4.54	2.36	92.37
6	Pesticides (litre)	3.67	5.68	-35.39
7	Irrigation (Nos.)	11.20	5.78	93.77

Source: Calculated using field survey data.

new seed has inbuilt mechanism to control bollworm attack. Therefore, it was expected that farmers who grew Bt cotton would be able to substantially reduce the amount of pesticide and gain better control of bollworm. Our survey data demonstrates that Bt cotton farmers are able to reduce total pesticides use by about 35 percent over the non-Bt cotton farmers (see, Table 3). Farmers cultivating Bt cotton variety have used less number of spray (4.34) as compared to non-Bt cotton variety growing farmers (6.14). As the bollworm attack in Bt cotton is very minimal, farmers growing Bt cotton are able to control the use of pesticides, which they have used mostly for controlling sucking pests.

Table 3: Number of spray and quantity of pesticides used in Bt and non-Bt cotton

(Units/acre)

S. No.	Particulars	Bt cotton	Non-Bt cotton	% over Non-Bt cotton
1	Number of spray	4.34	6.14	-29.31
2	Quantity per spray (milli litre)	750.00	1250.00	-40.00
3	Quantity of pesticides used (litre)	3.67	5.68	-35.39
4	Cost of pesticides (Rs.)	3694.12	4052.62	-8.84

Source: Calculated using field survey data.

5. Cost of Cultivation of Bt and non-Bt Cotton

Since Bt seed is relatively a new technology, an attempt has been made to study its cost of cultivation. Comparison has been made in each operation between Bt and Bt cotton to assess the difference in cost. Results presented in Table 4 clearly show that the cost of cultivation of Bt cotton is considerably higher than that of non-Bt cotton. The average cost of cultivation comes to Rs. 33,878/acre for Bt cotton and Rs. 27,666/ acre for non-Bt cotton, which is a difference of about 22 percent over non-Bt cotton. Many factors are responsible for the higher cost of cultivation for Bt cotton. First, the seed cost of Bt cotton comes to Rs. 1152/ acre, which is much higher than the seed cost of non-Bt cotton varieties (Rs. 615/acre). Second, the expenditures incurred on fertilisers and FYM are substantially higher among Bt cotton growers; about 75 percent higher than non-Bt counterparts. Third, due to higher productivity of Bt cotton, the cost incurred on its harvesting is substantially higher than non-Bt cotton.

Fourth, the cost of irrigation is also found to be much higher among the Bt cotton growers. Besides this, the cost incurred on account of transport and marketing is also relatively higher for Bt cotton mainly due to higher productivity. This increased cost requirement of Bt cotton suggests that it is relatively a cost-intensive agricultural technology.

Table 4: Operation-wise cost of cultivation for Bt and non-Bt cotton

(Rs/acre)

S. No.	Particulars	Bt cotton	Non-Bt cotton	% over Non-Bt cotton
1	Preparatory works	1098.20 (3.24)	822.05 (2.97)	33.59
2	Ploughing	4307.46 (12.71)	3407.66 (12.32)	26.41
3	Seed	1152.00 (3.40)	615.12 (2.22)	87.28
4	Sowing	1090.50 (3.22)	1283.00 (4.64)	-15.00
5	Fertilisers	5467.82 (16.14)	4840.50 (17.50)	12.96
6	FYM	5548.10 (16.38)	2336.01 (8.44)	137.50
7	Pesticides	4709.20 (13.90)	5253.58 (18.99)	- 10.36
8	Weeding and interculture	2912.50 (8.60)	3041.56 (10.99)	-4.24
9	Irrigation	1080.40 (3.19)	657.00 (2.37)	64.44
10	Harvesting (picking)	5698.84 (16.82)	4837.62 (17.49)	17.80
11	Transport and marketing	813.02 (2.40)	571.10 (2.06)	42.36
	Total	33878.04 (100.0)	27665.20 (100.0)	22.46

Notes: Figures in brackets are percent to total cost of cultivation.
Source: Calculated using field survey data.

6. Productivity of Bt and non-Bt Cotton:

Earlier studies on Bt cotton shows that it can increase productivity substantially as compared to the conventional hybrid/HYV varieties. Our survey also shows that productivity of Bt cotton variety is significantly higher than that of non-Bt cotton varieties (see, Table 5). The average productivity comes to 12.48 quintals/acre for Bt cotton, but the same is only about 7.56 quintals/acre for non-Bt cotton, representing a difference of about 65 percent over non-Bt cotton. There are three important reasons for the higher productivity in Bt cotton. First, the bollworm attack was found to be low in Bt cotton variety as compared to non-Bt variety and therefore, the damage of crop was less in Bt cotton. Despite applying higher quantity of pesticides in non-Bt variety, many farmers had to face heavy damage of crop due to bollworm attack. Second, the number of bolls produced by each plant was reported to be higher in Bt cotton. Third, yield-increasing inputs used by Bt cotton growers are also found to be higher in Bt variety as compared to non-Bt cotton growers, which may have also influenced its productivity.

Table 5: Productivity of Bt and non-Bt cotton

S. No.	Particulars	Productivity (Quintal/acre)	Range in Productivity (Quintal/acre)
1	Bt Cotton	12.48(1.11)	10 to 15
2	Non-Bt Cotton	7.56(1.25)	6 to 10
3	Absolute increase over non-Bt (quantity)	4.92	
4	% increase over non-Bt cotton	65.08	

Note: Figures in brackets are co-efficient of variation
Source: Calculated using field survey data.

After having analysed the productivity differences between Bt and non-Bt cotton varieties, we have tried to find out the relative contribution of various factors to productivity of cotton using regression analysis as specified in the methodology section. Specifically, we have tried to find out the impact of Bt variety on productivity of cotton. It is important to underline here that all the seven variables used in the equation (1) are expected to contribute the productivity of cotton one way or the other. The regression results presented in Table 6 clearly suggest that only variety dummy appears to have significantly contributed to the productivity of cotton crop. Among the various factors, variety dummy is turned out to be the most significant factor (highest coefficient value) in increasing the productivity of cotton. This is expected because most of the Bt cotton cultivators have harvested substantially higher productivity than that of non-Bt counterpart. The insignificant co-efficient of all other variables including land holding size (LHS) of farmers suggest that influence of all other variables on productivity of cotton is insignificant, which is a plausible result.

Table 6: Determinants of productivity of cotton: regression results

	Variables	Coefficients	't' value
1.	Variety Dummy (1=Bt and 0= Non-Bt)	4.992	14.78[a]
2.	Education (years)	-0.021	-0.718[NS]
3.	Fertilisers (Rs)	0.0002	0.856[NS]
4.	Farm Improvement Expenditures (Rs)	-0.001	-1.238[NS]
5.	Land Holding Size (acre)	0.005	0.107[NS]
6.	Irrigation (Rs)	0.0002	0.743[NS]
7.	Pesticides (Rs)	0.0002	1.798[c]
	Constant	5.964	4.322
	R^2	0.829	-
	Adjusted R^2	**0.815**	-
	F value	63.32	-
	D-W value	1.850	-
	N	100	-

Notes: a & b are significant at 1 and 5 percent respectively; NS- not significant.
Sources: Computed from field survey data.

7. Profitability of Bt and non-Bt Cotton

Profitability is expected to be very high from Bt cotton cultivation. But, the existing studies have shown diverged results on the issue of farm profitability of Bt vis-à-vis non-Bt cotton. Since the present study is carried out using field survey data, it is expected to provide convincing answers as well as to resolve the controversies about the economics of Bt cotton cultivation. Here, the profit is calculated by deducting the cost of cultivation from the gross value of production per acre, which is estimated by multiplying the productivity of cotton with the output price (per quintal) received by the farmers.

Data presented in Table 7 clearly shows that the profit realised from Bt cotton crop is substantially higher than that of non-Bt cotton crop. While the average profit comes to about Rs. 30,594/acre for Bt cotton, it is only about Rs. 16,184/acre for non-Bt cotton crop, implying a difference of around 90 percent over non-Bt cotton. How could the Bt cotton growers get such a higher profit than non-Bt cotton counterpart is the question that requires answers. As mentioned earlier, in Bt cotton, the sample farmers have harvested substantially higher yield than non-Bt growers, which helped them to get higher profit. Further, since the sample farmers have not received same price for Bt and non-Bt even though the stable length is low for Bt cotton varieties as compared to non-Bt cotton varieties of cotton, one can conclude that the higher profit from Bt cotton cultivation is mainly due to higher productivity and not because of higher output price. The data on input and output pattern of Bt and non-Bt cotton cultivators presented in Table 7 also suggest that the cost efficiency is also higher in Bt cotton crop. The cost efficiency measured in terms of cost required to produce one quintal of output shows that Bt crop requires only about Rs. 2,715/quintal, as against the requirement of about Rs. 3,660/quintal for non-Bt cotton crop. Overall, the analysis on income and expenditures suggests that the profit from the cultivation of Bt cotton is substantially higher than that of non-Bt cotton crop.

Table 7: Gross value of production and profit from Bt and non-Bt cotton

S. No.	Inputs	Bt cotton	Non-Bt cotton	% over Non-Bt cotton
1	Gross value of production (Rs/acre)	64472	43850	47.03
2	Gross cost of cultivation (Rs/acre)	33878	27666	22.45
3	Cost of production (Rs/ quintal)	2715	3660	-25.85
4	Profit (Rs/acre)	30594	16184	89.04
5	GVP/GCC	1.90	1.58	—

Notes: GVP – gross value of production; GCC – gross cost of cultivation.
Source: Field survey data.

8. Concluding Remarks

An attempt has been made in this study to find out the productivity and profitability of Bt cotton by comparing with non-Bt cotton cultivation. It shows that the cost of cultivation required for Bt cotton crop is relatively higher than that of non-Bt crop. As claimed by the seed company, Bt cotton has reduced the number of spray as well as the consumption of pesticides. Farmers cultivating Bt cotton are able to reduce the expenditures on account of pesticides. Because of less bollworm attack, productivity is found to be about 65 percent higher for Bt cotton as compared to non-Bt cotton. The augmented productivity helped to realise increased profit per acre by the Bt cotton farmers to the extent of about 89 percent over those farmers cultivating non-Bt cotton crop.

Although the results of the study clearly suggest that the productivity and profit from Bt cotton cultivation is substantially higher than the conventional hybrid cotton variety, it is not completely free from problems. Most sample farmers have expressed that the seed cost of Bt cotton is very high as cokpared to non-Bt cotton variety. The resource poor farmerws (marginal and small size

group) are constrained to adopt this new variety of seed despite of increased price. Therefore, concertd efforrt should be taken to reduce the seed cost of Bt cotton by promoting the role of public sector in transgenic cotton seed production though research and development activities. Quite a few farmers cultivating Bt cotton still continue to use the same quantity of pesticides as followed in the past partly because of poor awareness and partly due to fgear of bollworm attack. Many Bt cotton growers fear that the bollworm can attack cotton crop any time and therefore, they tend to use more quantity of pesticides. Besides increasing cost of cultivation, the over use of pesticides also increases the social cost by polluting the environment. Therefore, the Bt cotton seed companies should clearly advise the farmers at what circumstances they should spray pesticides through their own extension network. Though the present study revealsthat the return from Bt cotton crop is considerably higher than that of non-Bt cotton crop, one cannot firmly say that the same level of return can be achieved thoughout Tamil Nadu State or India without any risk. The relative return from Bt cotton ceop is expected to be less in all those rainfed areas, where the adoption of various yield-increasing inputs/ practices is generally less due to uncertainity in crop output. Hence, detailed study needs to be carried out covering rainfed areas to find out the risks associated with the cultivation of Bt cotton crop.

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"Problems cannot be solved at the same level of awareness that created them."

– Albert Einstein

Farmers Clubs and Livelihood Opportunities through Livestock Development: An Analysis in Select Villages of Nagapattinam District, Tamil Nadu

P. BALAMURUGAN

Livestock provides livelihood to two-third of rural community. It also provides employment to about 8.8 per cent of the population in India. India has vast livestock resources. Livestock sector contributes 4.11 per cent of gross domestic product (GDP) and 25.6 per cent of total agricultural GDP. Traditionally, livestock maintenance like country side cows and bulls breeding was done as an important part of the farming system. Cow milk, cow dung and cow urine were useful to organic farming and useful in maintaining sustainable environment for human health and natural resources development. At this juncture, an attempt has been made to analyse the uses of cow-based products and their importance to sustainable development in villages, where almost all households engage in cow breeding activities as part of livelihood support.

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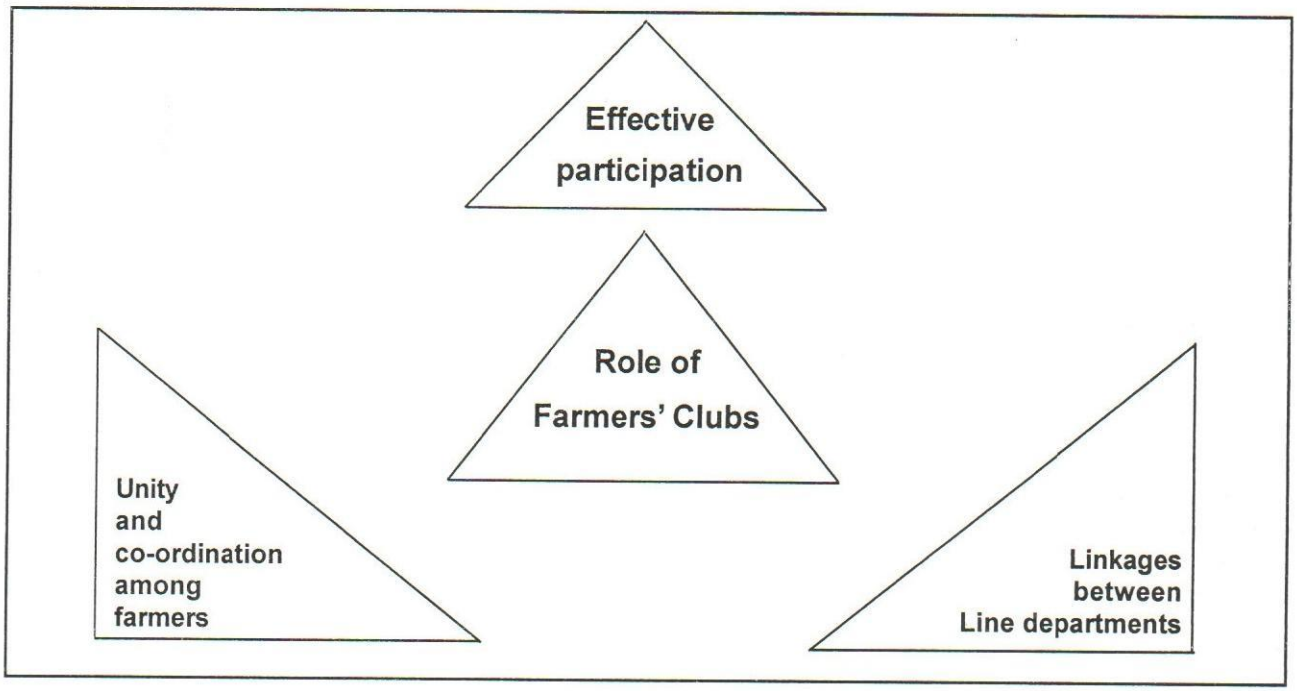
1. Conceptual Framework

Livestock plays an important role in Indian economy; especially its contribution to national development of country is highly accepted by the people. About 20.5 million people depend upon livestock for their livelihood in our country. Livestock contributes16 per cent to the income of small farm households as against an average of 14 per cent for all rural households. Livestock provides livelihood to two-third of the rural community. It also provides employment to about 8.8 per cent of the population in India. India has vast livestock resources. Livestock sector contributes 4.11 per cent of GDP and 25.6 per cent of total agricultural GDP. The livestock sector is more labour intensive than crop production and accounts for a major share in rural employment with 4.5 per cent annual growth as compared to 1.75 per cent for all sectors and 1.1 per cent for agriculture. To date, research in the livestock production system emphasised much on its production parameters and there is a paucity of information on its contribution to the livelihood of farmers. The Farmers' Club is innovative exercise in social engineering in the process of economic development of villages. It is on attempt to address the agricultural loans of banks at grass-root level. Under this, Farmers' Club is an informal forum of group of dedicated farmers among the borrowers who have taken loans and try to make timely repayment. Farmers Club is a grass root level organisation that provides a link between villages, bankers and development agencies.

The club is mainly functioning to help progressive farmers, with common economic and social needs,who absorb the advantages through the linkages with the bankers and development agencies. Farmers' Clubs have emerged mainly to participate in the development activities

Flowchart Showing the Role of Farmers' Clubs



for the welfare of farmers in particular and betterment of the village in general.

Indigenous cows' milk is preferred as calcium found in *desi* (indigenous) cow milk protects the colon cells from chemicals which lead to cancer. It helps in reducing PMS symptoms, prevents migraine headaches, prevents obesity in children and also helps adults lose weight, especially around the midsection. Calcium effectively fights breast cancer, while playing an integral role in muscle contraction, blood clotting and regulation of blood pressure and function of cell membrane.

Table 1: Cattle Population in India

(in thousand)

Category	2007	2012	% Change
Cattle			
Exotic/Crossbred			
• Male	6,844	5,971	-12.75
• Female	26,216	33,760	28.78
Total Exotic/Crossbred	33,060	39,732	20.18
ϖ Indigenous			
• Male	76,779	61,949	-19.32
• Female	89,236	89,224	-0.01
ϖ Total Indigenous	1,66,015	1,51,172	-8.94
Total Cattle#	1,99,075	1,90,904	-4.10

Source: Press Information Bureau (2014), Government of India, Ministry of Agriculture (All India Livestock Census).

From a pure utility perspective, cow dung is one of the best forms of natural fertilisers available. Application of cow dung for soil enrichment is an age old agricultural practice which was lost post introduction of chemical fertilisers.[1]

Table 2: Female Cattle Population in India

(in million numbers)

Species	1987	1992	1997	2003	2007$	2012
Cattle	199.7	204.6	198.9	185.2	199.1	199.9
Adult female cattle	62.1	64.4	64.4	64.5	73.0	76.7

Source: National Dairy Development Board(2015), Government of India, Ministry of Agriculture (All Indi Livestock Cencus).

With rising demand for chemical free food and growing acceptance of organic farming, cow dung forms a very important link in chemical-free farming. Another growing trend is the use of cow dung in producing biogas, a cheap alternative source of energy that can be used as a fuel for cooking or to even produce electricity.

Table 3: Decline in Total Population of Select Livestock in India (in millions)

Animal	2007			2012		
	Indigenous breed population	Exotic animals and cross breeds	Total	Indigenous breeds	Exotic animals and cross breeds	Total
Cattle	1,66,015	33,060	1,99,075	1,51,172	39,732	1,90,904
Sheep	67,828	3,730	71,558	61,288	3,781	65,069
Pig	8,744	2,389	11,133	7,837	2,456	10,293
Total	**2,42,587**	**39,179**	**2,81,766**	**2,20,297**	**45,969**	**2,66,266**

Source: A State of India's Environment, Centre for Science and Environment, New Delhi, 2015.

Though it may never move into the mainstream, an alternative medicine promoted by a Hindu group in India is getting some attention: cow urine as a treatment for numerous diseases, including cancer, diabetes and tuberculosis. But not any old cow urine will do. Only the urine collected from a female virgin cow will suffice and it's best when collected before dawn. Cow urine offers a cure for around 70 to 80 incurable diseases like diabetes. All are curable by cow urine. As rural institutions, farmers clubs motivate the farmers and their family members to engage in cow breeding for their livelihood.

2. Objectives

Based on the background, the present investigation is aimed at analysing the uses of cows for sustainable development, with help of farmers clubs. It also suggests a policy framework to promote such type of livestock activities that promote sustainable rural development in India.

3. Methodology

For the present investigation, both primary and secondary sources of data were collected.

4. Sampling Design and Study Area

The Sample size of the present study is 120, in which 60 respondents from each village were contacted to collect data. The respondents comprise the lead farmers (30) and small farmers (30), being major cow breeders and members of the farmers clubs in both villages. The study under villages are Mathiravelur and Thandavankulam belonging to Kollidam block, Nagapattinam District, Tamil Nadu.Mathiravelur village is located in western part of the

block with distance of 82 km from district headquarters-Nagapatinam and 38 km from Bay of Bengal. Another village under study is Thandavankulam which is the seashore village, located at a distance of 63 km from thedistrict headquarters and 6 km from Bay of Bengal.

In both villages, agriculture is the main occupation and major crops are paddy, sugarcane, groundnut and black and green gram, and the land topography is the tail end area of Cauvery delta. Black soil and clayeys and are the main soil features of both villages. Average infrastructural resources are available in these villages.

5. Analysis and Discussion

Required data include cow breeding, use of cow milk, dung and urine, along with the role of farmers clubs', challenges, and employment opportunities. The data was collected with help of a structured interview schedule. The collected data were analysed and tabulated in a proper manner. The percentage analysis and application of Chi-square test have been employed, in order to understand the uses of cow-based products and to find out the association between livelihoods opportunities and cow breeding, respectively.

As the limitation of the present investigation, the cows' keepers were only contacted in both villages due to resources constraints.

6. Finding, Suggestion and Conclusion

Livestock represents a major component of the rural economy in India, especially in areas where returns from farming are dwindling and marginal farmers rely on goats and sheep to eke out a living. The latest livestock census, released in September 2014, however, does not bode well for the agrarian sector. The census data, nineteenth in the series since it was started in 1919, shows livestock numbers have decreased in comparison to the previous census of 2007. The total livestock population in the country comprising cows, buffaloes, sheep, goats, pigs, horses and ponies, mules, donkeys, camels, mithun and yaks was 512.06 million in 2012, which is a decrease of 3.3 per cent over the previous census figure. The livestock sector alone contributes nearly 25.6 per cent of total value of output in the agriculture, fishing and forestry sector. The overall contribution of the livestock sector in India's total GDP was nearly 4.11 per cent at current prices during 2012–13. The census shows another interesting trend. Rural areas are witnessing a decreasing trend in population of all livestock animals, except buffaloes, horses and ponies, mules and poultry. The mule population has increased by a high 46 per cent. In urban areas, populations of all livestock animals, except horses and ponies, have decreased. In rural India, people have only two sources of livelihood: agriculture and animal rearing. A number of studies show that people are leaving agriculture and animal rearing and shifting to the industrial sector. The decrease in livestock is mainly due to decline in number of unproductive male cattle, indigenous breed of cattle, pig and sheep. Exotic breeds of cattle, sheep and pigs have, meanwhile, registered an increase. Female cattle numbers have also increased.

Based on the analysis, the following are the major findings, such as

1. Among the total respondents, 31.50 per cent represent Most Backward Community (MBC), 62 per cent of the respondents belong to Scheduled Caste (SC) and remaining represent Other Castes (OC).
2. 78 per cent of the respondents are purely dependent on agriculture as small and marginal farmers and 22 percent represent landless agricultural labourers.
3. Almost all the respondents are members of the farmers clubs from both villages.
4. Majority of the respondents (58 per cent in Mathiravelur [M] Village 55 per cent from Thandavankulam [T]) have more than three cows for milk production and only 23 per cent (M) and 26 per cent (T) respondents hold two cows and remaining of both villages own only one cow for their livelihood support.

Regarding additional income of that the surveyed households gained due to cow breeding and milk production, more than INR 22,000/per month earning was recorded by 43 per cent (M) and 51 per cent (T) of the respondents while 26 per cent (M) and 33 per cent (T) respondents have an income range between INR 15,000 and 22,000/per month.

1. More than 80 percent of the respondents from both villages have exotic and cross breed milch animals, in order to produce more milk and obtain more income.
2. Almost all the cow breeders are motivated, encouraged and trained with help of farmers' clubs in both villages.

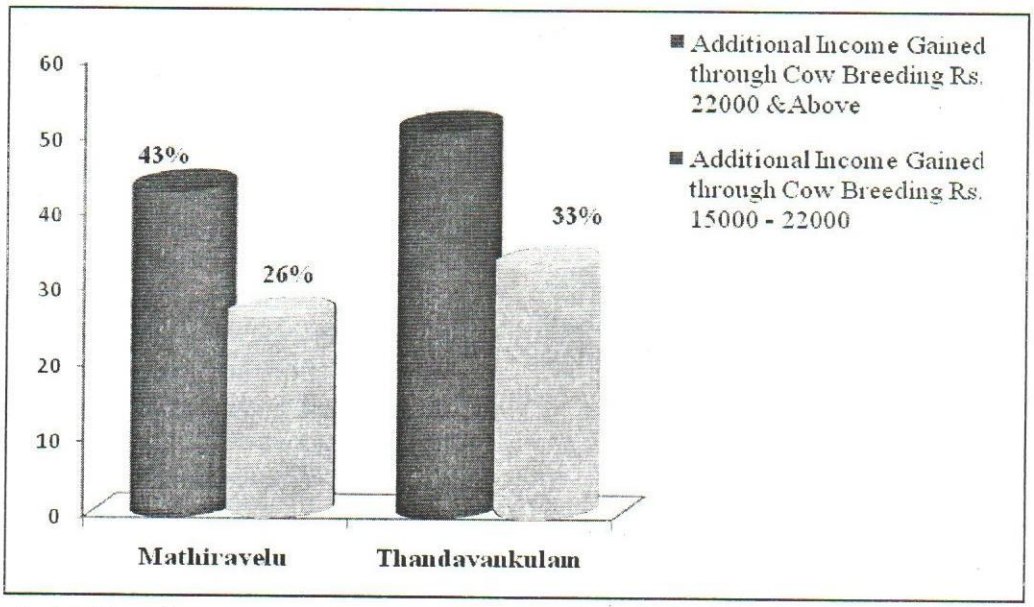


Figure1: Additional Income to Family Gained by the Members of Farmers Clubs through Cow Breeding

3. Majority of the respondents in both villages have appreciated the transparent activities of the farmers' clubs in connection with the modernisation in cow breeding, organisation of veterinary camps and marketing avenues for milk.

4. According to the majority of the respondents, there are employment opportunities gained by the almost all the households of both surveyed villages. Viz., Self employment (48 per cent [M] and 42 per cent [T]), wage employment (40 per cent [M] and 37 per cent [T]) and part-time employment (for remaining respondents from both villages).

7. Suggestions

1. Indigenous cow breeding and milk production should be encouraged.

2. Value added milk products will be required by almost all households of both villages.

3. The other activities like production of dung cake, cow urine collection and deposit may be encouraged and given preference for marketing as these products are useful in curing the diseases which cannot be cured by modern medicines.

4. Generally, village Panchayats should encourage all households to breed cows.

5. Teach and train the farmers and rural women for capacity building in livestock maintenance.

6. All nationalised banks should come forward to prefer promotional activities of livestock development through the extension/outreach activities in their service villages and nearest villages of the service points, with help of NABARD.

7. The industries and corporate sectors should provide financial assistance for livestock development through the schemes of CSR, in order to increase the livestock population and encourage the development and welfare measures of the country, in order to rejuvenate the rural economic development.

8. Conclusion

Livestock play an important role in the rural economy and contribute significantly to livelihoods of rural poor and they support to crop system, particularly organic farming, milk production and meet out the meat requirements of the country. The present analysis has clearly indicated that cattle keepers like cow breeders have economic support to the better livelihoods, but due to various constraints number of cows, especially indigenous cow breeding numbers is below 20 per cent. Hence, it is concluded that there were declension in livestock population in both surveyed villages for the last three decades and practices of crossbreeding of cows increased, to get more and more milk production. However, there are better livelihood opportunities like income generation, employment opportunities and supportive system of farming

communities from both villages. Finally, next to human resources livestock of a country is important resources for sustainable development, so that they should be properly protected and promoted to achieve sustainable environment in future.

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"A Sustainable Agriculture does not deplete soils or people."

– Wendell Berry

Determinants of Major Vegetables' Return on Investment in Telangana State

KAPPA KONDAL

The aim of the present study is to identify the determinants of major vegetables' return on investment (RoI) in Telangana state, India. Primary data have been collected from vegetable growers by using multi-stage random sampling method through structured schedule. Descriptive statistics and multiple natural log linear regressions have been employed. The present study revealed that medium farm size growers have received highest profitsINR 62,700.4 (63.2 per cent to their revenue). It seems that they were only more efficient producers compared to other farm size growers. Among all crops, ridge guard growers have received highest profits INR 81,640.9 (74.3 per cent to their revenue), but beans grower's RoI was highest (227.9 per cent). However, majority (84.5 per cent) of growers have received economies of scale. Profits and marketed surplus have positive and negative significant effect on return on investment respectively and remaining variables are not showing any significant effect but there is association with RoI. 91.2 per cent of the variation in the RoI explained by all independent variables. The hypothesis is rejected. It states that there is a significant effect of profits and marketed surplus on RoI, but marketed surplus is not positive effect in the study area.

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1. Introduction

India is the second largest producer of fruits and vegetables in the world, after China. Fruits and vegetables account roughly 10 and 15 per cent, respectively, in the world production (Sachdeva, 2013). Horticulture sector plays a unique role in the process of economic development by improving the income of the rural and urban people through cultivation of horticulture crops, diversification and nutrition security in India as well as Telangana state. Vegetable sector plays a significant role in horticulture sector. It contributes 58 and 44 per cent of production to total horticulture sector production in India and Telangana state, respectively (Indian Horticulture Database and Commissioner of Horticulture, 2014). Areas under the cultivation and production of fruits and vegetables have been increasing for last two decades. However, area under the cultivation of vegetables and production has recorded highest level followed by fruits crops in India (*Planning Commission Report*, 2011; Kappa Kondal, 2014). Major vegetables are exporting from India to neighbouring countries. Therefore, by exporting quality vegetables, India can earn foreign exchange. Now a days, not only large and medium growers contribute to exports of horticulture but also small and marginal growers. As per Agricultural Census (2010–11), over 87 per cent of total vegetables are grown by small holders. The exports and imports will be depended up on whether the vegetable production excess or not and production depends upon, how growers receive RoI by vegetable cultivation? Keeping this in view, the aim of the present study is to identify the determinants of major vegetables' RoI in the study area.

2. Review of Literature

L. P. Rupasena (1999) found that highest cost was input cost for growing vegetable crops compare to other

agricultural crops. The cost of production was higher for pea followed by cauliflower, tomato and cabbage. However, the cost of tomato for large size growers was higher than small size growers. The average total variable cost of sole tomato per hectare was higher than sole onion and tomato/onion combination. The labour cost was high in total cost. The average rate on return was positive for six crops except sole tomato. It states that the average investment in vegetable sector is highly profitable (Tsoho and Solav, 2012). M. S. Hoq *et al.* (2012) concluded that the per hectare production cost for cowpea, snake gourd and bitter gourd were estimated at TK 73,838, TK 72,029 and TK 1,04,644 respectively and value addition for cowpea, snake gourd and bitter gourd were calculated at TK 86,162, TK 1,52,661 and TK 2,37,356 respectively by farmers. The average marketing cost and value addition increased by supplier were TK 2,906 per ton and TK 3,094, respectively. The highest marketing cost and value addition increased by Kuwait (TK 1,03,499) and UK (TK 55,778), respectively. However, the bitter gourd is more profitable and benefit cost ratio (BCR) is highest (3.23) and UK market is more profitable for vegetables. The total cost of cultivation of vegetable per hectare found INR 11,2954.79 for cauliflower and INR 80,866.50 for potato. The fertiliser was significant variable effecting the yield of potato and chilli (Kumar *et al.*, 2013). The total marketing cost increased for tomato and brinjal growers (Patel *et al.*, 2013). The cauliflower growers received higher net return (Bris Bala *et al.*, 2011). Marginal and small farmers were more benefitted through growing off season vegetables and high return per unit of land (Dharam Paul and Singh, 2013). The carrot and chilli growers received highest and lowest average profits respectively, and also the return were relatively high on carrot vegetable than other vegetables (Jumo Khan Bajkani *et al.*, 2013). Rameez Ahmed Baloch *et al.* (2014) found that the growers did not get benefits from cultivation of onion crop because of inflation, high cost of cultivation, increasing input prices like fertiliser and pesticides prices, not only these problems, other factors were also affected such as irrigation facilities, distance to market, low quality seeds and exploitation of middlemen in the market. However, the marketing costs were higher in unregulated market than in regulated markets (Jain, 1976).

Earlier studies pointed out that the cost of cultivation has been increasing due several reasons, which were discussed above. As per cost of cultivation, growers could able to get RoI or not. In this connection, whether the vegetable growers received RoI as per cost of cultivation or not in study area. The study has taken place, because the agriculture sector is diversifying towards high value commodities such as horticultural crops mainly fruits and vegetables in Telangana state for the last two decades. The aim of the present study is to identify the determinants of major vegetables' RoI in the Telangana state, India.

Specific objectives:

- To examine the cost and returns of major vegetables; and
- To identify the determinants of major vegetables' RoI in the study area.

Hypothesis

- There is no significant effect of marketed surplus and profits on major vegetables' RoI in the study area.

Methodology

Towards the end of the objectives mentioned, the following methodology has been employed.

- Sampling design: For the purpose of the study, Ranga Reddy and Medak districts have selected on the basis of production of vegetables in the year of 2013–14. Samples have been selected by using multi-stage random sampling method through pre-designed schedule among the vegetable growers. At the first stage, two districts i.e., Ranga Reddy and Medak; at the second stage two *mandals* from each district; at the third stage two villages from each *mandal*; and at the fourth stage thirty vegetable growers from each village have taken into consideration. Total 240 vegetable growers were selected randomly.
- Source of data: The primary data have been collected directly from the vegetable growers by administering a pre-designed schedule among the growers.
- Period of study: For the purpose of the present study with regard to primary data, the researcher has been collected the data from vegetable growers in the year 2015 (April to July, 2015).

Tools and techniques of analysis

Simple percentages, descriptive statistics, cross tabs, ratios, return on investment and multiple natural log linear regression model have been employed.

- Farm size: marginal grower (< 1 acre), small grower (1 to 2 acre), medium grower (2 to 3 acre) and large grower (more than 3 acre).

Multiple natural log linear regression

$$\ln Y_i = \beta 0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + + \beta_4 X_{4i} D \ldots \beta_n \ln X_n + U_t$$

Where,

lnY = Dependent variable (Return on Investmetn = RoI)

$\beta 0$ = Intercept

βs are the regression coefficients of independent variables

X1, X2, X3 ... Xn are the independent variables (Profits, yield, marketed surplus, experience, educational status and marketing channel etc.)

D = Dummy variable (ex: Educated=1 and otherwise = 0)

U_t= Error term

Results and analysis

Table 1 shows the farm size wise production cost of vegetables per acre. Production cost plays a vital role in production of vegetables. On an average, the cost of cultivation was INR 5,365.41 per acre. Medium farm size growers' cost of cultivation was very high (INR. 6,809.52) followed by large, small and marginal farm size growers. Large farm size growers' cost of cultivation was high due to heavy grass in the field, for that reason, growers might have been cultivated extra once. On an average, the seeds cost was INR 4,094.62 per acre. Large farm size growers' seed cost was very high (INR 8,761.9) followed by medium, small and marginal farm size growers. Here, marginal and small growers' seed cost was close to the overall production cost and remaining growers expenditure on seeds were very high, because they might have been used hybrid and high yield variety seeds (HYVs) which gives more productivity per acre or hectare. On an average, the fertiliders cost was INR 4,212.54 per acre. Large farm size growers' fertiliser cost was very high (INR 4,716.16) followed by medium, small and marginal farm size growers. Here, marginal, small and medium growers' fertiliser cost was very close to the overall production cost and large growers' expenditure on fertiliser cost was high due to more fertiliser being applied/used to get additional production. On an average, the pesticides cost was INR 5,053.47 per acre. Medium farm size growers' pesticides cost was very high (INR 5,654.75) followed by marginal, small and large farm size growers. Medium farm size growers' cost on pesticides was high due to control of diseases on vegetable crops. On an average, the labour cost was INR 6,945.83 per acre. Within the labour costs, hired labourers' cost was high. Large farm size growers' labour cost was very high (INR 14,400) followed by small, medium and marginal farm size growers. Medium farm size growers' cost on labour was high due to heavy grass cutting and pickup in the field. On an average, the other miscellaneous cost of cultivation was INR 50 per acre. Medium farm size growers' miscellaneous cost was very high (INR 241.2), followed by small and marginal farm size growers. However, the average cost of labourers was high compared to other costs in the overall production cost. Labour cost has been increasing for the agricultural activities for last few couple of year, due to lack of availability of labourers. It has been happening mainly due to implementation of Mahathma Gandhi National Rural Employment Guarantee Schemes (MGNREGS) in rural areas.

Table 1: Farm Size Wise Production Cost of Vegetables per Acre (Values in INR)

Variables	Average of value of different farms' production cost				
	Marginal (N=170)	Small (N=53)	Medium (N=114)	Large (N=3)	Overall production Cost (N=240)
Cost of cultivation	5067.05	5892.45	6809.52	6222.20	5365.41
Cost of seed	3706.11	3982.07	8238.09	8761.90	4094.62
Cost of fertilisers	4156.64	4327.35	4348.80	4716.16	4212.54
Cost of pesticides	5104.11	4779.24	5654.75	4222.20	5053.47
Cost of labour(Hired and Family)	6237.05	8533.96	7942.85	14400	6945.83
Other cost of cultivation	5.88	150.94	214.28	0	50

Source: Primary data.

Table 2: Farm Size Wise Marketing Cost of Vegetables per Acre (Values in INR)

Variables	Average of value of different farms' marketing cost				
	Marginal (N=170)	Small (N=53)	Medium (N=114)	Large (N=3)	Overall Marketing Cost (N=240)
Cost of loading	261.5	362.5	331	240	287.6
Cost of packing	779.2	474.6	498.2	750	695.2
Cost of transport	1293.3	950.0	1044.6	900	1198.1
Cost of market	7.4	4.2	48.2	0	9

Source: Primary data.

Table 2 shows the farm size wise marketing cost of vegetables per acre. Marketing cost also play an important role to extend the area under vegetables. On an average, overall marketing of cost of loading was INR 287.6 per acre. Small farm size growers' loading cost was very high (INR 362.5) followed by medium, marginal and large farm size growers. Here, large and small farm size growers' cost of loading was low and high respectively. It happened due to frequent sale of commodities. While selling, the loading charges apply at different levels to reach the market. On an average, overall marketing cost for packing was INR 695.2 per acre. Marginal farm size growers' packing cost was very high (INR 779.2) followed by large, medium and small farm size growers. It happened due to frequent sale of their commodities and some of the growers receiving packing material from commission agents and wholesalers at free of cost. On an average, overall marketing of cost for transport was INR 1,198.1 per acre. Marginal farm size growers' transport cost was very high (INR.1,293.3) followed by medium, small and large farm size growers. It happened due to frequent sales of small amount of quantity by marginal farm size growers and hence transport cost was very high due to fluctuations of diesel and petrol prices. On an average, overall marketing cost of market was INR 9 per acre. Medium farm size growers' cost of market was very high (INR 48.2) followed by marginal and small farm size growers. Some of the growers had been selling their commodities directly in the Rythu Baazars and other markets at free of cost. However, transport cost was very high compared to other costs of marketing in the study area. On an average, minimum, maximum and average of marketing cost were INR 765, INR. 4,275 and INR 2,190 per acre, respectively.

3. Profit Analysis of Vegetable Crops

Nowadays, the profits are playing a significant role in any activity either in industrial sector and service sector or in agriculture sector. Thus, there are several factors which can influence such as input prices, weather condition, demand and supply, subsidies, middlemen, marketing facilities, government encouragement and socio-economic conditions of the vegetable growers particularly. On the basis of received return on the vegetable crops, the growers will decide, that, which crop is most efficient or profitable venture for their soil/land in the present time and future also. Generally, return depends on the nature of soil and climatic conditions. If these conditions are fulfilled, the grower can extend their cropping pattern under vegetables.

Table 3 shows the descriptive statistics of vegetable growers' profits and loss per acre. Profits are playing an important role in determining the cropping pattern and production of vegetables. Total cost includes cost of

Table 3: Descriptive Statistics of Vegetable Growers' profits and Loss per Acre

(Values in INR)

Variable	Minimum	Maximum	Mean
Total cost	8175.00	83675.00	29039.66
Total revenue	11142.40	696140.00	62833.92
Profit	- 40407	665165.00	33794.25

Source: Primary data.

production and marketing. On an average, total cost and revenue of vegetables were INR 29,039.66 and INR 62,833.92 per acre, respectively. On an average, profit for all vegetable crops was INR 33,794.25 per acre. It reveals that each crop growers have been received on an average of INR 33,794.25 per acre. Therefore, vegetable growers have benefitted by cultivation. Thus, it leads diversification of agriculture crops towards horticultural, especially fruits and vegetable crops. Due to diversification, the growth of area and production of horticultural and other crops have been increasing widely for the last decade. At the same time, in vegetable cultivation, there were losses also, due to rise in input prices such as; seeds, fertilisers, pesticides and fluctuations in prices of vegetable in the state because supply was more from the neighbouring states, so that supply exceeds to the demand, that is why some of growers have incurred loss also. The losses were up to INR 40,407 per acre.

Table 4 shows the farm size wise and average loss and profits of vegetable crops per acre. Out of 240 respondents, 15.4 per cent of the respondents' incurred loss by producing the vegetable crops. i.e., INR 1 to 40,407 per acre, remaining (84.6 per cent) growers have received profits. It states that majority of growers have received above INR 80,000. Within this range, 61.1 per cent of marginal farmers have received more profits compared to small farmers (22.2 per cent) and medium farmers (16.6 per cent). However, the table reveals that small growers have received more profits compared to other farmers by cultivating vegetable crops. All vegetable growers have been received profits as well as incurred loss by cultivation, but economies of scale. On an average INR 13,923.7 incurred loss by small farm size growers, which was higher than overall average of loss followed by marginal and large farm size growers. From medium farm size, nobody incurred any loss by cultivation of vegetables. It reveals that medium farm size growers have received profits only. With respect to average profits, medium farm size growers have received highest average profit (INR 62,700.4) followed by marginal, small and large farm size growers. It reveals that medium farm size growers have received profits higher than overall average of different farm size growers. In the range of INR 1 to 40,407 losses, 72.9 per cent of marginal farmers incurred loss compared to small farmers (24.3 per cent) and large grower (2.7 per cent). Out of 240 respondents, 55.8 per cent of the respondents' profit was between INR 1 to 40,000. Within this range, 69.4 per cent of marginal farmers had received more profits compared to small farmers (22.3 per cent), medium farmers (6.7 per cent) and large farmers (1.4 per cent). Out of 240 respondents, 21.2 per cent of the respondents earned profit between INR 40,001 to 80,000. Within this range, 76.4 per cent of marginal farmers have received more profits compared to small farmers (19.6 per cent) and medium farmers (3.9 per cent). Only 7.5 per cent of the respondents' profit was medium farm size growers have received profits only. It seems that they were only more efficient producers compared to other farm size growers in terms of received profits.

Table 5 shows the crop wise average loss and profits of vegetables per acre. Out of 240 respondents, 15.4 and 84.6 per cent of the respondents incurred loss and received

Table 4: Farm Size Wise and average Loss and Profits of Vegetables Crops per Acre

Farm size	Average loss	Average profit	Loss up to INR 40407	Upto 1 to INR 40000	INR 40001 to 80000	Above INR 80000	Total
Marginal farmer	13262.8	38999.3	27 (72.9)	93(69.4)	39(76.4)	11(61.1)	170
Small farmer	13923.7	33480.4	9(24.3)	30(22.3)	10(19.6)	4(22.2)	53
Medium farmer	***No loss***	62700.4	0(0)	9(6.7)	2(3.9)	3(16.6)	14
Large farmer	2808.5	21242.2	1(2.7)	2(1.4)	0(0)	0(0)	3
			37(100)	134(100)	51(100)	18(100)	240
Total	13141.0	39262.7	37(15.4)	134(55.8)	51(21.2)	18(7.5)	240(100)

Note: Figures in parentheses indicate percentages to total
Source: Primary data.

Table 5: Crop Wise Average Loss and Profits of Vegetables per Acre

Crops	Average loss	Average profit	Loss up to INR 40407	Upto 1 to INR 40000	INR 40001 to 80000	Above INR 80000	Total
Brinjal	7949.5	16779.1	6 (16.2)	15 (11.1)	0 (0)	0 (0)	21
Tomato	21100.1	30223.3	6 (16.2)	47 (35)	15 (29.4)	1 (5.5)	69
Onion	15834.9	60228.4	4 (10.8)	3 (2.2)	3 (5.8)	3 (16.6)	13
Okra (*Bhendi*)	15367.7	30736	5 (13.5)	18 (13.4)	10 (19.6)	0 (0)	33
Ridge Guard	9117	81640.8	5 (13.5)	6 (4.4)	5 (9.8)	9 (50)	25
Green Chilli	11468.7	27180.5	11 (29.7)	33 (24.6)	10 (19.6)	0 (0)	54
Beans	***No loss***	64413.4	0 (0)	12 (8.9)	8 (15.6)	5 (27.7)	25
			37 (100)	134 (100)	51 (100)	18(100)	240
Total	13141	39262.7	37 (15.4)	134 (55.8)	51(21.2)	18 (7.5)	240 (100)

Note: *Figures in parentheses indicate percentages to the total.*
Source: Primary data.

profits by producing the vegetable crops, respectively. With respect to average incurred loss, on an average tomato grower incurred highest losses (INR 21,100.1) followed by onion, okra, green chilli, ridge guard and brinjal growers. Beans grower did not get any loss by vegetable cultivation. It reveals that beans growers earned profits only. With respect to average profits, ridge guard growers' received highest average profit was INR 81,640.8 per acre followed by beans, onion, okra, tomato, green chilli and brinjal growers. It reveals that ridge guard, beans and onion growers earned profits higher than overall average of different crops. Out of 240 respondents, 15.4 per cent of respondents incurred loss up to INR 40,407 per acre. Within this group, green chilli growers incurred highest losses (29.7 per cent) followed by brinjal, tomato, okra and ridge guard and onion growers. Out of 240 respondents, 55.8 per cent of respondents earned profit between INR 1 to 40,000. Within this group, the tomato growers received most profits (35 per cent) followed by green chilli, okra, brinjal, beans, rigde guard and onion growers. Out of 240 respondents, 21.2 per cent of respondents earned profit between INR 40,000 to 80,000. Within this group, tomato growers earned highest profit (29.4 per cent) followed by green chilli, okra, beans, ridge guard and onion growers. Out of 240 respondents, 7.5 per cent of respondents earned profit above INR 80,000. Within this group, ridge guard growers earned most profits (50 per cent) followed by beans, onion and tomato growers. The table reveals the beans growers having received profits higher than INR 80,000 per acre. The brinjal growers were not able to get more profits because they were only able to get up to INR 40,000 per acre. And also okra and green chilli growers were not able to receive more than INR 80,000 in profits per acre. Moreover, the beans growers have received more profits compared to other crop growers, because beans might have been in good demand in the market during the study period.

Table 6 shows the crop wise average profits of vegetable per acre. Beans growers received highest profit (INR 64,413.4) followed by ridge guard, onion, tomato, okra, green chilli and brinjal growers per acre. However, the beans, ridge guard and onion growers received more profits compared to overall average of all crops. The beans and ridge guard growers received more than 2/3 profits (69.5 and 68.4 per cent) from their total average revenue per acre. Brinjal growers received very low profits compared to farmers cultivating other crops profits. Thus, due to lack of sufficient demand, more supply in the markets and highest cost of cultivation growers could not able to get more than INR 40,000 profits per acre.

Table 7 shows the farm size wise average profits of vegetables per acre. Medium farm size growers received highest profits INR 62,700.4 (63.2 per cent to their revenue) by cultivating different types of vegetable crops followed by marginal, small and large farm size growers per acre. However, medium and marginal farm size growers' profits to as percentage of revenue were higher than overall

Table 6: Crop Wise Average Profits of Vegetables per Acre

Crops		Average		
	Sample (N)	Revenue	Cost	Profit
Brinjal	21	36423.8	26710	9713.8 (26.6)
Tomato	69	63882.8	29042.7	34840.1 (54.5)
Onion	13	69628.1	32803.8	36824.3 (52.8)
Okra (*Bhendi*)	33	50707.7	26957.1	23750.6 (46.8)
Ridge Gurad	25	92798	29308.8	63489.2 (68.4)
Green Chilli	54	49851.8	30544.2	19307.5 (38.7)
Beans	25	92674	28260.6	64413.4 (69.5)
Grand Total	240	62833.9	27905.6	34928.2 (55.5)

Note: *Figures in parentheses indicate percentages to the average revenue.*
Source: Primary data.

Table 7: Farm Size Wise Average Profits of Vegetables per Acre

Farm size	Sample (N)	Revenue	Cost	Profit
Marginal farmer	170	58594.8	27895.9	30698.9 (52.4)
Small farmer	53	55331.6	29900.9	25430.7 (46)
Medium farmer	14	99259.5	36559.0	62700.4 (63.2)
Large farmer	3	56771.2	43545.8	13225.4 (23.3)
Total	240	60223.5	29039.7	31183.8 (51.8)

Note: Figures in parentheses indicate percentages to the average revenue.
Source: Primary data.

Table 8: Farm Wise Average Return on Investment (RoI) of Vegetables per Acre

Farm size	RoI for 203 samples		RoI for 240 samples	
	Sample (N)	RoI (Values in %)	Sample (N)	RoI (Values in %)
Marginal farmer	143	149.2	170	110
Small farmer	44	125	53	85
Medium farmer	14	171.5	14	171.5
Large farmer	2	47.7	3	30.4
Total	203	144.5	240	107.4

Source: Primary data.

average of different kinds of farms (51.8 per cent). Therefore, large farm size growers received lowest profits compared to all other farm size growers.

Table 8 shows the farm size wise average return on investment of vegetables per acre. With respect to 203 growers, who gained profits by cultivating different types of vegetables, medium farm size growers received highest

Table 9: Crop Wise Average Return on Investment (RoI) of Vegetables per Acre

Crops	RoI for 203 samples		RoI for 240 samples	
	Sample (N)	RoI(Values in %)	Sample (N)	RoI (Values in %)
Brinjal	15	66.6	21	36.37
Tomato	63	111.0	69	119.96
Onion	9	224.4	13	112.26
Okra (*Bhendi*)	28	122.3	33	88.11
Ridge Gurad	20	288.4	25	216.62
Green Chilli	43	97.0	54	63.21
Beans	25	227.9	25	227.93
Total	203	144.5	240	125.17

Source: Primary data.

(171.5 per cent) return on investment of vegetables followed by marginal, small and large farm size growers. Therefore, on an overall average, of return on investment was (144.5 per cent) lower than medium farm size growers. The study found that, as medium farm size growers received highest return on investment because of they did not incur any loss. Marginal farm size growers received more than overall average of all farm sizes' return on investment.

Table 9 shows the crop wise average return on investment of vegetables per acre. It is found that beans grower's return on investment was highest (227.9 per cent) followed by ridge guard, tomato, onion, okra, green chilli and brinjal growers. However, beans growers received highest RoI compared to overall average return of investment of all crops per acre. Brinjal growers received lowest RoI, due to low profits and high cost of cultivation and attack of pests diseases in the study area.

4. Determinants of Major Vegetables' RoI

RoI play a vital role in every farm becoming financially sound and stable. It is the measure which is widely used for measuring the efficiency and effectiveness of performance of farms. It gives a good picture of how efficient a farm is in using its investment on farm to generate profits. Thus, before sowing the seeds of vegetables, growers normally make sure that farm has ability to produce profits in the short run only because vegetable commodities are perishable in nature. There are some important variables which can influence the RoI. Such as area, productivity, profits, education, gender, marketed surplus, distance, experience and market channels etc. Due to multi-co-linearity problem, few important variables have been considered in the natural log linear regression model.

Table 10 shows the determinants of RoI of vegetable growers per acre. The study reveals that the value of constant found to be negative (-5.783). It states that growers have to incur minimum loss due to high amount of money spent on fertilisers, pesticides, labour, transport costs, fluctuation in prices per quintal in the market, lack of minimum support price (MSP) and more supply from neighbouring states. Profits per acre and marketed surplus have positive and negative significant effect on return on investment respectively, and remaining variables are not showing any significant effect but there is association with RoI. The coefficient of profits per acre is 1.066. It indicates that 1 per cent change in profits, there will be 1.066 per cent increase in RoI. The coefficient of marketed surplus is (-.071). It indicates that 1 per cent increase in marketed surplus leads to decrease of 0.071 per cent in RoI as due to heavy supply from the neighbouring states, growers sold their commodities at lowest rate and if they did not receive their cost of transport, some time they might have even given their commodities free of cost as well. The coefficient of yield is (-.091). It indicates that for 1 per cent increase in yield of vegetable crops, there will be decrease (.091 per cent) in RoI. There is an inverse relationship between yield and RoI. It happened due to high cost of fertiliser, pesticides and labour cost. In order to increase the yield of vegetables, the RoI decreased. There is a positive relationship between educational status,

Table 10: Determinants of RoI of Vegetable Growers Per Acre

Variables	Coefficient	t-statistic
Constant	-5.783** (.239)	-24.209
Profit (Per Acre)	1.066** (.028)	37.453
Yield	-.091 ^{NS}(.072)	-1.263
Marketed surplus	-.071*(.033)	-2.142
Educational status (dummy)	.034 ^{NS}(.048)	.716
Experience (in years)	.025^{NS}(.028)	.890
Marketing channel (dummy)	.042^{NS}(.035)	1.224
R^2= 0.915 DW Statistics = 1.948	Adjusted R^2= 0.912 (N=203)	

Note: ** and * *significant at the 0.01 and 0.05 level.*
Figures in parentheses indicate standard error of the coefficient.
Source: Primary data.

experience and marketing channel of vegetable growers. The coefficient of educational status is .034. It seems that there is a difference between educated and illiterate growers' RoI. Educated growers have received more RoI compared to uneducated growers. The coefficient of experience is (0.025). It means for 1 per cent increase in experience of the growers, there will be increase (0.025 per cent) in RoI of vegetable crops. The coefficient of marketing channel is 0.042. It seems that there is a difference between producer to consumer channel and producers to commission agent to retailer to consumer channels' RoI. It states that those who sold their commodities directly i.e., producer to consumer, benefitted.

The adjusted R^2 value is 0.912. It reveals that the model is a best fit and all the explanatory variables collectively explained about 91.2 per cent of the variation in the explained variables (RoI), keeping all other variables constant in the study area. Remaining percentage of variation is explained by other variables which are not included in the model. The hypothesis is rejected. It states that there is a significant effect of profits on RoI, but marketed surplus a significant but not positive effect in the study area.

5. Conclusion and Suggestions

The study concluded that the average cost of labourers was high compared to other costs in the overall production cost and large farm size growers' labour cost was higher than other farm sizes, due to lack of availability of labourers and implementation of MGNREGS in rural areas. 78.3 per cent of respondents' production cost was less than INR 30,000 per acre, and onion growers have spent highest average (INR 30450) of production cost per acre. On an average, overall marketing of cost of loading was INR 287.6 per acre. Small farm size growers' loading and transport cost was very high (INR 362.5 and INR 1,293.3, respectively). It happened due to frequent sale of small amount of quantity by marginal farm size growers. The transport cost was very high also due to fluctuations of diesel and petrol prices. The marginal farm size growers had the highest (2341.58 per cent) average marketing cost on vegetables and majority (59.5 per cent) of growers' marketing cost was more than INR 2,000 per acre. Among all vegetable growers, green chilli growers incurred the highest average (INR 2,862.5) marketing cost per acre which was higher than overall average marketing cost (INR 2,190) per acre. On an average, total cost and revenue of vegetables were INR 29,039.66 and INR 62,833.92 per acre, respectively. On an average, profit for all vegetable crops was INR 33,794.25 per acre. Out of 240 respondents, 84.6 per cent of growers received profits while the remaining 15.4 per cent of the respondents incurred loss by cultivating vegetable crops. i.e., INR 1 to 40,407 per acre. However, medium farm size growers have received profits higher than overall average of different farm size growers. Almost all, vegetable growers received profits as well as incurred loss by cultivating vegetables, but beans growers did not incur loss and instead received highest profit (INR

64,413.4) followed by other crops per acre. Medium farm size growers received profits only. It seems that they were the more efficient producers compared to other farm size growers in terms of received profits. In addition to that, ridge guard growers received highest profits INR 81,640.9 (74.3 per cent to their revenue). Marginal growers incurred highest losses INR 13,262.8 (55.3 per cent to their revenue) by cultivating different types of vegetable crops. With regard to RoI, it is found that beans growers' RoI was highest (227.9 per cent). Brinjal growers received lowest RoI due to low profits and high cost of cultivation and subsequently attack of pest on the crop during the study area. The regression analysis revealed that the value of constant found to be negative. It states that minimum amount of loss when incurred by growers were due to high amount of money spent on fertilisers, pesticides, labour, transport costs, fluctuation in prices per quintal in the market, lack of minimum support price (MSP) and more supply from neighbouring states. Profits per acre and marketed surplus have positive and negative significant effect on return on investment respectively, and remaining variables are not showing any significant effect but there is association with RoI. All explanatory variables collectively explained about 91.2 per cent of the variation in the explained variable (RoI), keeping all other variables constant in the study area. The hypothesis is rejected. It states that there is a significant effect of profits and marketed surplus on RoI, but marketed surplus is not showing positive effect in the study area. The study suggests that the government should implement the MGNREGA Scheme in crop lean season. In order to reduce the transport cost, the government should also introduce transport vehicles to collect the goods from farm gates. In order to reduce the cost of inputs such as mainly fertiliser and pesticides, the government should take initiative to give more subsidies on seeds, fertilisers, pesticides and electronic goods to reduce the burden of the growers. It will help increase the yield and profits of the growers. In order to increase the welfare of the growers, the government should also provide MSP to stabilise the prices of vegetables.

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"We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect. "

– Aldo Leopold

Feature

Role of Indian Cement Sector towards Sustainable Development

ARUN KUMAR VISHWAKARMA, SHIRISH SANGLE AND ARVIND K. NEMA

Infrastructure development is the basic requirement for any developing country like India. Huge investments are being made towards infrastructural development. However, the abrupt use of natural resources has resulted in damage to the environment in the form of greenhouse-gas emission, specifically carbon dioxide. Cement sector is a major contributor towards greenhouse-gas emission. These environmental issues must be addressed so that the development can be considered sustainable. Corporate environmental strategies play a key role in defining the approach of an industry towards environmental protection by way of waste reduction and pollution prevention. Adoption of proactive environmental strategies by the cement sector has resulted in sustainable development without causing damage to the natural environment. Several companies have made a distinguished place in the industry by way of proactive adoption of environmental strategies. Sustainable development is the only way, which can help in overall development at present without depleting natural resources for the future.

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1. Background

Concrete is considered to be the second most consumed material after water. Cement is the key ingredient for the production of concrete. Use of cement is essential for the infrastructure development. Due to abundant availability of the main raw material i.e. limestone throughout the world, cement is produced globally. More infrastructure development requires more cement, with more production of cement comes to the issue of emissions causing pollution.

Recent changes and developments on the environmental protection front have created a confrontation between the environmentalists and the cement sector. The emissions from the cement sector include kiln dust, hazardous air pollutants, CO2, NOx, and SOx. The cement industry is considered to be one of the greatest emitters of NOx (Gebhardt, 1997). Cement industry has become a major emitter of CO2 due to dominant use of carbon-based fuels like coal. Apart from the burning of fossil fuels, a clinker-making process during calcination also results in CO2 emission. As a result of combined CO2 emission from these two stages, the cement sector contributes around 8 percent of the global CO2 emissions (Wilson, 1993). Due to concern towards global warming people's attention has been drawn towards emission from the cement sector. The cement industry consumes around 2 percent of the global primary energy consumption or around 5 percent of the total global industrial energy consumption (World Energy Council, 1995), this represents a highly energy-intensive process. Indian cement industry started its journey in 1914 with only one plant having a production capacity of 1000 tonnes per annum at Porbunder in Gujarat. It has travelled a long way by emerging as the second largest cement producer

in the world. At present, there are 81 cement companies with around 206 major cement plants and a total capacity of about 350 million tonnes.

It has been observed that over the last few decades, those environmental issues have been given a prominent attention. The emissions from the cement industry have caused serious concern amongst the external and internal stakeholders. The local community has been on a collision course with industry for the pollution and waste generation. These groups, which oppose the pollution from the cement industry, can cause disruption in the production process resulting in huge financial losses. The use of water for the manufacturing process has also been a cause of concern along with damage to the local vegetation.

Cement industry has to deal with environmentalists, regulatory authorities, media, judiciary, NGOs, shareholders etc. along with local communities who can act as a threat to its production process resulting in loss of production and huge financial losses. Not only the public concern is towards dust on surrounding land around the plant but also even the urban areas have specifically drawn their attention to solid particle emission (Schobesberger et al. 2013). Considering these concerns, cement sector has taken a proactive decision to adopt environmental strategies and apply management tools to reduce emissions, thus addressing environmental, legal and social issues, keeping a view on market benefits. Sincere efforts have been made by the cement industry to not only prevent the pollution by reducing the emission but also to reduce usage of water by way of adoption dry manufacturing process. Transparent reporting by way of environmental auditing has become the trend. The cement companies declare their achievement through the corporate sustainability reports, which are published annually. Corporate Social Responsibility (CSR) has also become a major trend along with sustainable development. Afforestation activities taken up by the cement industry has reduced the opposition of the local communities. Employment generation along with availability of infrastructure for education and health has gained the confidence of local community. The cement industry is basically considered to be an industry which is the source of pollution. The persistent watch by the regulatory authority and its power to cause disruption in terms of stoppage of production and disconnection of water and electricity has forced the cement industry to not only comply with the regulations but to think beyond regulations by way of being proactive in adoption of environmental strategies. The energy intensity of cement industry was around 125 kWh/tonne of cement produced few decades ago, it has been brought down to around 68-70 kWh/tonne of cement, which is considered at par with the best among global cement industry. The cement industry has come a long way in terms of thermal energy consumption which also is amongst the best globally at around 680 kcal/kg clinker. The biggest problem faced by the cement industry is the availability of quality coal at a competitive price. The Indian coal has a very high ash content and has low calorific value as compared to imported coal. The high cost of imported coal prevents the cement industry from using the imported coal, which has less ash content and high calorific value. Use of alternative fuels has been encouraged in place of fossil fuels. Discarded tyres, paint residues, municipal waste, waste oils, non-recyclable plastics, textiles and paper residues, effluent treatment sludge from water and wastewater treatments plants etc. have found a place among the alternatives to the fossil fuels. The alternate fuel usage not only is a lever for CO2 reduction bur has a high potential for the Indian cement industry to reduce its carbon footprint. Use of state of the art technology by modern cement plants has created a very competitive scenario amongst the cement manufacturers. The use of pre-heating of a raw meal before calcination and use of vertical ball mills and roll presses for grinding has been adopted widely due to better results and better efficiency. Several alternatives are being worked out to reduce the clinker ratio. Usage of discarded concrete as a clinker replacement is also in the pipeline. However, market acceptance of such products is still a cause for concern. Other options available for clinker replacement are fly ash, ground blast furnace slag and other blending materials like Lead-Zinc slag, copper slag, Jarosite, Kimberlite, and marble slurry some other materials which can be used as clinker substitute. However, their availability at an affordable price has to be kept in consideration. Some other technologies which are available for reducing the CO2 emissions are, an addition of mineralizers to the raw material entering the kiln has the potential to reduce the kiln temperature by 50°C without any loss of quality in clinker production resulting if consumption of fuel and subsequent reduction of CO2 emission. Other technology available raw material replacement by way of use of Magnesium Oxide in place of limestone. Carbon capture and storage though in its nascent stage is considered as a potential CO2 reducing technology. The high cost involved and lack of specific guidelines from the

government has prevented this technology for major penetration into the cement sector.

2. Literature Review

According to Mintzberg (1989), "a pattern in action over time" represents corporate environmental strategy, which is intended for managing the interface between business and the natural environment. The environmental strategy can be classified into two groups: reactive and proactive (Aragón-Correa & Sharma, 2003; Hart, 1995; Russo & Fouts, 1997). A reactive environmental strategy is adopted to comply with the legal requirements, where firms depend on pollution control through an "end of pipe" approach, in order to resist the enactment and enforcement of environmental legislation (Hart, 1995). Proactive environment strategy is adopted beyond compliance through a systematic focus on pollution prevention, source reduction and process innovation (Hart, 1995). According to Sharma (2000), a reactive pollution control strategy involves "end-of-pipe" investments in available developed technologies and "does not require the firm to develop expertise or skills in managing new technologies or processes" (Russo & Fouts, 1997). However, a proactive pollution prevention strategy requires the "acquisition and installation of new technologies" (Russo & Fouts, 1997) involving higher order learning to lead to the development of valuable competent capabilities (Russo & Fouts, 1997; Sharma & Vredenberg, 1998). Production and service delivery processes need to be redesigned for implementing a proactive environmental strategy. Hart (1995) have mentioned four different types of resource-based environmental approaches:

- The end-of-the-pipe approach
- Pollution prevention
- Product stewardship
- Sustainable development

Out of these, the end-of-the-pipe approach is a reactive environmental strategy whereas pollution prevention, product stewardship, and sustainable development form proactive environmental strategy (Hart, 1995; Russo & Fouts, 1997). Additional technical installation is required under end-of-pipe protection for the control of emissions, for e.g. electrostatic precipitators are installed for controlling dust during the cement manufacturing process. These installations are not part of standard manufacturing process or can be identified as an addition to manufacturing process (OECD, 1997). In this case, compliance is primarily achieved through additional device installation for pollution removal or filtration with the existing system without any requirement of any new technology or change in production process. Such device installation does not cause any change in manufacturing process (Groenwegen & Vergragt, 1991; Kemp, 1993). According to Pollution Prevention Act, 1990, pollution prevention is defined as source reduction along with practice, which results in reduction or elimination of creation of pollutants. Product stewardship may be defined as a cradle to grave approach where one who designs, manufactures, markets or uses a product takes the responsibility of minimizing its environmental impact (Keolean & Menerey, 1993). The scope of this responsibility covers the products life cycle right from selection of raw materials to the disposal of the finished goods (The Northern Product Stewardship Council, 2001). Product stewardship involves integration of external stakeholders' opinion in the design and development processes (Allenby, 1991; Fiksel, 1993). It involves some form of life-cycle-assessment (LCA) (Davis, 1993). Green firm and sustainable firm are different. A green firm concentrates on preservation of ecological components like air, water and natural environment, on the other hand sustainable development involves economic, social and environmental components of corporate policies. World Commission on Environment and Development (the BrundHand Commission, 1987) defines sustainable development as "the capacity to meet the needs of the present without compromising the ability of future generations to meet their own needs".

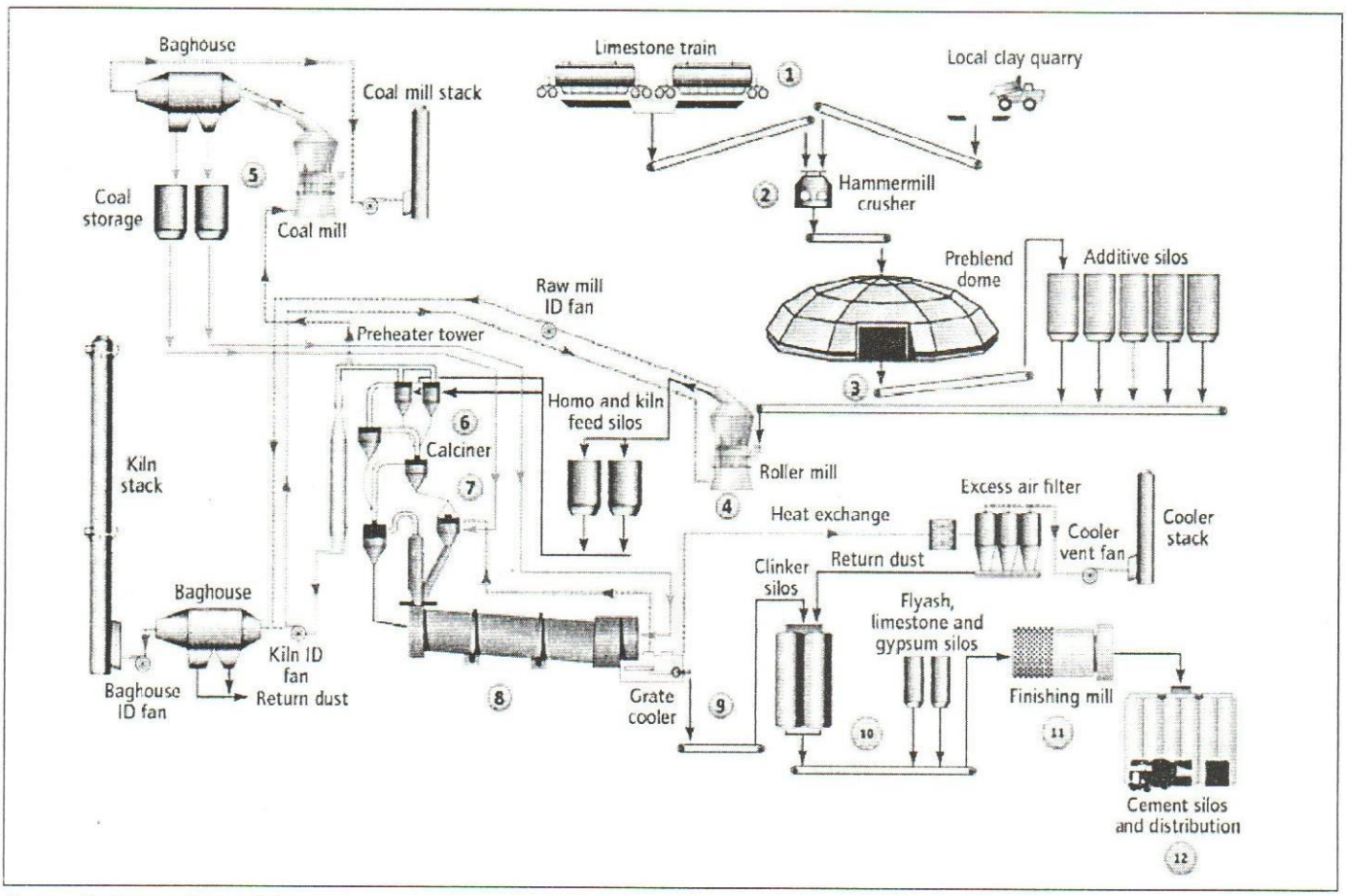
Sustainable development involves technology integration with legislation and business for the development of infrastructure, human resources and creating competition (Schmidheiny, 1992).

Legal regulation, stakeholder pressure, economic opportunity and ethical motives have been mentioned as four drivers of corporate environmental strategy (Bansal and Roth, 2000). Earlier literature also mentions that company's stakeholder creates environmental pressure. Henriques and Sadorsky (1999) have identified four key stakeholders: regulatory stakeholder, organizational stakeholders, community stakeholders and the media. It has been observed that the influence of regulatory bodies and local communities along with media has a major influence on the implementation of environmental strategies. Stakeholders can be internal or external. Internal

stakeholders comprise shareholders, employees, and management while external stakeholders involve regulatory authorities, media, a local community along with contractors and raw material suppliers (Henriques & Sardorsky, 1999; Mitchell et al, 1997).

3. Cement Manufacturing Process (World Business Council for Sustainable Development, 2013)

Cement is the essential binding component in concrete, which is the fundamental building construction material required for the infrastructure development globally. Cement production depends on the type of process used either wet or dry. The process can be wet or dry depending on the water content of the raw material. As more energy is required for evaporating the water in the slurry before heating the raw materials to the desired temperature for the calcination, the wet process is more energy intensive than dry process. The cement manufacturing process is a combination of complex stages requiring specialized equipment. Every step in the manufacturing process requires energy input leading to CO2 and other greenhouse gases emission. Thus energy efficiency plays a very important role in reducing energy consumption and emissions at every step of the process.



Source: HeidelbergCement Group.

Figure 1: Cement manufacturing process.

The cement manufacturing process involves the following steps (please refer figure 1):

1. Mining/quarrying of raw materials

Calcareous materials like limestone and chalk are naturally occurring and are required to be mined. A considerable amount of energy is consumed in mining; the energy required is reduced by locating cement plants near to the source of raw materials.

2. Crushing

The raw materials after being transported to the plant are crushed through primary/secondary crushers breaking them into approximately 10 centimetres size.

3. & 4. Pre-homogenisation and raw meal grinding

Different raw materials are mixed in the required proportions to get the desired chemical composition for the given 'batch' of cement. Small quantities of other components like as iron ore, bauxite, shale, clay or sand are required to provide additional iron oxide (Fe2O3), alumina (Al2O3) and silica (SiO2) to adopt the chemical composition of the raw mix to the process and product requirements of cement manufacturing. 'Raw meal' is produced by milling of the crushed material. Careful monitoring of raw meal is done to ensure the quality of the cement.

5. Coal grinding/kiln fuel preparation

Coal is pulverised for efficient combustion when it is fed to the kiln as a fuel for generating the required temperature for the calcination.

6. Preheating

The efficiency can be improved by preheating the raw meal before feeding it to the kiln in order to ensure faster chemical reactions. Pre-heater involves multiple vertical cyclones, which heats the raw meal by passing hot air moving in opposite direction. This hot air is the exhaust from the kiln, thus waste heat recovery is done and energy required is reduced. The stages of cyclones depend upon the moisture content of the raw meal.

7. Pre-calcination

Decomposition of limestone is carried out through the process of calcination requiring heat energy and stimulation at two stages in the process: within the pre-calciner situated above the kiln and inside the kiln. This is the first stage for the start of emission production. 60 percent to 65 percent of the total emissions are produced due to chemical decomposition of the limestone. The combustion of fuel required to generate heat for the pre-calcination process also produces emissions, which is approximately 65 percent of the balance total emissions. Thus, majority of the emission is generated at the calcination process.

8. Clinker production in the rotary kiln

A high heat at 14500C in the kiln heats the pre-calcined raw meal resulting in physical and chemical reactions melting the meal partially in the form of clinker.

9. Cooling and storing

Hot clinker coming out from the kiln drops on the grate cooler and is subsequently cooled by the incoming combustion air, resulting in energy loss minimization. The clinker is stored between kiln and blending and/or grinding unit.

10. Blending

Blending is done to reduce them by adding slag, fly ash or other minerals to minimize the clinker requirement for the cement. The resultant product is called as blended cement. Further. 4-5 percent gypsum is added to all types of cement to control the setting time.

11. Grinding

The cooled clinker along with the blended materials is grinded into a very fine powder which is normally grey in colour. This powder is universally known as Ordinary Portland Cement (OPC) or the blended cement. Traditionally ball mills were used in cement plants for grinding which consumed a lot of energy. Nowadays, more energy efficient roller presses and vertical mills replace it.

12. Storage

The end, i.e. the cement, is stored in cement silos from where it can be despatched to packaging station.

4. CO2 reduction levers in cement production

The majority of the cement producers is adopting dry process manufacturing. The cement industry has adopted latest technologies for conservation of energy and pollution control along with highly advanced automation systems. However, effective use of waste heat recovery for power and heat co-generation, use of alternative fuel and raw and efforts to reduce nitrogen oxide emissions is still at the nascent stage. In India, the demand of highly developed technologies for emission reduction is not as high as compared to other developed countries.

The most commonly used fuel in India is coal as it is easily available and cheap. The quality of Indian coal is a cause of concern due to its lower calorific value of 4400 kcal/kg as compared to 6162 kcal/kg of the coal available in Europe. In spite of this, the Indian cement industry has been able to reduce total CO2 emissions to 0.719 tCO2/t cement in 2010 from 1.12 tCO2/t cement in 1996.

There are five key levers, which can contribute to emissions reduction:

- Alternative fuel and raw materials (AFR)
- Thermal and electrical energy efficiency
- Clinker substitution
- Waste heat recovery (WHR)
- Newer technologies

4.1 Alternative fuel and raw materials

In India, the use of AFR is reported to be only 0.6 percent of thermal energy compared to global average of 4 percent. Industrial, municipal and agricultural wastes can be effectively used as alternative fuels. However, the absence of a policy to support incineration of waste, both hazardous and combustible and lower public acceptance makes it difficult for the cement industry to use waste as alternative fuels. Use of discarded tyres is gaining popularity as an alternative fuel globally. Further, the cost involved towards transportation also acts as a hindrance to this practice adoption. Still, the cement industry is hopeful that with continuous efforts they can achieve best waste utilization practices adopted globally.

4.2 Thermal and electrical energy efficiency

Some highly efficient cement plants in India have achieved the levels of specific energy consumption, 680 kcal/kg clinker and 66 kWh/t cement which is comparable to best in the world. Significant modifications have been carried out in older plants by way of retrofitting with new technologies; however, specific prioritization towards specific energy reduction is expected at par with best achieved internationally. It may be noted that the Indian cement is ground to a lower fineness than the others in the world are.

4.3 Clinker substitution

Use of carbon-based materials should be minimized in order to reduce the pollution. The waste from the other industries must be utilized as a raw material so that effective waste utilization can be achieved. Waste from thermal power plants i.e. fly ash and from steel plants, i.e. slag is being used in blending thereby substituting the clinker usage. Production of blended cement has increased to 76 percent as compared to only 37 percent, 15 years ago.

4.4 Waste heat recovery

The adoption of waste-heat-recovery system in cement industry is relatively slow as compared to other countries. Very few plants have installed waste heat recovery system. High initial cost is preventing the manufacturers in adopting the waste-heat-recovery system.

4.5 Newer technologies

Newer technologies in terms of carbon capture and storage and low carbon cement production are in the pipeline and will take some to be commercially available. Many cement companies at the international level are focussing their efforts towards production low-carbon or carbon-negative cement. Calix, Celitement and Novacem are some of the alternative cements, which are being tried at a small scale, and it is expected that they will be available commercially over a period of time.

5. Discussion

India is the second largest producer of cement in the world. The cement industry plays a vital role in the country's economy by providing employment to more than a million people. Huge investments both from the Indian as well as foreign investors have been attracted after deregulation of cement industry in 1982. Heavy investment in the infrastructure development is going to benefit the cement industry in a large way. Development of smart cities is going to provide a big opportunity for the cement industry. The current annual production of cement is approximately 350 million tonnes. Cement industry has been the target of various stakeholders for the emissions emanating as a result of production process. The damage to environment by way of mining, waste generation and emission of CO2 and fierce protest from the stakeholders has forced the cement industry to have an environment friendly approach at the production process. Several environmental strategies have been adopted to ensure minimum damage to the environment. The role of both internal and external stakeholders have created a totally changed scenario in the environmental front. The companies have started becoming proactive towards environment. The adoption of proactive environmental strategies has resulted in brand differentiation, increased efficiency, reduced emissions, effective waste management and relief from disruption in production process resulting in a long-term profit for the industry. The Indian cement Industry has reached a stage where it can compete with high global standards. The

transparent environmental reporting have made the competitors to follow the suit and report their environmental compliance similarly. The Indian cement industry has set very competitive environmental goals for themselves. Sustainable development is the primary concern of the government. Several cement manufacturers have implemented waste heat recovery system along with reduction in clinker ratio. Today blended cement has captured a large market in India. The waste from one industry has become the raw material for the other. This way the industries are not only able to effectively utilise the waste from the power and steel industry but are playing a key role in pollution prevention. Rapid growth of the cement industry has brought many global manufacturers to India. They have introduced the latest technologies and environmental policies resulting high efficiency and reduced emissions. The competitive nature of cement industry has forced the non-believers of environmental policies to rethink their approach. A possible loss in profit due to market rejection of the product has compelled the majority of the companies to adopt the environmental strategies by committing to protect the environment by way of sustainable development. However, there is still some hindrances in acceptance of lower carbon footprint products in the society like cement made from recycled concrete. The mind-set of the society has to be changed so that the manufacturing of products with low carbon footprints is encouraged. Encouragement from the government in term of policy incentives are also expected. Some companies have adopted the proactive environmental strategies, which are beyond the regulatory requirement. This healthy competition will ensure an overall development of the nation. The cement industry has come a long way in terms of CO2 emitting sector to highly proactive environmental strategy adopting sector. Several big plants are decades old. However, these plants are being retrofitted with new technologies, not only to increase efficiency but also to reduce emissions largely. Several new players have come in the field who have adopted the latest technologies and have gained over their competitors. As compared to European cement, the quality of Indian cement is considered lesser as Indian cement is grinded less finely than the European cement. This factor has to be considered in terms of evaluating electrical energy intensity. Finer grinding will lead to more power consumption, which will lead to more electrical energy intensity. As compared to other sectors, Indian cement sector has emerged as a keen adopter of proactive environmental strategies thus reflecting a responsible attitude towards sustainable development. It has been observed that with increased cement demand for the infrastructure development the cement sector has to struggle to keep the emissions under control along with fulfilling the demand. High investments are being made to ensure better regulatory compliance along with increased production. Entry of foreign players and acquisition of smaller plants by major cement producers have ensured uniform adoption of environmental policies for sustainable development. There is a paradigm shift of the society towards the cement industry. Once a highly pollution oriented industry is considered as an essential component for the infrastructure development keeping sustainable development in focus. India has committed to the world to reduce the emissions at a very promising level. Indian has to ensure that it has to take drastic steps to minimise the emissions without compromising the demand for infrastructure development. India is one of the fastest growing economies in the world, which has taken responsibility of reducing the emissions from its industries along with development of infrastructure for the comfortable living for its billion-plus population. Thus, sustainable development is the only path which can not only address the concern of the environmentalists towards the environment but also can fulfil the demand of the infrastructure development and lead the nation towards an era of overall development.

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"Our twenty-first century economy may focus on agriculture, not information."

– James-Howard Kunstler

Feature

Human Development and Economic Growth in Kerala: Sustainability Issues

MANJU S. NAIR

Historically, the state of Kerala has followed a human development lopsided development pattern evidenced by high human development index (HDI) despite low growth rates.For the last two decades, along with high HDI the state experienced high growth in NSDP; the sustainability of this phenomenon (i.e., a movement towards virtuous cycle) depending upon the strength of the causal chain from human development to economic growth and vice versa.The paper attempts at exploring these chains and argues for a complementary approach of strengthening the links between economic growth and human development through successful policies aimed at larger allocation to public services (such as education, health care, nutritional support and environmental protection) and much more comprehensive programmes of economic equity and social security along with development of the physical and social infrastructure.

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1. Introduction

The annals of Kerala's history replete with uniqueness in achievements in social development (human development) have evoked wide discussions at national and international levels. The initial focus of discussion revolved around the high attainments in human development despite low levels of economic growth. As compared to many states in India, the rate of growth of Net State Domestic Product(NSDP) in Kerala was below the national average, however this limit to resources did not affect the momentum of the state with respect to social sector development as reflected in high levels of literacy, life expectancy and low levels of infant and child mortality rate. This Kerala model of high human development amidst low economic growth has created euphoria across those under developed nations and regions which were struggling to provide basic minimum necessities of life to its citizens. A group of studies probed into the reasons for the same[1] and few others questioned the viability and sustainability of the model.[2] Amidst these discussions that lasted for decades, a perceptible change took place in the economy of Kerala, when Kerala started recording increasing levels of growth towards the end of 1980s.[3] The recovery of growth has now lasted for a period of more than twenty-five years, (albeit fluctuations) with long run growth rate of more than 6 per cent. Some pertinent questions arise in this context with reference to Kerala's development experience: What sort of relationship exists between human development and economic growth, both in the short run and long run? What is the future prospect of the state with reference to economic growth and human development i.e.,whether the state is moving towards a sustainable virtuous cycle of development? Whether the macro level human development index camouflages the real human development issues of

the state? These questions need a deep probe at this juncture, when the state of Kerala is celebrating her sixtieth year of formation and a modest attempt of the same is done in this paper.

2. Relationship between Economic Growth and Human Development

Theoretical and empirical studies held in various parts of the world have given four possible combinations of relationships between human development and economic growth. They are virtuous, vicious and two types of lop-sidedness, that is lopsided with strong human development/weak growth (called human development lopsided) and lopsided with weak human development/ strong growth (called economic growth lopsided). In the virtuous cycle case, good human development enhances growth, which in turn promotes human development and so on. In the vicious cycle case, poor performance on human development tends to lead to poor growth performance which in turn depresses human development achievements and so on. Much depends on the linkages in the two chains from economic growth to human developmentand from human development to economic growth(explained in the next section).The stronger the linkages in the two chains, the more pronounced the cycle of economic growth and human development, either in positive or dampening direction. Where linkages are weak, case of lopsided development may occur and such lopsided developments are unlikely to persist. Either the weak partner in the cycle eventually acts as a brake on the other partner, leading to a vicious cycle case, or if the linkages are strengthened possibly by policy change, a virtuous cycle case results (Ranis, 2000).

Historically Kerala has followed a human development lopsided development pattern, evidenced by high literacy rate, life expectancy, low infant and child mortality rate in spite of the decadal growth rate of 3.2 per cent, 3.4 per cent and 4.9 per cent during 1960–61 to 1970–71, 1970–71 to 1980–81 and 1980–81 to 1990–91, respectively. For the last two decades along with high human development indices the state experienced high growth in NSDP as evidenced by the decadal growth of 6.12 per cent and 8.05 per cent during 1990–91 to 2000–01 and 2000–01 to 2010–11, respectively. The sustainability of this phenomenon of high growth alongside high human development(i.e., the movement towards virtuous cycle) depends upon the strength of the causal chains from human development to economic growth and from economic growth to human development. This aspect is probed in the next section.

3. Future Prospect of Kerala with Respect to Economic Growth and Human Development

Ranis (2000) has sharpened the understanding of two way links between human development and economic growth at theoretical level. There are two distinct causal chains– one which runs from economic growth to human development, as the resources from growth are allocated to activities contributing to human development, the other runs from human development to economic growth, indicating how, in addition to being an end in itself, human development helps in increasing economic growth. High economic growth and high human development can lead to a virtuous cycle only if the two causal chains reinforce each other. Whether this is happening in Kerala is explored.

4. Chain A: From human development to economic growth

Ample evidence suggest that as people become healthier, better nourished and educated, they contribute more to economic growth since higher human development enhances people's capabilities and consequently their productivity and creativity. However this connection link between human development and economic growth depends upon (a) investment rate; (b) the distribution of income; and (c) the policy setting (Ranis, 2000). More the investment rate in the economy, more equal the distribution of income and more appropriate the policy setting, more is the chance for better human development for getting translated into better economic growth. These causal chains turned out to be very strong for Kerala since the mid 80s, as illustrated below.

The progress attained by Kerala in social sector development was more or less equal; irrespective of the position in the socio economic ladder, everyone had access to quality education and healthcare at an affordable rate. The new generation with enhanced capabilities in terms of better healthcare and education and with improved awareness of the opportunities abroad started migrating to the rest of the world, suitably utilising the opportunities. International migration was a slow and steady consequence of the social development achieved by Kerala (Kannan, 2005). By the time when reforms were initiated in 1991, it provided the policy setting for improving economic growth based on the remittance income received

by the state. The discontinuance of fixed exchange rate system and the following depreciation of the rupee resulted in increasing flow of remittances to the state. The state of Kerala received around one lakh crores of rupees as remittance from abroad which forms around 25 per cent of the total GSDP of the state. (Zachriah and Rajan, 2014). In the new policy setting, the remittances increased the effective demand for goods and services possibly in the construction sector, health, tourism etc. and private investment complemented government investment in these fields. Together, these effects led to enhancement of economic growth in Kerala. Thus, the human development of Kerala manifested in international migration coupled by policy changes resulted in human development being translated into economic growth.

Is the situation sustainable?The answer depends on the policies that we adopt. The causal link between human developments to economic growth can remain to be strong only if careful efforts are done. The economic base of Kerala is very fragile, which depends on volatile economic and political conditions prevalent in other parts of the globe. If any eventuality occurs, tertiary sector will be affected with resultant dampening effect on growth.Global macro environment is drastically changing, all the West Asian countries which had been the main destination for Keralites are increasingly adopting conservationist polices that have resulted in massive return migration.The slogan such as Saudi for Saudians and the policy of Nithakat is a signal for the crisis that Keralites are facing in finding employment opportunities abroad. Settlement migration areas, especially USA have also made clear what its policy on migration will be. The opportunities for migration, if turns out to be dwindled, should be viewed seriously, since the current unemployment within the state is high and this will be accentuated if external destinations of employment become problematic. Data from the fifth Annual Employment-Unemployment Survey (2015–16) by the Government of India records 12.5 per cent unemployment rate for Kerala based on UPS[4] approach as against the national figure of 5 per cent. Work participation rate for Kerala is given in Table 1 as evidence to the fact that the unemployment rate in Kerala is on the increase, particularly in the rural areas and among females.

Table 1: Worker Participation Rate (per 1000) in Kerala

		2011–12				2009–10			
	Gender	UPS	UPS and SS	CWS	CDS	UPS	UPS and SS	CWS	CDS
Rural	Male	543	565	527	462	550	564	539	471
	Female	161	221	180	145	176	218	191	155
	Total	399	382	342	293	354	383	357	306
Urban	Male	540	552	525	482	534	547	526	469
	Female	161	191	168	150	171	194	179	158
	Total	341	363	338	308	344	363	344	307
Rural and urban	Male	542	562	526	468	545	560	536	471
	Female	161	213	177	146	175	212	188	156
	Total	340	377	341	297	351	377	353	306

*Note:*WPR is defined as the number of persons /person- days employed per 1,000 persons/person days. UPS=Usual Principal Status, UPS and SS= Usual Principal and Subsidiary Status, CWS=Current Weekly Status, CDS=Current Daily Status

Source: Economic Review, 2016.

The educated unemployment in Kerala has remained always high (refer Table 2 and 3 which gives the data for registered persons) pointing to the failure by the state to create adequate employment opportunities suitable to the educational attainments. The state needs to devise adequate steps to provide opportunities for the educated to be productively employed, if the achieved growth is to be sustained.

Another related aspect is the growing inequality in income distribution in Kerala. Gini coefficient,

Table 2: Distribution of Work Seekers in Kerala by Educational Level (lakh persons)

Year (at the end of December)	Below SSLC	SSLC	HSC	Degree	Post graduate	SSLC and above	% to Total work seekers	Total work seekers
2005	6.29	21.81	5.75	2.30	0.55	30.41	82.9%	36.70
2006	6.37	23.16	6.17	2.33	0.54	32.20	83.5%	38.57
2007	6.31	24.21	6.45	2.38	0.53	33.57	84.2%	39.88
2008	6.21	25.50	6.85	2.35	0.53	35.23	85.0%	41.44
2009	6.24	26.76	7.08	2.39	0.53	36.76	85.5%	43.00
2010	5.94	26.90	7.18	2.61	0.47	37.16	86.2%	43.10
2011	5.88	27.40	7.24	2.62	0.48	37.74	86.5%	43.62
2012	5.98	28.37	7.49	2.66	0.49	39.01	86.7%	44.99
2013	4.26	23.09	6.37	2.25	0.54	32.25	88.3%	36.51
2014	3.81	22.86	6.65	2.39	0.50	32.40	89.5%	36.21
2015	3.73	20.84	6.57	2.37	0.58	30.36	89.1%	34.09
2016*	3.47	20.19	6.87	2.01	0.13	29.20	89.4%	32.67

Note: *upto 30/10/2016.

Source: Directorate of Employment, Government of Kerala, 2016

Table 3: Number of Professional and Technical Work Seekers (number of persons)

Year (at the end of December)	Medical graduates	Engg. graduates	Diploma holders in engg.	ITI certificate holders	Agricultural graduates	Veterinary graduates	Total
2005	3428	6389	41345	124410	803	547	176922
2006	2925	8466	41700	109780	762	522	164155
2007	2319	7608	35216	103018	704	584	149449
2008	2225	7941	31850	100183	654	578	143431
2009	2420	9495	36186	96655	581	602	145939
2010	2090	8143	35164	104201	402	411	150411
2011	2439	10953	37748	111751	491	517	163899
2012	2912	14477	38841	112493	529	719	169971
2013	2945	40091	38010	85590	500	583	167719
2014	3439	25203	39495	85444	803	707	155091
2015	3497	23984	46061	87727	915	557	162741
2016*	3369	30719	48180	86191	1182	609	170250

Note: *upto 30/10/2016.

Source: Directorate of Employment, Government of Kerala, 2016.

Table4: Rural/Urban Income Inequality in India, Represented by Gini Co-efficient

States	Rural Gini co-efficient	Urban Gini co-efficient
Assam	0.21	0.35
Jharkhand	0.22	0.34
Bihar	0.23	0.32
West Bengal	0.25	0.39
Orissa	0.25	0.36
Andhra Pradesh	0.26	0.32
Uttarakand	0.26	0.40
Jammu andKashmir	0.26	0.34
Gujarat	0.26	0.29
Chhattisgarh	0.27	0.43
Haryana	0.27	0.39
Rajasthan	0.27	0.37
Uttar Pradesh	0.27	0.42
Maharashtra	0.28	0.39
Karnataka	0.29	0.42
Himachal Pradesh	0.30	0.33
Tamil Nadu	0.30	0.35
Punjab	0.30	0.32
Madhya Pradesh	0.32	0.39
Kerala	0.37	0.44

Source: NSSO 68th Round (2012), Ministry of Statistics and Programme Implementation, Government of India.

measuring the inequality in income distribution worked out from NSSO data for rural and urban areas shows that Kerala has turned out to be the state with highest inequality in income distribution and this may distort the social fabric of the state and can have adverse economic consequences.

4. Chain B: From Economic growth to Human Development

Kerala achieved high level of human development with less level of economic growth, mainly due to the increasing social expenditure made by the state along with strong social reforms supplemented by the active role played by civil society. Once growth gets enhanced, the chance of augmenting human development is high, but it again depends on the causal links in the chain from economic growth to human development. Economic growth contributes to human development through household and government activity and through the activities of the civil society. The way in which growth translates into income distribution and poverty reduction depends on the nature of growth process,in particular, the extent to which it is based on the generation of employment and on increasing rural incomes. The not so optimistic state of affairs with respect to generation of employment is already explained in the previous section. Regarding rural incomes generated by economic growth also the state of affairs is not so positive.The percentage of deprived rural households against their total number of rural households across different categories provides a bleak picture (Table 5). As per Socioeconomic and Caste Census, 2011, landless households deriving major part of their income from manual casual labour forms 18.86 per cent of the rural Kerala households.

Table 5: Percentage of Deprived Rural Households against Their Total Number of Rural Household across Different Categories in Kerala

Districts	Categories of rural households (in per cent)					
	All	SC	ST	Others	Female headed	Disabled
Thiruvananthapuram	38.36	61.28	62.72	34.61	45.49	48.37
Kollam	28.11	58.67	74.83	23.26	31.44	36.05
Pathanamthitta	26.61	63.21	59.52	20.29	27.65	35.57
Alappuzha	27.78	52.52	51.99	24.9	29.42	34.86
Kottayam	23.02	49.96	42.89	20.14	29.59	30.37
Idukki	33.99	50.65	53.76	29.36	43.34	36.79
Ernakulam	20.3	47.06	65.19	17.13	28.78	28.32
Thrissur	28.57	57.74	49.54	24.45	31.6	35.62
Palakkad	42.33	66.32	62.9	37.38	49.2	50.95
Malappuram	32.71	62.63	76.8	29.78	33.33	40.1
Kozhikode	30.89	58.05	73.52	28.31	33.14	38.64
Wayanad	36.33	50.11	55.32	31.06	42.75	39.73
Kannur	24.25	42.38	73.09	22.6	25.96	30.46
Kasaragod	32.82	64.69	81.25	28.74	34.06	39.25
State	30.33	57.66	61.68	26.54	34.31	38

Source: Socio Economic and Caste Census, 2011.

Turning to the government sector, the allocation of resources to improving human development is a function of total public sector expenditure, of how much of this flows to the human development sectors and of the way in which it is allocated within these sectors. This can be experienced as three ratios; (a) the public expenditure ratio defined as the proportion of GNP spent by various levels of government; (b) the human development allocation ratio: defined as the proportion of total government expenditure going to human development sectors; and (c) human development priority

Table 6: Per cent Share of Social Sectors in Expenditure of Kerala State

Year	Education	Health	Water and sanitation	Nutrition
2004–05	5.14	1.27	0.41	0.000345
2005–06	5.08	1.29	0.32	0.000276
2006–07	5.14	1.31	0.31	0.000508
2007–08	5.19	1.29	0.34	0.000672
2008–09	5.04	1.29	0.28	0.000649
2009–10	4.09	1.03	0.37	0.000578
2010–11	4.05	1.07	0.29	0.000567
2011–12	4.86	1.33	0.24	0.000825
2012–13	4.61	1.26	0.27	0.000866
2013–14	4.97	1.37	0.24	0.00109
2014–15	6.53	1.75	0.35	0.001566
2015–16	5.84	1.77	0.39	0.001606

Source: State Finances (various years), Reserve Bank of India (RBI).

Table 7: Allocative Pattern of Revenue and Capital Expenditure for Education and Health in Kerala Budget

Year	Expenditure on education		Expenditure on health	
	Capital expenditure	Revenue expenditure	Capital expenditure	Revenue expenditure
2000–01	0.58	99.41	3.13	97.80
2001–02	0.75	99.24	3.07	99.22
2002–-03	0.62	99.37	4.82	97.19
2003–04	0.47	99.52	2.27	95.43
2004–05	0.74	99.25	2.79	97.91
2005–06	0.59	99.40	4.90	97.70
2006–07	0.91	99.08	3.82	96.18
2007–08	0.75	99.24	1.18	92.10
2008–09	0.57	99.42	2.42	97.58
2009–10	0.82	99.17	4.12	95.87
2010–11	1.31	98.68	8.27	91.73
2011–12	0.83	99.16	6.18	93.82
2012–13	1.29	98.70	5.73	94.27
2013–14	1.67	98.32	5.18	94.82
2014–15	2.34	97.65	7.01	92.98
2015–16	3.02	96.97	5.23	94.78
2016–17	2.12	97.87	6.84	93.15

Source: State Finances (various years), RBI.

ratio: defined as the proportion of human development sector expenditure going to priority sector.

Historic experience of Kerala demonstrates a prominent figure for these ratios,[5] irrespective of the fact that resources were low, these led to progress in human development for Kerala. But since economic reforms, these ratios are coming down (Table 6) and within the social development sectors, very minimal share goes in as capital expenditure which will impair the long term development prospects of these human development inducing sectors.

Defining priority sector depends up on the levels of development of a region. Regarding education, during the initial years, Kerala focused on universal school education since expansion of primary education is an efficient way of advancement in terms of its contribution to growth which in turn advances human development. When primary education is universalised, investment in secondary education will yield higher social returns and beyond that as the economy begins to rely on knowledge based sectors, tertiary education becomes important. Kerala's priority is to be shifted from primary and secondary education to higher education, both general and technical. In modern technical education in Kerala (degree, diploma and certificate), there has been an unbridled expansion which has affected its quality, however the question of access and availability remains high. Expansion doesn't mean accessibility since accessibility depends upon affordability. Only those with family academic support or the benefit of expensive private tuition get into the stream. For a long time there was a hope in the socially and economically backward sections that they too could take advantage of the Kerala Model of development that if their children attended school and studied well, they will be able to have equal footing in the society. The withdrawal of government from the technical education and the increasing privatisation and related costs of technical education, perceived decline in the quality of government education etc. has eroded their confidence. The argument put forth by Amartya Sen in terms of first boys[6] and last boys where a minor share of the first boys get access to quality education while vast majority of last boys are not able to get it, finds applicability in present day Kerala.[7]

This surely will widen the inequality and impinge upon the growth process in the state. There is a need to shift priority to quality, access and the functional orientation of education, with particular reference to technical education, so that this vital component of human development may serve as an impetus to economic growth in a mutually reinforcing relationship. In consonance with the global dynamic labour market, education needs to respond to the increasing demands for adaptable workers, who can readily acquire new skills rather than for workers with a fixed set of technical skills.

The story is same with health sector also, whereas Kerala focused on government-led three tier health care facilities based on the principle of affordability, and accessibility, the withdrawal of government from the scene in addition to increasing demand for quality healthcare (perceived through private sector) due to rising incomes led to the development of private hospitals. An average Keralite spends 15 per cent of monthly per capita non-food expenditure as health expenditure and this figure is very high compared to any other state in India. As per the NSSO report (2014) the average health expenditure spent by Keralite in

Table 8: Institution Wise Disease Treatment in Kerala (in percent)

Diseases	Public	Private
Cancers	55.1	44.9
Blood disease	7.4	92.6
Endocrine	30.2	69.8
Psychiatric & neurological	25.8	74.2
Eye	32.1	67.9
Ear	22.2	77.8
Cardiovascular	33.1	66.9
Respiratory	31.5	68.5
Gastrointestinal	26.5	73.5
Skin	39.3	60.7
Musculoskeletal	37.6	62.4
Genitourinary	23	77
Obstetric	30.1	69.9
Injuries	32.9	67.1
Total	30.49	69.51

Source: Computed from unit level data, NSS 71st Round, Social Consumption: Health.

availing inpatient treatment from private sector is around seven times that of public sector (Table 9). In spite of this cost difference, there is an increasing demand for private sector treatment in Kerala because of the perceived quality difference (Table 8) and falling sick is now considered as the major reason for poverty.

An added aspect is the role of civil society and public action in shaping and maintaining the Kerala model of development. Non-governmental organisation (NGO) and other civil society activity is typically heavily oriented towards human development objectives (generating incomes for the poor and on schools, nutrition and health projects). In Kerala, these civil society movements appear to represent a major source of human development enhancement and of late with increasing globalisation, the role played by civil society is also questioned.

Thus, the connection link between economic growth and human development are not automatic, the strength of the link in the chain varies according to a large range of factors including the structure of the economy, the distribution of assets and the policy choices made, the social capital etc. The connection link between economic growth and human development tends to be stronger (a) the more equally income is distributed; (b)the higher

Table 9: Medical Expenditure Incurred for Diseases: Public vs. Private (2014)

Diseases	Public (in INR)	Private (in INR)	Difference in percent
Cancers	11496.45	36577.57	218.16
Blood disease	300.00	8700.83	2800.28
Endocrine	1201.13	18160.19	1411.93
Psychiatric &neurological	3346.62	29037.20	767.66
Eye	1860.14	14868.72	699.33
Ear	8200.00	17264.29	110.54
Cardiovascular	3974.22	41227.44	937.37
Respiratory	719.57	15614.23	2069.94
Gastrointestinal	4859.20	35083.54	622.00
Skin	3259.86	17581.69	439.34
Musculoskeletal	4792.27	22550.25	370.55
Genitourinary	2729.84	32883.36	1104.59
Obstetric	2139.17	11798.58	451.55
Injuries	3564.72	24947.56	599.85
Total	3745.942	23306.82	900.2207

Source: Computed from unit level data, NSS 71st Round, Social Consumption: Health.

proportion of GNP directed to priority social expenditure by the government; and (c)the more effective the contribution of social capital including community organisation and other NGOs. It is interesting to note that these connection links were stronger in Kerala when her economic growth was less. As documented, when Kerala's economic growth improved, the connection link tends to be weaker, and if economic growth and human development has to reinforce each other, the connection link must be strengthened which requires immediate policy intervention. Next section provides a probe on the relevance of human development index in the Kerala context.

5. Whether HDI Represent the Real Human Development Issues of the State?

The indicators selected for constructing HDI are literacy rate and school enrolment (education index), life expectancy (health index) and per capita income (income index). These macro indicators used to reflect the real situation of the state during the initial decades of development. As of now these indicators tend to under report the issues faced by the state in human development particularly in the health and education front. For example in the health sector, Kerala stands first in India in terms of morbidity continuously for the last two decades. Kerala is witnessing triple burden of diseases, the increasing incidence of non-communicable diseases (like cancer, cardio vascular diseases), re-emergence of once eradicated communicable diseases (like leptospirosis, plague etc.) and emergence of new communicable diseases (chikunguinea, dengue feveretc.). Kerala also stands first in India in terms of monthly per capita health expenditure as per cent of total expenditure, hence falling sick has been reported as the major reason for poverty. There is a tendency among the Keralites to equate quality of health services to price of health services which has resulted in the mushrooming of private hospitals in Kerala. If the progress of health sector is evaluated on the basis of outcome, the state of Kerala is poorest in India as compared to other states. Also, there are very serious concerns regarding social determinants of health including waste management,

water and sanitation and nutrition. The same is the case of education also. Literacy rate and school enrolment of Kerala is high, but the real issue now is quality of education, affordability of education and linking education sector to employability. The HDI tends to underreport these emergent issues, which is sure to snag Kerala's further progress in the economic growth and human development front. It is time to rethink whether the traditional HDI is applicable to Kerala and the euphoria relating to high HDI needs to be discontinued. The higher position of traditional HDI status also gives the state a disadvantageous position for getting a due share from the central government at the time of devolution of divisible pool of tax revenue and grants.

6. Conclusion

To conclude, the sustainability of the current pattern of progress exhibited by Kerala depends upon the policy measures adopted to strengthen the vital link between human development and economic growth. This can be achieved by adopting the policies leading to a shift in resource allocation towards education and health services, especially those serving the majority of the people, those generating a more equitable income distribution (for example, through land reform or a move towards a more employment intensive pattern of output) and those providing extensive opportunities for the unemployed etc. Priority may be redefined to meet the emergent needs including the roles of science and technology institutions and higher education and strengthening public hospitals. Issues of accessibility, affordability and quality of higher education must be given priority. Slip back from virtuous growth to human development lopsidedness can occur for some reasons if growth slows down, but as long as human development stays high such cases have a good chance of resuming their virtuous cycle. Hence, human development aspect of the state should be given priority by addressing the emergent needs.The development of human resources must also be linked with a proper man power planning suitable for employment creation, not only inside the state but also outside the state.

The constructive use of public resources generated by economic growth to enhance human capabilities contributes not only to the quality of life but also tohigher productivity and further growth. Hence there is a strong case for forceful public demand for much larger allocation to public services (such as education, healthcare, nutritional support and environmental protection) and much more comprehensive programmes of economic equity and social security as well as the development of the physical and social infrastructure.This complementary approach of strengthening the links between economic growth and human development through successful policy is the need of the hour.The new decentralised planning initiatives now being chalked out could be effectively used for enhancing both human development and economic progress of the state.

Notes

[1] See Kannan(1990) and papers in the special issues of *Economic and Political Weekly*, Volume 25, Nos. 26 and 27

[2] See George (1993).

[3] This has been documented by Ahluwalia (2000)and by Subrahmaniam and Azeez (2000).

[4] A person is considered in the labour force on **Usual Principal Status** (UPS) if he/she has spent relatively longer time (i.e., major time criterion) on economic activity during 365 days preceding the date of survey.

[5] See Ramankutty (2000).

[6] Here the terms 'the first boys' and 'last boys' imply the children belonging to privileged and underprivileged sections in the society respectively.

[7] See Sen and Dreze (2013).

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"It is no coincidence that in countries where agriculture has taken off there have been large investments in research and infrastructure."

– Kanayo Nwanze

Feature

Child Waste Pickers in the City of Allahabad, Uttar Pradesh: Unfolding Some Facts

BHASKAR MAJUMDER AND G. RAJVANSHI

The children from underprivileged households remain engaged in collecting materials discarded by the final users on the public space. We assume that the children working as waste pickers in the city of Allahabad are self-employed, in absence of any identified employer, to earn income to sustain the livelihood of their households. The paper, based on a primary survey of children engaged in waste picking in the city of Allahabad in Uttar Pradesh, concluded that the out-of-school children engaged in waste picking reflected their adverse inclusion at the bottom of the labour market. Notwithstanding the fact that the state intervention through Acts so far could hardly protect the childhood of these children, this paper argues for protection of the waste picking children through state intervention.

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Introduction

In caste-ridden Indian, the children of the underprivileged households remain deprived of education through schooling for no fault of their own. It is because of the circumstances of their birth in the first place and the subsequent compulsions to earn for the household. In the age bracket between five and seventeen years the children of such communities in India are mostly deprived of education. They often feel forced to be engaged in work to supplement household income. They work on a daily basis, self-engaged, working as much as possible both in terms of time and qualityof work to enhance household income. In rural economies they support family labour, while in urban fringes they are engaged in brick kilns for example to supplement the their parents' earnings.In urban areas they are engaged in both visible and invisible activities, many of which are unpaid, underpaid, or based on food-arrangement.

We chose one such activitiy that apparently the children are engaged in on their own. This is waste picking in the urban public space where mostly the children are engaged incollecting materials discarded by the final users. To the waste pickers, these discarded materials have exchange-value. Waste picking entails collecting, sorting and selling of materials discarded at dumpsites, river banks, sides of railway tracks, inside train compartments, bus depots, street corners and residential areas. The employer of these child workers either does not exist or exists by invisibility; the dealer in junk is not within the ambit of law to be called the employer of the waste pickers. A type of guardian mode was observed elsewhere where the junk dealers helped the waste pickers by providing shelter, arranging vehicles and protecting them from ill-treatment by the police; the junk dealers

were also observed acting as custodians of cash income the child waste pickers earned daily and providing interest-free credit in their need(Choudhary, 2003). Waste picking is not household enterprise. It is, thus, difficult to identify the parents or adult guardians as employers.

The single-use goods are disposed of by the users anywhere outside the residential areas in countries like India. Urban society expects that these materials discarded inthe urban public space are cleaned up. The city administration gets in the working children a substitute of their responsibilities to keep the city clean in countries like India. A waste is a discarded material that has no immediate use value to the consumer abandoning it (Cointreau, 1982, 4). The waste picking children discover exchange value in these discarded materials. A market in the city develops for exchange of waste materials.

Rather than engaging children in formal institutional education, the children are sent to collect discarded materials from the garbage. The garbage as an economic space for these children is also a food-space for dogs, cows, pigs and other not-readily-visible insects. The waste pickers, thus, are in competition with stray animals in collection of materials from garbage. The waste picking children enter into an economy that is rejected by the first-hand users of materials. This inclusion shows more adverse consequences relative to the state of exclusion (Xaxa, 2012, 1).

There has been a continuous influx of children into urban informal labour market (NCEUS, 2008,101). For children the unpaid domestic work, the paid non-domestic work and distinction between being engaged in hazardous and non-hazardous work make the actual conditions of employment obscure (Lieten, 2002, 5192). The concentration of child labour in the urban informal economy is absence of any statutory minimum age for employment, impossibility in fixing any minimum wage rate, free entry and free exit of child labourers, absence of requirement for formal education and manual nature of such work. In case of rag picking, the children get support in kind from the junk dealers. The dumping ground becomes work zone once the garbage piles up in direct proportion with the rate at which the final users throw these away in public space. The waste pickers work on non-annexed public space or space not occupied by any individual.

We examined the nature, causes and consequences of the children engaged as waste pickers in the city of Allahabad. We examined their working-cum-living conditions, security and identity, and the possibilities of their rehabilitation. The rest of the paper is structured as follows. In Section I, we present the sample and methodology. In Section II, we briefly present the phenomenon of child labour and laws. In Section III, we present some selected quantitative indicators about the child waste pickers. In Section IV, we explain qualitatively why the children remain engaged in waste picking. Finally, in Section V we present conclusions and recommendations.

Methodology and Sample

The city of Allahabad is one of the six million-plus populated cities in the state of Uttar Pradesh following Census 2011. We selected this city to explore the engagement of children in waste picking. We collected quantitative data about child waste pickers and their parents and junk dealers (*Kabbadiwalas*) administering structured schedules. We collected qualitative information through conversations with child waste pickers and their parents, observations on the work space of child waste pickers, participant observations and facilitating zones like tea shops as assembly points for the waste pickers. We also relied on distant observations and group discussions (GDs) with child waste pickers.

Most of the child waste pickers live in slums. We made pilot visits in the selected work-locations. We identified five locations (*Adda*) of waste pickers, namely, Jhusi, Manmohan Park, Behrana, Allahpur and Allahabad Railway Station. To understand the estimated number of child waste pickers who assemble everyday on the selected *Adda* early in the morning, we remained personally present there. Thus, we selected the child waste pickers, both male and female, in the *Adda*. We interacted with the households of those children who could identify their houses.

We took a sample of twenty-five child waste pickers. In parallel, we interviewed their parents (twenty) residing in slums, facilitators (five) and junk dealers (five) who had links with these child waste pickers. We could not locate the parents or guardians of five children.

Child Labour and Laws

The expanding carrying capacity of a city leads to influx of population from rural areas and consequent formation of labour colonies and slums consisting of families/

individuals living in cluster of houses called *jhopris*. This rural-urban influx forms and expands the city labour market. It is estimated that urban child labour accounts for 5.5 per cent of all-India child labour in India (Lieten, 2002, 5192).

The UNICEF India estimated that 28 million children between the ages of five to fourteen are involved in work (UNICEF, 2011). Following Census of India, the total number of child workers declined from 11.0 million in 1991 to 3.6 million in 2001. Following NSSO, the estimated number of child workers was 13.3 million in 1993–94 and 8.6 million in 2004–05. They constituted about 6.2 per cent of children in the age group of five to fourteen years in 1993–94 and 3.4 per cent in 2004–05 (NCEUS, 2008,100). It is observed that 'not all child work is child labour' (Lieten, 2006, 106). The ILO Convention 138 allows children above age twelve in less developed countries to get engaged in light form of work that does not extend beyond two hours a day as through such works children learn by doing or inherit skill (Lieten, 2006, 106). It remains questionable what is 'light form of work' and who checks if working hours of a child is 'limited to two hours'.

Legislations on child labour in India

The first legislation on child labour in India was introduced in British India in 1881 as incorporated in Indian Factories Act which prohibited employment of children below seven years, limiting the working hours for children to nine hours a day and providing four holidays per month.

In addition to India's Constitutional provisions, the Acts that pledged to provide legal protection to working children included the following:

- The Children (Pledging of Labour) Act, 1933
- The Employment of Children Act, 1938
- Child Labour (Prohibition and Regulation) Act, 1986
- Child Labour (Prohibition andRegulation) Amendment Act, 2016.

The 1986 Act was a follow up of the National Commission on Labour (1966–69), the Gurupadaswamy Committee on Child Labour (1979) and the Sanat Mehta Committee (1984). The 1986 Act aimed to prohibit the entry of children into hazardous occupations and to regulate the work of children in non-hazardous occupations. The 1986 Act prohibited work of children between 7 pm and 8 am (NCEUS, 2008, 159).

The Child Labour (Prohibition and Regulation) Amendment Act, 2016 amended the 1986 Act. The 2016 Act distinguished between adolescents and children, defining the former as persons aged between fourteen and eighteen years; and defining the latter as persons aged below fourteen years, or such age as may be specified in the Right of Children to Free and Compulsory Education Act, 2009 whichever is more. The Act completely banned employment of children below fourteen in all occupations, except those run by his or her own family with a condition of continued education. It defined children between fourteen and eighteen years as adolescents and barred their employment in any hazardous occupations.

Waste Picking: Some Quantitative Facts

The children were forced in the labour force due to poverty of the households. Each of the households in the slums identified as housing the selected waste pickers had at least one child engaged in such picking or works related to it.

Demographic-geographic background: selected Indicators

Waste picking children in the sample comprised of 84.0 per cent male workers. Among the child rag pickers under study, 60.0 per cent belonged to Hindu households and the rest hailed from Muslim households. 60.0 per cent of the children belonged to Scheduled Castes (SCs), 32.0 per cent minority (Muslim) communities and 8.0 per cent to general castes (Table 1).

Table 1:Distribution of Households of Child Waste Pickers by Sub-castes and Minority

Sub-caste	Number
Banskar	13 (52.0)
Jamadar	1 (4.0)
Chamar	1 (4.0)
Sheikh	5 (20.0)
Khan	1 (4.0)
Ansari	1 (4.0)
Ahmad	3 (12.0)
Total Rag Pickers	25 (100.0)

Note: Figures in parentheses show percentages of total.
Source: Field Survey, 2016.

The household size of 64.0 per cent of child waste pickers was between five and twelve; for 16.0 per cent it was between two and four; 20.0 per cent of the children were homeless implying they were street children. 44.0 per cent of the households of these children lived in *Jhopri* (dilapidated *kutcha* house), 20.0 per cent in *kutcha* house, 32.0 per cent in semi-*pucca* house, and 4.0 per cent in *pucca* house. 64.0 per cent of the children never went to school, 32.0 per cent were school drop-outs and 4.0 per cent were school going (Field Survey, 2016). Excepting two, all the waste picking households in the sample migrated from the adjoining states to Allahabad city over varying periods (Table 2).

Table 2: States from where Households of Waste Picking Children Migrated

States	Number
Madhya Pradesh	13 (52.0)
Jharkhand	9 (36.0)
West Bengal	1 (4.0)
(Intra-state) Uttar Pradesh	2 (8.0)
Total rag pickers	25 (100.0)

Note: Same as in Table 1.
Source: Field Survey, 2016.

Reasons why children were engaged in wastepicking

Household poverty was the major reason why the waste picking children remained deprived of education (Table 3).

Table 3: Reasons for Absence of Education of Waste Picking Children

Reasons	Number
Not interested to go to school	10 (40.0)
Parents did not send to school	13 (52.0)
Poverty of household	15 (60.0)
Coercion by teacher	9 (32.0)
Classmates teased and abused	5 (20.0)
Total rag pickers	25 (100.0)

Note: Same as in Table 1.
Source: Field Survey, 2016.

Working hours per day of waste picking children

The working hours per day of the generally barefoot waste picking children ranged between four hours at the minimum and above ten hours at the open-ended maximum (Table 4).

Table 4: Working hours per day of waste picking children

Working hours	Number
4–6	8 (32.0)
6–8	5 (20.0)
8-10	12 (48.0)
Above10	3 (12.0)
Total rag pickers	25 (100.0)

Note: Same as in Table 1.
Source: Field Survey, 2016.

Waste Material collected

The waste pickers used to collect materials for sale and also were on the lookout for any saleable materials based on learning by doing. Their hands were absolutely uncovered and infrequently they had a short-length brittle stick to extract the collectable materials from garbage; collection of waste materials was done by their uncovered hands; the use-and-throw stick was collected from some garbage. The kits for collection of waste materials were one backpack (*bora*) on the back of the child and one small stick in one hand. The collected items were exchanged at different prices as fixed by the junk dealer (Box 1).

Box 1: Waste Materials Collected by Children

Waste materials

plastic, bottle, glass, iron, cans, aluminum foil, bones, hair, medicines wrapper, papers, electric bulb, tin, *tanbha*, petal, medical wastage.

Source: Field Survey, 2016.

Children as bread earners in households

The major reason why the children were engaged in waste picking was to earn income for their households. The range of income that a child earned from rag picking was between INR 40.00 and INR. 250.00 per day (Table 5).

The income per month of 92.0 per cent of rag picking children's households was in the range between INR 2,000 and INR 8,000 (Table 6).

Table 5: Income of Child Waste Pickers per Day

Income (INR)	Number
40.00-50.00	3 (12.0)
51.00-100.00	3 (12.0)
101.00-150.00	8 (32.0)
151.00-200.00	7 (28.0)
201.00-250.00	4 (16.0)
Total rag pickers	25 (100.0)

Note: Same as in Table 1.
Source: Field Survey, 2016.

Table 6: Income per Month of Households of Waste Picking Children

Income (INR)	Number
2,000.00-4,000.00	4 (16.0)
4,001.00-6,000.00	13 (52.0)
6,001.00-8,000.00	6 (24.0)
More than 8,000.00	2 (8.0)
Total rag pickers	25 (100.0)

Note: Same as in Table 1.
Source: Field Survey, 2016.

Tenure and trainers in waste picking

The children remained engaged in waste picking since past one year and since remote past (ten years). 60.0 per cent of the children learnt waste picking from their parents, 24.0 per cent from neighbours and friends; 16.0 per cent were self-learnt. 48.0 per cent of these children were engaged other part time employment like in hotels and festivals (Field Survey, 2016).

Borrowing by households of waste pickers

The households of child waste pickers borrowed from multiple sources like *mahajans* (moneylenders), neighbours, *kabaadiwaalas* (junk dealers) and *samooh* (self-help groups). The households borrowed to meet expenses on basic needs (mainly food) and rituals.

Waste Picking: Some Qualitative Facts

Based on observations, focus group discussions and case studies, we present below how the waste picking children worked to live.

Household works and gender

In slums during off-work all used to be engaged in daily unpaid activities; girl children supplemented the gender role of their mothers. Household activities of waste picking girl children included child care, cleaning and washing, cooking, fetching water, collecting fuel and babysitting. Most of the girls never went to school; they remained engaged in household activities to substitute or to supplement their mothers' gender-specific roles. They were engaged in waste picking froman early age and stopped early for reasons of security and early marriage.

Physical injury, hazards and health

Iron pricked unnumbered times in the hands and legs of all the rag pickers; most of them were bitten by animals and insects, and hands and legs were cut by broken glass during working hours. The adverse working conditions resulted in many of them falling sick. Getting injured was common for them because of cold weather, malnourishment and exposure to contamination and bacteria. Most of them suffered from fever, cold, tetanus, skin problem, headache, pain in bone joints, eye infections, backache and injuries. For curative healthcare, they took treatment from medical practitioners or from medical shops; others relied on treatment at home, *Yadu-tona* (black magic) in illness. The work environment adversely affected their psychological development.

Self-employment in waste picking: nature and causes

Most of the pickers were slum dwellers that facilitated them to get engaged in the city labour market. All the junk dealers and parents/guardians, and the Nagar Nigam officials in the city of Allahabad denied that they employed children. Thus, by non-existence of any employer, we presumed that the children were self-employed in collection of wastes for sale to junk dealers. The employer remaining absent, the 2016 Child Labour Amendment Act remained outside the ambit of the administration's efforts to bring to book any employer for engaging children. The children had no idea about the existence of any such Act meant to protect them.

The waste materials dispersed daily on public space showed the opportunity for the children to scratch in search of re-usable materials to collect for sale. This type of self-employment for collection of abandoned public resources did not need anybody to negotiate at the collection point. The collection, thus, was unobstructed and free from imposition of any penalty for trespassing.

Assembly point of waste pickers

The waste pickers generally faced no resistance while collecting materials discarded by people in public spaces. They used to assemble in a tea shop called *Adda* coming either by foot or on bicycles depending on the distance to be covered within the city. The children formed groups in *Adda* and self-allotted the number of collection points in the city and outskirts. The tea shop provided a communicative space for them for dispersal to different locations to collect wastes.

Supply point for waste pickers

The *kaabadiwaalas* (junk dealers) in the city of Allahabad having fixed locations were the purchase points where the waste pickers used to sell materials after these were classified, cleaned and sometimes reshaped. The prices of items were fixed by the junk dealers. The waste pickers had no organisation to represent them in bargaining for fixing the price per unit of the exchangeable materials while the junk dealers were in collusion being connected through social network and communication over mobile phone. Our conversations with the selected junk dealers in the city did not reveal much about the market in junks. They, however, reported not to have faced any trouble from the waste pickers or from the local police and public administration. They did not disclose if they used to pay *subhida sulk* (bribe money) to the caretakers of law.

Reasons why children remained engaged in waste picking

The children remained engaged in waste picking because of the following factors:

- the adult members of their households did not have any certain source of income;,
- wastepicking was the only means of survival;
- wastepicking was a non-excludable activity performed on self-chosen time;
- wastepicking required no employer;
- wastepicking made the children financially independent; and
- unreliable work as agricultural labourers of household members.

Caste as a barrier to entry in educational institutions

The waste picking children were not in schools. They either never got admission into school or dropped out early due to trade off between education and work that went against education. Caste-coupled practice of looking at human beings as untouchables erected historical barriers against the latter in India. Birth-determined social status kept the members in low caste households distanced from mainstream socio-cultural life. Children from bottommost caste households were victims of discrimination in schools from teachers and ill-treated by privileged children. This was because of the social stigma attached to their occupations. The waste picking children even if enrolled in schools were often absent or used to come late and their concentration in studies reduced due to their fatigue. In spite of willing to go to school some children could not do so due to conflicting learning hours and work hours.

In Alopi Bagh Jhoparpatti (slum) most of the waste picking children was averse to attending school because the teachers used to physically abuse them, made them wait outside the classroom; non-slum children also used to abuse them. The Anganwaadi centre that was set up inside Alopi Bagh slum was locked because the inhabitants of this slum mostly belonged to scheduled castes (*neechi jaati*). The lady teacher was from upper caste (*pundit*) household who declined to make the school functioning by teaching lest the children from low caste households would have polluted her caste-purity. The caste discrimination faced by the child waste pickers in their schools was also observed in Minto Park slum and Huddi Godam slum.

The reason why children could not attend school was not only because they were engaged in waste picking. In many cases parents could not afford the costs (fees, uniform, meals and study materials) of sending their children to school. Education of girl children was not a priority for the parents.

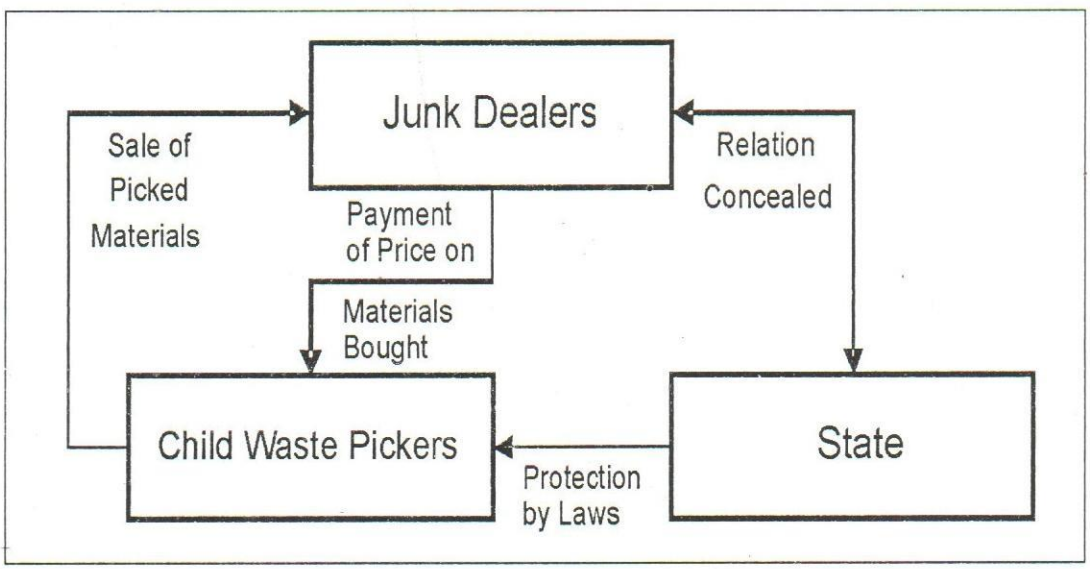
Social identity of child wastepickers

The income-poor illiterate parents liked to have more working hands to supplement household income. The entry was easy for the children in the labour market at the bottom but not the exit. The stigma of caste-cum-poverty encompassed the waste picking children in the city of Allahabad. In India, rights and opportunities are cemented in the caste system (Olivelle, 2006, 189). Historically, caste played the role of one of the major determinants in India's institutions. The people at the bottom in the caste hierarchy remained silent.

The primary reason why the waste picking children remained silent in the public domain over generations was their birth in the pad-Dalit (lowest of the low by caste hierarchy) Bansor community in Uttar Pradesh. They could not emerge as a strong political entity; they did not have adequate resources for secure livelihood; they remained incapacitated through absence of education, consciousness and Dalit identity by birth. Their children did not go to school even in case their hamlet had it because of their birth in lowest caste, living in dirty places and engaged on garbage. They had been struggling since remote past for state-identity.

Waste pickers, junk dealers and the state: interlinks

The junk dealers had storage-cum-shops displaying dumped discarded materials and were the supply point for the waste pickers. The relationship between the waste pickers and the junk dealers was extremely unequal – the former were not represented by any union in price fixing, weighing and counting of materials. The roaming *Kabaadiwalaas* (hawkers generally plying cycle carts purchasing disposable materials from residential houses at piece or weight rate) were the substitutes of the waste pickers for the fact that the disposable materials as soon as purchased by these roaming *Kabaadiwalaas* reduced the quantum disposed off on the public space by the residents-cum-sellers of used household materials. While the roaming *Kabaadiwalaas*, owning or hiring cycle carts generally self-driven, had access to the door of the houses, the waste picking children had no such cart-support for collection of materials and no access to reach the door of the house; the latter also lived in fear lest the household members perceived them as thieves once they would enter the private space adjoining the residential houses. The child waste pickers had no competition with the *Kabaadiwalaas* for the fact that the wastes they used to collect were more than what they could manage over time. The links between the junk dealers and the state administration was opaque though it was alleged by one of the junk dealers that he used to pay extra-legal money to local *dabang* (muscleman) for smooth running of his business (Flow Chart 1).



Flow Chart 1: Interlinking Waste Pickers, Junk Dealers and State

Relevance of law: a critique

The introduction of Acts to protect children by rescuing them from hazardous occupations and sending them back to school had only partial impact for the reason that the adult members of the households considered these children as the main earners of household income. The parents/guardians could hardly be made to pay penalty for their denial of the fact that they sent their children to work on the dumping ground of waste materials; this is apart from the impact of clause in 2016 Act of the Government of India that delinked domestic works of children deemed as child labour from penal provisions conditioned by the fact that education of children continued unabated (Ganotra, 2016,20). Apart from the fact that children were out of school not only because of their

engagement in waste picking, we found conflicting hours between waste picking and institutional education; also, the time-compartmentalisation of household work and garbage collection was opaque particularly for girl children who were either at home substituting their mothers' gender-specific roles or outside engaged in collection of waste materials. State intervention in intra-household child labour is also a difficult proposition. The employer of child waste pickers remaining absent or invisible in a city like Allahabad, the inspection and control by the official entrusted with the task may end up in failure contrary to the pledge of the 2016 Act that 'The appropriate Government shall make or cause to be made periodic inspection of the places at which the employment of children is prohibited and hazardous occupations or processes are carried out ...' (GoI, 2016). The de jure distinction between children and adolescents as in Act 2016 is opaque and not verifiable de facto. At the socio-cultural level, the girl children working as waste pickers and out of school were withdrawn from waste picking after they attained two-digit age for security and imminent marriage decided by the adult members intra-household making the provision of 2016 Act by distinction between children and adolescent gender-neutrally not-much-relevant. The 2016 Act had a provision of constituting 'a Fund in every district or for two or more districts to be called the Child and Adolescent Labour Rehabilitation Fund ...' that will show accumulation of money deposited from collection of penalty on the offender for the purposes of rehabilitation of the rescued child labour (GoI, 2016). The fixing of responsibility in maintaining this Fund once created at district levels needs transparency.

Conclusions and Recommendations

The major concluding points are the following:

- The waste picking children lived in dilapidated houses in slums or they were homeless.
- They were not in schools due to the illiteracy of their parents and household poverty.
- They were engaged to earn income for their households.
- They were self-employed to collect the materials from garbage to sell to junk dealers.
- They had no idea about the equivalence in exchange.
- The female waste picking children experienced eve teasing during working hours.
- The female waste picking children experienced double burden of home keeping and rag picking.
- None of these children had shoes, gloves and masks for their protection at the workplace.

Recommendations

In principle, no child should be engaged as waste pickers. However, so long as the children are not rehabilitated, we recommend the following immediate short-term measures:

- identify the households having children engaged as wastepickers;
- provide cost-free light weight carrying bag to each child waste picker;
- provide protective equipment to each child waste picker like gloves, footwear, masks and tools to sort wastes; and
- set up healthcare centres in slums in each city to take care of the child waste pickers.

In both, provision of protective instruments and healthcare, the responsibility has to be fixed by the government.

The long term measure must be to identify, based on city-specific slum census, the children engaged in waste picking plus street children working as waste pickers and rehabilitate them to boarding school and retain them there for each million-plus populated city in India through cost-free distribution of food for education. The Rehabilitation Fund as incorporated in 2016 Act will cover the cost of education-cum-food of the rescued and rehabilitated children.

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"Agriculture is our wisest pursuit, because it will in the end contribute most to real wealth, good morals, and happiness."

—Thomas Jefferson

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