Working Paper 265

Total Factor Productivity Growth and Its Determinants in Karnataka Agriculture

Elumalai Kannan

ISBN 978-81-7791-121-3

Institute for Social and Economic Change (ISEC) is engaged in interdisciplinary research in analytical and applied areas of the social sciences, encompassing diverse aspects of development. ISEC works with central, state and local governments as well as international agencies by undertaking systematic studies of resource potential, identifying factors influencing growth and examining measures for reducing poverty. The thrust areas of research include state and local economic policies, issues relating to sociological and demographic transition, environmental issues and fiscal, administrative and political decentralization and governance. It pursues fruitful contacts with other institutions and scholars devoted to social science research through collaborative research programmes, seminars, etc.

The Working Paper Series provides an opportunity for ISEC faculty, visiting fellows and PhD scholars to discuss their ideas and research work before publication and to get feedback from their peer group. Papers selected for publication in the series present empirical analyses and generally deal with wider issues of public policy at a sectoral, regional or national level. These working papers undergo review but typically do not present final research results, and constitute works in progress.

TOTAL FACTOR PRODUCTIVITY GROWTH AND ITS DETERMINANTS IN KARNATAKA AGRICULTURE

Elumalai Kannan*

Abstract

The present study has estimated TFP of ten major crops grown in the Indian state of Karnataka and analysed its determinants. Growth accounting method of Tornqvist-Theil Index has been used for estimating TFP. The study has relied on Cost of Cultivation data published by the Ministry of Agriculture, Government of India. The study draws motivation from the lack of research evidence to show whether productivity growth in the crop sector has improved post 2000s on account of its widespread slow down or negative growth witnessed during 1980s and 1990s. The analysis confirms that most crops have registered low productivity growth across these periods. Interestingly, during 2000-01 to 2007-08 all crops have showed a positive growth in TFP. Further, the analysis of determinants of TFP indicates that the government expenditure on research, education and extension, canal irrigation, rainfall and balanced use of fertilisers are the important drivers of crop productivity in Karnataka. It is necessary that both public and private investment should be enhanced in agricultural research and technology, and rural infrastructure for sustaining productivity growth in the long run.

Background

Karnataka is one of the developed Indian states placed above the median level of social and economic development (Bhalla and Singh 2001; Deshpande 2004). The growth and structure of Karnataka economy have undergone dramatic changes since the introduction of the new economic policy in 1990s. The economy has registered an impressive average annual growth rate of over 7.0 per cent during 1999-00 to 2007-08 with a major share of this high growth coming largely from the booming service (tertiary) sector. With structural change, the share of agriculture and allied sector in the Gross State Income (at 1999-00 prices) declined from 30.8 per cent in 1999-00 to 16.4 per cent in 2008-09, while the share of the industry increased only marginally from 23.9 per cent to 27.7 per cent. However, the contribution of the service sector increased significantly from 45.3 per cent to 55.9 per cent between 1999-00 and 2007-08. The structural changes observed in the state economy are largely in line with the changes evident at the national level.

Considering the fact that the overall economy has been greatly influenced by the tertiary sector with an anticipated decline in the contribution of the agricultural and allied sectors to state income, the structural transformation should have substantially transferred people dependent on agriculture to non-agricultural sector. However, this has not happened both at the state and national levels. According to the 2001 Population Census, out of 23.5 million total workers, about 13.1 million workers (55.7 per cent) depend on the agriculture and allied sector for employment in the state of Karnataka. A decline in income share combined with a large dependent workforce on agriculture has hindered productivity gains in this sector over time. Further, despite considerable efforts made by the state government to augment the irrigation potential, area irrigated to gross cropped area has remained low at 29 per cent.

---

* Associate Professor, ADRTC, Institute for Social and Economic Change (ISEC), Bangalore-560 072. Author would like to thank the anonymous referee for useful comments.

The green revolution technology introduced in the late 1960s in the form of new seeds cum chemical fertilisers had greatly helped to increase crop production in the State. This was made possible with a higher public investment in agricultural research, education and training, irrigation and other infrastructures. However, the technological gains could not spread evenly across regions and crops in the state due to diverse agro-climatic conditions and varying natural resource endowments. The growth performance of the agricultural sector has also been varied with wide fluctuations. Meanwhile, there were concerns on stagnation in production and productivity of crops during 1980-81 to 1989-90. An Expert Committee constituted by the State Government in 1993 had concluded that investments made in agriculture during 1980s were not optimally utilised to sustain the growth momentum witnessed during the seventies. While analysing the impediments to agricultural growth, Deshpande (2004) contended that both public and private investments have not adequately been made in the backward regions particularly in the un-irrigated plateau zone of Northern Karnataka and that of Southern Karnataka to spur the growth process. There is also empirical evidence to suggest that productivity growth measured by Total Factor Productivity (TFP) declined during the eighties (Ananth *et al*, 2008). But, there is lack of research evidence to show whether declining productivity growth in the crop sector has reversed during the recent years. This is particularly important from the point of view of renewed efforts made by the state government through various developmental programmes for accelerating growth in the agricultural sector. This, in fact forms the motivation for the present study to estimate and analyse trends in total factor productivity of important crops in the state of Karnataka. From the policy perspective also, it is important to assess and understand the determinants of TFP so as to take appropriate initiatives for accelerating agricultural output growth. More specifically, the present study estimates total factor productivity growth of major crops in Karnataka and analyses the factors affecting TFP at the state level.

The rest of the paper is organised as follows. The second section discusses data and analytical method. Changes in cropping pattern and growth in area, production and yield of crops are presented in the third and fourth section, respectively. Fifth section analyses trends in public investment in Karnataka agricultural sector. Cost structure of major crops is discussed in the sixth section. Seventh and eight sections discuss growth in input, output and TFP index, and determinants of TFP, respectively followed by concluding remarks in the final section.

Data and Methodology

1. Data

In the present study, TFP is estimated taking into account two outputs and nine inputs. Output index includes main product and by-product. The input index comprises seed, fertiliser, manure, human labour, animal labour, machine labour, pesticide, irrigation and land. Data on quantity and value of output and inputs for ten major crops viz., paddy, jowar, maize, ragi, arhar, groundnut, sunflower, safflower, cotton and sugarcane have been compiled from Cost of Cultivation of Principal Crops published by the Ministry of Agriculture, Government of India and the Department of Agriculture, Government of Karnataka. However, as for some inputs only value is available, the quantity of such inputs is measured through indirect methods.

For instance, the quantity of by-product has been generated by using grain-straw ratios as given by Nirman *et al* (1982) and Kolay (2007), while machine labour is measured as number of four-wheeled tractors. Land has been measured as the total area under respective crops. The wholesale price index of pesticides and electricity consumption in agriculture has been used to derive the quantity of pesticides and irrigation, respectively. Further, for constructing aggregate (weighted) output, input and TFP indices for Karnataka as whole, the share of area of respective crops in total gross cropped area have been used as weights.

To analyse the determinants of total factor productivity, the data on government expenditure on research and education, extension and farmers training, rural literacy, canal irrigation, rainfall and fertiliser consumption have been compiled from published sources. The Combined Finance Accounts published by Comptroller and Auditor General of India provides data on expenditure on research, education and extension. Information on canal irrigation, fertiliser consumption, rainfall and rural literacy has been compiled from Statistical Abstract of Karnataka published by the Directorate of Economics and Statistics, Government of Karnataka.

2. Analytical Method

In simple terms, productivity is defined as the ratio of output to input. The partial productivity measures like labour productivity and land productivity are of limited use in the presence of multiple outputs and multiple inputs as they do not indicate the overall productivity when considered in isolation. When the productivity concept is extended beyond single output and single input case, an alternative approach for aggregating outputs and inputs is used. The Total Factor Productivity (TFP) relates aggregate output index to aggregate input index. Growth accounting (index number method) is commonly used for measuring TFP in the agricultural sector as it is easier to implement without econometric estimation (Evenson *et al* (1999); Kumar and Mruthynjaya (1992); Kumar and Rosegrant (1994); Desai and Namboodiri (1997); Mukherjee and Kuroda (2003); Elumalai and Pandey (2004); Kumar *et al* (2004); Murgai (2005)). Under growth accounting method, TFP measures growth in output which is not accounted for growth in inputs. In other words, the residual productivity is considered as a measure of technical change, which indicates a shift in the production function.

Among index number methods Tornqvist-Theil index, which is an approximation to Divisia index, is widely used for constructing the aggregate output index and aggregate input index. The properties and difficulties in using Divisia index in its original integral form are expounded in Hulten (1973). The popularity of Tornqvist-Theil index can be attributed to the fact that it is exact for linear homogenous translog production function and such an index is called 'superlative' by Diewert (1976). Further explanation on theoretical properties and issues in measurement can be found in Diewert (1978, 1980), Christensen (1975), Capalbo and Antle (1988) and Coelli *et al* (2005).

Tornqvist-Theil output, input and TFP index in logarithmic form can be expressed as follows.

Output Index

$$\ln\left(Q_t / Q_{t-1}\right) = 1/2 \sum_j \left(S_{jt} + S_{jt-1}\right) \ln\left(Q_{jt} / Q_{jt-1}\right)$$

Input Index

$$\ln\left(X_t / X_{t-1}\right) = 1/2 \sum_i \left(S_{it} + S_{it-1}\right) \ln\left(X_{it} / X_{it-1}\right)$$

TFP Index

$$\ln\left(TFP_t / TFP_{t-1}\right) = \ln\left(Q_t / Q_{t-1}\right) - \ln\left(X_t / X_{t-1}\right)$$

Where, S_{jt} is the share of output j in total revenue, Q_{jt} is output j, S_{it} is the share of input i in total input cost, X_{it} is input i and all specified in time t.

For constructing TFP index, chain index is preferred to fixed base index (Coelli *et al*, 2005). Chain index combines annual changes in productivity to measure changes in productivity over a period of time. Formally, let I (t+1, t) be an index for the period t+1 with the base period t. This index is applied to time series t=0 to T. A comparison between period t and fixed base 0 is made by following chain indexing of successive periods.

I(0,t) = I(0,1) x I(1,2) x I(2, 3) x.....x I(t-1, t)

Changes in Cropping Pattern

Food grain crops dominate the cropping pattern accounting for about two-thirds of the total gross cropped area (GCA) in Karnataka **(Table 1)**. Among food grains, coarse cereals occupy a prominent place in the cropping pattern. Nevertheless, per cent area under food grains has declined from 71.9 per cent in the triennium ending 1962-63 to 60.0 per cent in the triennium ending 2007-08. However, the decline in area under food grains is offset by an increase in area under oilseeds and other crops (which includes coconut, arecanut, chillies and coffee). Data on horticultural crops compiled by the Directorate of Economics and Statistics, Government of India and National Horticultural Board (NHB) do not match due to differences in the method of data collection. The coverage of crops by these two government agencies also differs. Despite data limitations as per NHB data, the share of area under fruits and nuts in the GCA has marginally declined during recent years. However, the share of area under vegetables has increased to 3.1 per cent in 2007-08 from 1.0 per cent in 1992-93.

During 2007-08, jowar and rice have occupied predominant positions in the cropping pattern followed by sunflower and maize. Despite accounting for relatively high share, area under jowar declined drastically since the early sixties. A similar pattern could be noticed with respect to other

coarse cereals like bajra, ragi and small millets. In fact, jowar and small millets seem to have lost their area by over 50 and 80 per cent, respectively between 1962-63 and 2007-08. However, crops like maize, arhar (pigeon pea) and gram have gained in their relative area during the study period. Maize constituted only 0.1 per cent of GCA in 1962-63, which has steadily increased to reach 1.4 per cent in 1982-83 and then to 7.8 per cent in 2007-08. Similarly, per cent area under arhar in total cropped area has increased from 2.5 per cent in 1972-73 to 4.9 per cent in 2007-08. Although the share of area under gram decelerated during the seventies and early eighties, it started picking up since nineties.

Table 1: Changes in Cropping Pattern in Karnataka

(Percentage share of GCA)

Crop	TE 1962-63	TE 1972-73	TE 1982-83	TE 1992-93	TE 2000-01	TE 2007-08
Rice	9.9	10.7	10.3	10.3	11.9	11.2
Jowar	28.0	21.8	19.2	18.0	15.4	11.3
Bajra	4.8	4.6	5.4	3.3	2.6	3.3
Maize	0.1	0.7	1.4	2.3	4.9	7.8
Ragi	9.6	9.8	9.8	8.8	8.1	6.2
Wheat	2.9	2.9	3.0	1.7	2.2	2.1
Small Millets	4.2	4.1	3.2	1.1	0.6	0.3
Cereals	59.7	55.4	52.4	45.5	46.6	42.2
Arhar	2.7	2.5	3.3	3.9	4.3	4.9
Gram	2.5	1.4	1.3	1.7	2.8	4.4
Pulses	11.9	11.0	13.2	13.8	15.8	17.6
Foodgrains	71.9	68.3	66.6	59.4	62.4	59.7
Groundnut	8.4	9.2	7.6	10.5	9.3	7.1
Sunflower	-	-	1.0	8.6	4.9	9.6
Total Oilseeds	9.7	11.0	12.2	22.7	17.3	19.5
Cotton	9.3	10.2	9.0	5.0	4.7	3.1
Sugarcane	0.7	1.0	1.6	2.2	3.1	2.2
Tobacco	0.4	0.3	0.5	0.4	0.6	0.8
Fruits and nuts	-	-	-	1.2	2.6	2.1
Vegetables	-	-	-	1.0	2.8	3.1
Others*	0.7	1.3	4.6	4.8	6.7	7.2
GCA	100.0	100.0	100.0	100.0	100.0	100.0

Note: * include coconut, arecanut, chillies and coffee
Source: Statistical Abstracts of Karnataka (various issues), Government of Karnataka

Groundnut is one of the traditional crops grown in Karnataka both under irrigated and rain fed conditions. The per cent area under this crop declined sharply since 2000 due to persistent drought like conditions prevailing in the State. However, share of area under sunflower registered sharp increase from 1.0 per cent in 1982-83 to 9.6 per cent in 2007-08. Among cash crops, the area under cotton declined drastically over time. However, sugarcane area increased considerably from 1960s to 2000s,

but showed declining trend since 2001-02. It emerges from the analysis that there has been a marked shift in area from cereals to pulses, oilseeds and high value crops like vegetables and plantation crops.

Growth in Area, Production and Yield

The compound annual growth in area, production and yield of major crops grown in Karnataka is given in **Table 2.** Growth rates have been computed for four different periods viz., pre-green revolution (1960-61 to 1966-67), green revolution (1967-68 to 1979-80), post-green revolution (1980-81 to 1989-90) and economic reforms (1990-91 to 2007-08). The compound annual growth in area under food grains was 0.3 per cent during pre-green revolution period, but it declined to -0.1 per cent in during green revolution period. However, growth in food grains production was high at of 3.5 per cent during the green revolution period. This high growth rate has largely come from growth in yield (3.8 per cent) when compared to pre-green revolution period during which growth in production was contributed by growth in area. However, during post-green revolution period growth in area under food grains was positive at 0.4 per cent, but growth in its production has declined due to fall in growth in yield. During the period of economic reforms, food grains production grew at a respectable rate of 2 per cent per annum, which was mainly contributed by growth in yield. These results broadly indicate that the growth in yield of food grains has fallen during 1980s and consequently impacted production. Interestingly, decline in growth in production and yield has got reversed during the recent period.

However, the crop-wise analysis of growth rates is more revealing. During the pre-green revolution, growth in area for most of the food crops was negative except rice (2.5 per cent), maize (12.0 per cent), ragi (3.5 per cent) and arhar (0.7 per cent), while growth in yield was negative for rice, maize, ragi, small millets and wheat. However, the situation has changed from mid-1960s to 1970s during which Karnataka agriculture has started benefiting from the new seed and fertiliser technology. In fact, this period can be called the golden period of Karnataka agriculture with relatively high growth in production of most crops. Although area growth under certain crops has declined, remarkable achievements have been made on the fronts of production and yield growth. Except gram, yield of all other food grain crops have recorded positive growth during this period.

Table 2: Compound Annual Growth Rates of Area, Production and Yield of Major Crops

Crop	1960-61 to 1966-67			1967-68 to 1979-80			1980-81 to 1989-90			1990-91 to 2007-08		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Rice	2.5	1.7	-1.0	-0.4	1.9	2.2	0.2	0.0	-0.2	0.4	1.7	1.3
Bajra	-0.3	1.7	1.9	3.0	5.6	2.6	-2.9	0.4	3.2	0.2	1.7	1.5
Jowar	-1.0	3.0	3.8	-2.5	0.8	3.5	1.4	-0.1	-1.5	-2.5	-1.4	1.1
Maize	12.0	2.2	-8.1	12.0	15.0	3.0	6.1	7.0	0.8	8.6	7.9	-0.7
Ragi	3.5	-7.2	-10.3	0.9	8.4	6.7	0.9	0.6	-1.7	-1.7	-0.6	1.1
Small Millets	-2.9	-5.3	-2.5	2.3	8.0	5.6	-6.9	-5.8	1.2	-7.0	-6.2	0.9
Wheat	-3.4	-8.5	-6.3	2.3	7.1	4.7	-3.8	-6.4	-5.5	1.3	1.9	0.6
Cereals	0.3	0.3	0.0	-0.3	3.5	4.2	0.2	0.4	0.2	-0.7	1.9	2.1
Arhar	0.7	2.9	2.0	1.3	5.3	3.9	4.2	2.0	-2.1	5.7	6.3	3.5
Gram	-12.9	-4.2	8.8	-1.7	-2.1	-0.3	6.1	3.0	-3.9	2.7	8.1	2.3
Pulses	-2.1	1.5	0.0	2.2	3.4	2.5	1.7	0.1	-1.0	1.2	3.9	2.7
Foodgrains	0.3	0.4	0.1	-0.1	3.5	3.8	0.4	0.4	0.1	0.4	2.0	1.6
Groundnut	0.3	3.2	0.1	-1.0	-1.6	-0.6	5.0	7.1	2.0	-2.7	-4.6	-1.9
Sunflower	-	-	-	-9.0	-11.2	-2.4	32.1	26.8	-4.0	0.3	1.6	1.4
Total Oilseeds	-1.4	1.2	1.5	3.4	3.3	-0.1	7.7	9.2	0.8	-1.2	-1.8	-0.5
Cotton	0.1	-7.3	-6.2	0.3	4.9	3.9	-7.3	1.7	9.7	-3.1	-2.8	0.3
Sugarcane	4.1	6.6	2.1	4.2	2.0	-2.1	4.7	5.4	0.6	-0.3	-0.5	-0.2
Tobacco	-1.9	-9.5	-8.6	1.4	5.4	4.7	-0.6	1.4	1.9	4.3	1.0	-3.2
Fruits and nuts	-	-	-	-	-	-	-	-	-	0.6	0.2	-0.4
Vegetables	-	-	-	-	-	-	-	-	-	1.8	-0.2	-2.0

Source: Statistical Abstracts of Karnataka (various issues), Government of Karnataka

However, the momentum in yield growth in food grains did not appear to continue during the 1980s with most of the crops registering negative growth rates. Only bajra, maize and small millets have witnessed positive growth in yield. Except gram, growth in production of food crops has declined. But, during 1990-91 to 2007-08 there was a reversal in growth in yield of food grain crops. Only maize has registered negative growth in yield, but its production growth was impressive at 7.9 per cent, which was contributed by high growth in area. Despite positive growth in yield, production of jowar, ragi and small millets was negative due to drastic decline in their area.

The performance of oilseeds appeared better during the 1980s with the introduction of Technology Mission of Oilseeds. The growth in area under total oilseeds was negative at 1.4 per cent during pre-green revolution period, but increased positively to 3.4 per cent in green-revolution period and then to 7.7 per cent during post-green revolution period. Although growth in yield of oilseeds has not changed in the same manner as the expansion of area, but it has registered positive growth of 0.8 per cent during 1980s. However, growth momentum did not continue during 1990-91 to 2007-08. The growth in area, production and yield of all oilseeds was negative. Among individual oilseed crops, growth in area, production and yield of sunflower was positive, while that of groundnut negative.

In case of cotton, growth in area has declined continuously since 1980s. However, it is encouraging to note that growth in yield of cotton has increased from -6.2 per cent in the pre-green revolution period to 3.9 per cent in the green-revolution and 9.7 per cent in post-green revolution periods. Unfortunately, it has again declined during the recent period. Meanwhile, the growth in production of sugarcane was found largely driven by increase in area during pre-green revolution, green revolution and post-green revolution periods. But, negative growth in its area as well as yield has resulted in decline in production during the reforms period. Area under tobacco has showed high growth rate during the recent period, which has helped to register positive growth in its production. Overall, the growth analysis indicates that the yield of most crops particularly food grains have declined during 1980-81 to 1989-90 leading to stagnation in production. Interestingly, during 1990-91 to 2007-08 there is reversal in growth rate in production and yield for some food and non-food crops. Among various growth promoting factors, the public investment in agriculture seemed to have played an important role in accelerating growth and this merits some discussion here.

Public Investment in Agriculture

Table 3: Public Investment in Agriculture and Allied Sector

Year	Capital Expenditure (Rs. Lakhs)		Capital Expenditure/000' ha of Net Sown Area (Rs.)	
	Current Prices	Constant Prices (1999-00)	Current Prices	Constant Prices (1999-00)
TE 1976-77	1077	6737	10806	67490
TE 1982-83	1355	5689	13320	55985
TE 1992-93	1368	2405	12946	22780
TE 2002-03	2753	2571	27208	25400
TE 2008-09	8484	6122	81755	59007

Source: Finance Accounts (various issues), Comptroller and Auditor General of India

Public investment in agriculture takes place in the form of provisions of basic infrastructures like irrigation, market, roads, storage facilities, and research and technology. **Table 3** presents public investment in agriculture and allied sectors in Karnataka. In absolute terms (at 1999-00 prices) average public investment in agriculture amounted to Rs. 6,737 lakhs during triennium ending 1976-77 and it had declined steadily to Rs. 2,405 lakhs in triennium ending 1992-93. Although there was a reversal in trend during recent years, it had never reached the level registered during 1976-77. A similar trend can be observed on per thousand hectare basis also. In fact, capital expenditure per thousand hectare of net sown area was Rs. 67,490 in 1976-77 and thereafter it declined continuously till late nineties.

The decline in public investment seems to have adversely affected growth in the agriculture sector during 1980s and early 1990s. According to the Report of the Expert Committee (1993) constituted by the Government of Karnataka, decline in investment along with its non-optimal utilisation has resulted in stagnation in agricultural productivity. Public investment in agricultural infrastructure has the potential to attract private investment, which might help to make improvements in farming activities. Understandably, increase in public investment in the agricultural sector during the early 2000s has provided some hope for the revival of growth in the sector. It is also quite encouraging to note the seriousness of the state government to invigorate agricultural research and education for developing and disseminating better technology to farmers. This is evident from a high growth in public investment in agricultural research and education by 10.1 per cent during 2000-01 to 2007-08, which otherwise has been declining continuously from 15.8 per cent in 1970s to 6.8 per cent in 1980s and 4.7 per cent in 1990s (Kannan and Shah, 2010).

Changing Cost Structure of Principal Crops

The cost structure of crops has changed with the advent of new technology, machinery and management practices. The availability of modern inputs at affordable rates and their increased use determine crop productivity. In this section, an attempt has been made to analyse the trends in cost structure of major crops like paddy, jowar, arhar, groundnut and cotton. Traditional inputs like land and human labour have accounted for over 50 per cent of the total cost of paddy cultivation in Karnataka **(Table 4a)**. The cost share of seed was 4.5 per cent during triennium ending 1982-83, while declining to about 3.2 per cent in 1992-93 and further down to 2.8 per cent in 2007-08. The decline in cost of seed might be due to supply of seeds at subsidised rate by the state government through developmental programmes and schemes.

While the per cent cost share of animal labour has declined, the share of machine labour has increased over time. The share of pesticides by and large, has increased between 1982-83 and 2000-01. However, the share of fertilisers in the total cost of cultivation has showed declining trend. “Others” included land revenue, cesses and taxes, interest on working and fixed capital, and depreciation on farm implements and buildings. The cost share of “others” has by and large, showed declining trend over time.

Table 4a: Trends in Cost Structure of Paddy

(Per Cent)

Items	TE 1982-83	TE 1992-93	TE 2000-01	TE 2007-08
Traditional Inputs				
Land	28.4	31.1	27.5	27.5
Seed	4.5	3.2	3.1	2.8
Manure	6.8	3.9	4.7	2.0
Human Labour	25.8	30.1	31.7	29.0
Animal Labour	9.8	7.7	4.8	5.4
Modern Inputs				
Pesticides	0.3	2.0	2.8	2.2
Irrigation	2.2	2.2	2.2	3.0
Fertilizers	10.8	9.3	11.8	13.3
Machine Labour	0.6	2.2	6.2	9.2
Others	10.9	8.4	5.3	5.7
Total Cost	**100.0**	**100.0**	**100.0**	**100.0**

Source: Cost of Cultivation of Principal Crops in India, Government of India

Jowar is one of the major coarse cereals cultivated in Karnataka. Of the total cost of cultivation, land and human labour together accounted for about 50 per cent **(Table 4b)**. As this crop is cultivated largely under dry land conditions, the use of modern inputs like fertilisers, pesticides and irrigation are very much limited. The respective share of pesticides and irrigation was less than one per cent of the total cost. Animal labour accounted for relatively high cost share when compared to that of machine labour. Further, the cost share of seed has come down marginally over time due to the operation of State subsidy schemes for distribution of seeds to small and marginal farmers. Overall, traditional inputs accounted for about three-fourth of the total cost.

Table 4b: Trends in Cost Structure of Jowar

(Per Cent)

Items	TE 1982-83	TE 1992-93	TE 2000-01	TE 2007-08
Traditional Inputs				
Land	25.4	30.0	21.9	22.1
Seed	3.3	2.0	2.2	1.9
Manure	4.7	2.7	3.4	1.1
Human Labour	25.9	24.8	28.9	32.0
Animal Labour	16.8	9.9	15.9	19.2
Modern Inputs				
Pesticides	0.3	0.8	0.4	0.0
Irrigation	0.9	1.1	0.7	0.3
Fertilizers	6.4	9.4	9.7	8.2
Machine Labour	1.0	2.2	5.6	5.7
Others	15.5	17.3	11.3	9.5
Total Cost	**100.0**	**100.0**	**100.0**	**100.0**

Source: Cost of Cultivation of Principal Crops in India, Government of India

Table 4c: Trends in Cost Structure of Arhar

(Per Cent)

Items	TE 1982-83	TE 1992-93	TE 2000-01	TE 2007-08
Traditional Inputs				
Land	29.1	26.3	22.2	26.0
Seed	4.9	3.8	3.4	3.1
Manure	3.5	3.7	3.8	3.8
Human Labour	25.8	28.2	27.9	25.0
Animal Labour	12.6	10.8	11.3	13.5
Modern Inputs				
Pesticides	11.7	11.5	7.0	9.0
Irrigation	0.0	0.0	0.6	0.0
Fertilizers	3.1	4.6	7.3	5.9
Machine Labour	0.0	0.7	4.6	4.6
Others	9.2	10.3	11.9	9.2
Total Cost	**100.0**	**100.0**	**100.0**	**100.0**

Source: Cost of Cultivation of Principal Crops in India, Government of India

Arhar is largely cultivated under dry land conditions. The availability of improved varieties and favourable prices has induced farmers to expand the area under arhar in recent times. Traditional inputs accounted for about two-thirds of the total cost. Land and human labour together accounted for a relatively high cost shares **(Table 4c)**. The cost share of pesticides was little over 11 per cent until 1992-93, but has come down during the recent years. Further, the share of fertilisers has showed increasing trend over time. Although use of machine labour has increased, animal labour continues to dominate operations in the cultivation of arhar.

Table 4d: Trends in Cost Structure of Groundnut

(Per Cent)

Items	TE 1982-83	TE 1992-93	TE 2000-01	TE 2007-08
Traditional Inputs				
Land	23.0	27.8	19.4	22.7
Seed	21.5	22.9	19.4	20.2
Manure	5.7	4.8	4.0	1.7
Human Labour	21.7	20.8	29.2	23.9
Animal Labour	9.7	7.2	9.0	10.4
Modern Inputs				
Pesticides	0.2	1.0	0.4	0.4
Irrigation	0.3	0.9	1.1	1.7
Fertilizers	6.4	4.9	6.3	6.0
Machine Labour	0.2	0.3	2.3	4.9
Others	11.4	9.5	8.9	8.1
Total Cost	**100.0**	**100.0**	**100.0**	**100.0**

Source: Cost of Cultivation of Principal Crops in India, Government of India

Groundnut is an important oilseed crop cultivated in Karnataka. Among the cost components, seed cost accounted for about one-fifth of the total cost of cultivation **(Table 4d)**. Human labour and animal labour have accounted for about 23.9 per cent and 10.4 per cent, respectively of the total cost in 2007-08. Since, this crop is cultivated largely under dry land conditions, the share of improved inputs like pesticides, irrigation and machine labour is found to be low. However, the cost share of fertilisers has, by and large, increased over time.

The cost structure of cotton is presented in **Table 4e**. Traditional inputs constituted about 70 per cent of the total cost. Among traditional inputs, land and human labour accounted for 50 per cent. Interestingly, the cost share of animal labour, by and large has declined, while that of machine labour increased. The share of pesticides has declined considerably during recent years with 3.3 per cent in 2007-08. This might be due to rapid spread of B.t. cotton technology in the state. Fertilisers and others have constituted about 8.7 per cent and 6.6 per cent, respectively.

Table 4e: Trends in Cost Structure of Cotton

(Per Cent)

Items	TE 1982-83	TE 1992-93	TE 2000-01	TE 2007-08
Traditional Inputs				
Land	25.6	30.6	20.6	27.4
Seed	3.6	5.8	6.3	10.0
Manure	2.2	4.1	4.1	2.9
Human Labour	27.1	20.5	30.4	26.9
Animal Labour	4.7	9.7	11.4	8.3
Modern Inputs				
Pesticides	14.0	6.9	6.4	3.3
Irrigation	0.1	0.3	0.9	0.8
Fertilizers	16.6	9.5	8.7	8.7
Machine Labour	2.3	2.0	1.7	5.2
Others	3.6	10.5	9.6	6.6
Total Cost	**100.0**	**100.0**	**100.0**	**100.0**

Source: Cost of Cultivation of Principal Crops in India, Government of India

It is clear from the analysis of cost structure that traditional inputs have accounted for higher cost shares than modern inputs. However, the share of modern inputs like machine labour and fertilisers have by and large, increased over time. As expected, the cost share of irrigation is found to be low for major crops grown in Karnataka.

Growth in Output, Input and TFP Index

Average annual growth in output, input and TFP index for ten major crops across different periods is presented in **Table 5**. The period of analysis for different crops is guided by the availability of data on inputs and output from the cost of cultivation study. It can be observed from the table that TFP of paddy has registered positive growth during 1980-81 to 1989-90 (1980s), 1990-91 to 1999-00 (1990s)

and 2000-01 to 2007-08 (2000s). Higher output growth triggered by technological change has resulted in positive TFP growth. Annual growth in TFP was impressive at 1.48 per cent in the 1990s and 2.68 per cent in the 2000s when compared to 0.42 per cent during the 1980s. For the entire period of analysis, i.e. 1980-81 to 2007-08 TFP has risen at 1.49 per cent. Overall, the contribution of TFP to output growth was found to be 60.02 per cent. The contribution of technological change to paddy output growth was positive and respectable across sub-periods. This indicates that the productivity growth rather than the input growth is the main driver of paddy production in Karnataka.

Table 5: Annual Growth in Input, Output and TFP Index of Various Crops in Karnataka (%)

Crop	Input	Output	TFP	Share of TFP in Output Growth
Paddy				
1980-81 to 1989-90	0.42	0.84	0.42	50.20
1990-91 to 1999-00	2.99	4.47	1.48	33.19
2000-01 to 2007-08	-0.87	1.82	2.69	147.53
1980-81 to 2007-08	0.99	2.48	1.49	60.02
Jowar				
1980-81 to 1989-90	1.71	2.70	0.99	36.56
1990-91 to 1999-00	0.45	-0.90	-1.35	150.55
2000-01 to 2007-08	-0.97	6.45	7.42	115.00
1980-81 to 2007-08	0.45	2.48	2.03	81.74
Maize				
1980-81 to 1989-90	0.54	2.52	1.98	78.60
1990-91 to 1999-00	0.79	-0.56	-1.35	241.98
2000-01 to 2007-08	0.69	3.91	3.23	82.46
1980-81 to 2007-08	0.68	1.79	1.12	62.22
Ragi				
1980-81 to 1989-90	0.95	-2.70	-3.65	135.22
1990-91 to 1999-00	1.84	2.66	0.82	30.83
2000-01 to 2007-08	-1.19	6.56	7.75	118.17
1980-81 to 2007-08	0.64	2.03	1.39	68.25
Arhar				
1980-81 to 1989-90	1.63	7.10	5.47	77.06
1990-91 to 1999-00	2.12	-0.75	-2.87	382.89
2000-01 to 2007-08	0.15	7.29	7.14	97.89
1980-81 to 2007-08	1.37	4.25	2.88	67.65
Groundnut				
1980-81 to 1989-90	3.27	3.83	0.56	14.70
1990-91 to 1999-00	-1.59	-3.27	-1.68	51.29
2000-01 to 2007-08	-1.01	10.97	11.98	109.18
1980-81 to 2007-08	0.20	3.32	3.12	93.93

Contd...

Crop	Input	Output	TFP	Share of TFP in Output Growth
Sunflower				
1980-81 to 1989-90	11.49	12.04	0.55	4.57
1990-91 to 1999-00	-1.16	-1.28	-0.12	9.48
2000-01 to 2007-08	3.02	6.38	3.35	52.59
1980-81 to 2007-08	4.30	5.43	1.13	20.85
Safflower				
1980-81 to 1989-90	5.77	15.20	9.43	62.02
1990-91 to 1999-00	-1.52	1.45	2.97	205.06
2000-01 to 2007-08	0.41	1.74	1.32	76.19
1980-81 to 2007-08	1.48	6.12	4.64	75.77
Cotton				
1980-81 to 1989-90	0.34	4.00	3.67	91.59
1990-91 to 1999-00	-0.56	-4.98	-4.42	88.77
2000-01 to 2007-08	-1.77	15.62	17.39	111.34
1980-81 to 2007-08	-0.62	4.12	4.74	115.04
Sugarcane				
1980-81 to 1989-90	-7.03	-0.34	6.69	Negative
1990-91 to 1999-00	6.04	0.78	-5.27	Negative
2000-01 to 2007-08	-0.55	0.97	1.51	156.45
1980-81 to 2007-08	-0.27	0.46	0.73	157.93
All Crops				
1980-81 to 1989-90	1.72	1.81	0.09	4.95
1990-91 to 1999-00	0.42	-0.56	-0.98	174.27
2000-01 to 2007-08	0.13	5.01	4.88	97.47
1980-81 to 2007-08	0.77	1.88	1.11	59.26

Jowar has registered output growth of 2.7 per cent in the 1980s. But, a higher growth of inputs over output during nineties has resulted in negative TFP growth. However, TFP had risen positively during 2000-01 to 2007-08. During 1980-81 to 2007-08 annual growth in TFP was 2.03 per cent, which contributed over 80 per cent of jowar output growth. A similar growth pattern could also be observed in case of maize. Growth in maize output index was impressive at 2.52 per cent in the 1980s, but it had declined to 0.56 per cent in the 1990s. However, turnaround in higher output growth in recent periods has been commendable. Overall, TFP of maize has grown at 1.12 per cent contributing 62.22 per cent of output growth.

In case of Ragi, except in 1980s both output and TFP have registered positive growth rates across all other periods of analysis. During 1990s and 2000s, it showed impressive output growth of 2.66 and 6.56 per cent, respectively. Annual growth in TFP during the corresponding periods was 0.82 per cent and 7.75 per cent. For the entire period of analysis, TFP has recorded annual growth rate of 1.39 per cent contributing 68.25 per cent of total output growth.

As for Arhar, except during 1990s output growth was mainly driven by technology. In fact, output growth of arhar was impressive at 7.10 per cent and 7.29 per cent during 1980s and 2000s, respectively. Growth in TFP during the corresponding periods was 5.47 per cent and 7.14 per cent. Overall, growth in TFP of arhar was 2.88 per cent with a contribution of 67.65 per cent to output growth.

Barring 1990-91 to 1999-2000, the growth in output and TFP of groundnut was positive in all other periods under study. TFP has registered a positive growth rate of 0.56 per cent in the 1980s. But, it has decelerated to -1.68 per cent in the 1990s. During entire period of analysis, the respective growth in output and TFP was 3.32 per cent and 3.12 per cent. TFP has contributed about 93.93 per cent to output growth indicating that technology has played a greater role in augmenting the production of groundnut in Karnataka.

With respect to Sunflower production, use of inputs seems to be relatively high. The growth in inputs was the main driver of output growth during 1980s and 1990s. Interestingly, during 2000s growth in output and TFP of sunflower was positive at 6.38 per cent and 3.35 per cent, respectively. Contrarily, the growth pattern of TFP appears to be different for safflower with both output and TFP rising positively across all periods. However, growth in TFP has decelerated from 9.43 per cent in 1980s to 2.97 per cent in 1990s and then to 1.32 per cent in 2000s.

For cotton, input, output and TFP have shown positive growth rates during 1980s. TFP has registered healthy growth rate of 3.67 per cent with its contribution of 91.59 per cent to output growth. However, during 1990s all the three indices have registered negative growth. But, output and TFP grew impressively in 2000s which could be attributed to spread of B.t. cotton technology. For the entire period of analysis growth in output and TFP was 4.12 and 4.74 per cent, respectively. Technical change seems to have played an important role in increasing cotton output growth in Karnataka.

In case of sugarcane, input and output index have showed negative growth during 1980s. However, high input growth as compared to output growth has resulted in negative TFP growth of 5.27 per cent in 1990-91 to 1999-00. During 2000s growth in output and TFP was 0.97 and 1.51 per cent, respectively. Overall, TFP of sugarcane has registered positive growth of only 0.73 per cent indicating that sugarcane production is input based with technology playing some role in it.

With regards to Karnataka state as whole, during the entire period of analysis, input and output indices have registered growth rate of 0.77 and 1.85 per cent, respectively. TFP has risen at 1.09 per cent per annum and it has contributed 58.67 per cent to total output growth. Low TFP growth implies that there is huge scope for increasing agricultural production through new technological breakthrough. Among sub-periods, growth in TFP was found negligible during the 1980s supporting the contention that crop sector in Karnataka had witnessed stagnation in growth during that period. Even though output and TFP have showed negative growth rates in the 1990s, they have improved remarkably during the 2000s. In fact, the deceleration in TFP growth in Indian agriculture during 1990s has been well documented in Kumar *et al* (2004 and 2008).

Determinants of Total Factor Productivity

In this section, an attempt has been made to analyse the determinants of total factor productivity of the crop sector in Karnataka. The analysis has been carried out at the state level by aggregating the crop-wise TFP index using area share as weights. To examine the determinants of TFP, a multiple regression technique in double log functional form was carried out.

The TFP index was regressed on the following variables.

TFP = f (RES_EXP, EXT, RURALLIT, CANALIRR, KHRAIN, PNR)

Where,

RES_EXP is Government expenditure on research and education (Rs per ha of gross cropped area)

EXT is Government expenditure on extension and farmers training (Rs per ha of gross cropped area)

RURALLIT is Rural literacy in percent

CANALIRR is Per cent canal irrigated area

KHRAIN is Kharif rainfall

PNR is Ratio of P_2O_5 to N nutrients

The estimated regression results are presented in **Table 6**. Except rural literacy, coefficient of other variables appeared with expected signs. Results indicate that government expenditure on agricultural research and education has positive and significant impact on TFP. The coefficient associated with extension was positive and significant. It implies that public expenditure on agricultural research, education and extension assumes a greater role in accelerating productivity in agriculture. The canal irrigation, relatively an assured source of irrigation has positive and significant effect on TFP. In Karnataka, a substantial cropped area falls under rain-fed agriculture. The coefficient of Kharif rainfall (April-September) was positive and significantly impacting productivity.

Table 6: Determinants of Total Factor Productivity in Karnataka Agriculture: 1980-81 to 2007-08

Dependent variable: TFP Index at state level

Variable	Regression Coefficient	Standard Error	t' ratio	Level of Significance
Research Expenditure	0.2304	0.0765	3.0100	0.0070
Extension	0.1280	0.0592	2.1600	0.0420
Rural literacy	-0.0103	0.0031	-3.2900	0.0030
Canal irrigation	0.0159	0.0058	2.7400	0.0120
Kharif rainfall	0.2420	0.0442	5.4800	0.0000
P_20_5 to N ratio	0.2519	0.0518	4.8700	0.0000
Constant	1.9060	0.5112	3.7300	0.0010
Adjusted R-Squared	0.9911			
D-W Statistics	1.7819			

The ratio of phosphoric to nitrogen nutrients was taken as proxy for the balanced use of fertiliser. The coefficient of this variable appeared positive and significant implying that the balanced use of plant nutrients enhance soil health and thus increase crop productivity. However, effect of rural literacy was found to be negative and significant. The possible explanation for such a result is the migration of rural literates to urban areas due to availability of increased non-farm employment opportunities and distress like conditions in agriculture sector. Thus, they may not contribute directly to increasing agricultural productivity.

On the whole, the analysis of TFP shows that most crops have registered a decline in productivity growth during the nineties. Interestingly, during 2000-01 to 2007-08, all crops have showed positive growth in TFP. Further, the analysis of determinants of TFP indicates that the government expenditure on research, education and extension, canal irrigation, rainfall, and balanced use of fertilisers are the important drivers of crop productivity in Karnataka.

Summary and Conclusion

The present study has estimated the total factor productivity growth of ten major crops in Karnataka and analysed the factors affecting it at the state level. A widely used Tornqvist-Theil Index was utilised for constructing aggregate output and aggregate input of individual crops. Two outputs and nine inputs have been used to construct output and input index. The cropping pattern has undergone visible changes since 1960s with a shift in area from cereals to pulses, oilseeds and high value crops like vegetables and plantation crops. The growth analysis has revealed that yield of most crops in particular food grains has declined during 1980-81 to 1989-90 leading to stagnation in production. However, during 1990-91 to 2007-08 there is a reversal of growth in production and yield for some food and non-food crops. Among various growth promoting factors, public investment in agriculture seemed to have played an important role in accelerating growth.

Although TFP of most crops has registered decline in productivity growth during the 1990s, there has been a revival in terms of positive TFP growth in the recent period. For Karnataka state as whole, input and output indices have registered growth rate of 0.77 and 1.85 per cent, respectively during 1980-81 to 2007-08. TFP has risen at 1.09 per cent per annum contributing about 58.67 per cent to the total output growth. Further, the analysis of determinants of TFP indicate that the government expenditure on research, education and extension, canal irrigation, rainfall, and the balanced use of fertilisers are the important drivers of crop productivity in Karnataka. A low TFP growth implies that there is huge scope for increasing agricultural production through new technological breakthrough by enhancing investment in research and technology, and rural infrastructure. More public and private investments should be encouraged in under developed regions of the state through providing incentives and a favourable policy environment.

References

Ananth, G S, P G Chengappa and Aldas Janaiah (2008). Research Investment on Technology Development in Peninsular India. In Keijiro Otsuka and Kaliappa Kalirajan (eds), *Agriculture in Developing Countries Technology Issues*. New Delhi: Sage Publications.

Bhalla, G S and Gurmail Singh (2001). *Indian Agriculture Four Decades of Development*. New Delhi: Sage Publications.

Capalbo, Susan M and John M Antle (1988). *Agricultural Productivity Measurement and Explanation* (edited). Washington, D.C.: Resources for the Future.

Christensen, L R (1975). Concepts and Measurement of Agricultural Productivity. *American Journal of Agricultural Economics,* 57 (5): 910-15.

Coelli, Timothy J, D S Prasada Rao, Christopher J O'Donnell and George E Battese (2005). *An Introduction to Productivity and Efficiency Analysis,* Second Edition. USA: Springer.

Desai, Bhupat M and N V Namboodri (1997). Determinants of Total Factor Productivity in Indian Agriculture. *Economic and Political Weekly,* 32 (52): A165-A171.

Deshpande, R S (2004). *Agricultural Development of Karnataka: Promises to Keep (Research Report).* Bangalore: Agricultural Development and Rural Transformation Centre (ADRTC), ISEC.

Diewert, W E (1976). Exact and Superlative Index Numbers. *Journal of Econometrics,* 4 (2): 115-45.

———— (1978). Superlative Index Numbers and Consistency in Aggregation. *Econometrica,* 46 (4): 883-900.

———— (1980). Capital and Theory of Productivity Measurement. *The American Economic Review,* 70 (2): 260-67.

Elumalai, K and U K Pandey (2004). Technological Change in Livestock Sector of Haryana. *Indian Journal of Agricultural Economics,* 59 (2): 249-58.

Evenson, Robert E, Carl E Pray and Mark W Rosegrant (1999). Agricultural Research and Productivity Growth in India. *Research Report 109*. Washington, D.C.: International Food Policy Research Institute.

Hulten, Charles R (1973). Divisia Index Numbers. *Econometrica,* 41 (6): 1017-105.

Kannan, E and Khalil Shah (2010). Determinants of Stagnation in Productivity of Important Crops in Karnataka. *Research Report: XI/ADRTC/127,* Agricultural Development and Rural Transformation Centre, ISEC, Bangalore.

Kolay, A K (2007). *Manures and Fertilisers.* New Delhi: Atlantic Publishers and Distributors.

Kumar, Praduman and Mark W Rosegrant (1994). Productivity and Sources of Growth in Rice in India. *Economic and Political Weekly*, 29 (53): A183-A188.

Kumar, Praduman and Mruthynjaya (1992). Measurement and Analysis of Total Factor Productivity Growth in Wheat. *Indian Journal of Agricultural Economics*, 47 (3): 451-58.

Kumar, Praduman, Anjani Kumar and Surabhi Mittal (2004). Total Factor Productivity of Crop Sector in the Indo-Gangetic Plain of India: Sustainability Issues Revisited. *Indian Economic Review*, 34 (1): 169-201.

Kumar, Praduman, Surabhi Mittal and Mahabub Hossain (2008). Agricultural Growth Accounting and Total Factor Productivity in South Asia: A Review and Policy Implications. *Agricultural Economics Research Review*, 21 (2): 145-72.

Mukherjee, A N and Yoshimi, K (2003). Productivity Growth in Indian Agriculture: Is there Evidence of Convergence Across States?. *Agricultural Economics*, 29 (1): 43-53.

Murgai, Rinku (2005). The Green Revolution and Productivity Paradox: Evidence from Indian Punjab. *Agricultural Economics*, 25 (2-3): 199-209.

Nirman, K P S, Shivtar Singh and K C Raut (1982). Estimation of Crop Residues Using Grain to Straw Ratios. *Agricultural Situation in India,* 37 (3): 32-43.

Report of the Expert Committee (1993). *Stagnation of Agricultural Productivity in Karnataka during 1980's*. Bangalore: Government of Karnataka.

Recent Working Papers

203 Changing Child Population: Growth, Trends and Levels in Karnataka
C M Lakshmana

204 Awareness About HIV/AIDS Among Karnataka Woment: An Analysis of RCH 2002-04 Data
K S Umamani

205 The Microfinance Promise in Financial Inclusion and Welfare of the Poor: Evidence from Karnataka, India
Naveen K Shetty

206 Structure of Central Himalayan Forests Under Different Management Regimes: An Empirical Study
Sunil Nautiyal

207 Poverty and Natural Resources: Measuring the Links (Some Issues in the Context of Karnataka)
K G Gayathri Devi

208 Federalism and Decentralisation in India: Andhra Pradesh and Tamil Nadu
V Anil Kumar

209 Capital, 'Development' and Canal Irrigation in Colonial India
Patric McGinn

210 Gender, Ecology and Development in Karnataka: Situation and Tasks Ahead
K G Gayathri Devi

211 Greenhouse Gases Emission and Potential Corbon Sequestration: A Case Study of Semi-Arid Area in South India
Lenin Babu and K V Raju

212 Emerging Trends in Managing Drinking Water – Case Studies of Coastal Villages in Karnataka
Manasi S, Latha N and K V Raju

213 Spatio-Temporal Analysis of Forests Under Different Management Regimes Using Landsat and IRS Images
Sunil Nautiyal

214 Traditional Knowledge System (Medicine): A Case Study of Arakalgud Taluk, Karnataka, India
B K Harish, K Lenin Babu

215 Tribal Movement in Orissa: A Struggle Against Modernisation?
Patibandla Srikant

216 Technological Progress, Scale Effect and Total Factor Productivity Growth in Indian Cement Industry: Panel Estimation of Stochastic Production Frontier
Sabuj Kumar Mandal and S Madheswaran

217 Fisheries and Livelihoods in Tungabhadra Basin, India: Current Status and Future Possibilities
Manasi S, Latha N and K V Raju

218 Economics of Shrimp Farming: A Comparative Study of Traditional Vs. Scientific Shrimp Farming in West Bengal
Poulomi Bhattacharya

219 Output and Input Efficiency of Manufacturing Firms in India: A Case of the Indian Pharmaceutical Sector
Mainak Mazumdar, Meenakshi Rajeev and Subhash C Ray

220 Panchayats, Hariyali Guidelines and Watershed Development: Lessons from Karnataka
N Sivanna

221 Gender Differential in Disease Burden: It's Role to Explain Gender Differential in Mortality
Biplab Dhak and Mutharayappa R

222 Sanitation Strategies in Karnataka: A Review
Veerashekharappa and Shashanka Bhide

223 A Comparative Analysis of Efficiency and productivity of the Indian Pharmaceutical Firms: A Malmquist-Meta-Frontier Approach
Mainak Mazumdar and Meenakshi Rajeev

224 Local Governance, Patronage and Accountability in Karnataka and Kerala
Anand Inbanathan

225 Downward Dividends of Groundwater Irrigation in Hard Rock Areas of Southern Peninsular India
Anantha K H

226 Trends and Patterns of Private Investment in India
Jagannath Mallick

227 Environmental Efficiency of the Indian Cement Industry: An Interstate Analysis
Sabuj Kumar Mandal and S Madheswaran

228 Determinants of Living Arrangements of Elderly in Orissa: An Analysis
Akshaya Kumar Panigrahi

229 Fiscal Empowerment of Panchayats in India: Real or Rhetoric?
M Devendra Babu

230 Energy Use Efficiency in Indian Cement Industry: Application of Data Envelopment Analysis and Directional Distance Function
Sabuj Kumar Mandaland S Madheswaran

231 Ethnicity, Caste and Community in a Disaster Prone Area of Orissa
Priya Gupta

232 Koodankulam Anti-Nuclear Movement: A Struggle for Alternative Development?
Patibandla Srikant

233 History Revisited: Narratives on Political and Constitutional Changes in Kashmir (1947-1990)
Khalid Wasim Hassan

234 Spatial Heterogeneity and Population Mobility in India
Jajati Keshari Parida and S Madheswaran

235 Measuring Energy Use Efficiency in Presence of Undesirable Output: An Application of Data Envelopment Analysis (DEA) to Indian Cement Industry
Sabuj Kumar Mandaland S Madheswaran

236 Increasing trend in Caesarean Section Delivery in India: Role of Medicalisation of Maternal Health
Sancheetha Ghosh

237 Migration of Kashmiri Pandits: Kashmiriyat Challenged?
Khalid Wasim Hassan

238 **Causality Between Energy Consumption and Output Growth in Indian Cement Industry: An Application of Panel Vector Error Correction Model**
Sabuj Kumar Mandaland S Madheswaran

239 **Conflict Over Worship:A Study of the Sri Guru Dattatreya Swami Bababudhan Dargah in South India**
Sudha Sitharaman

240 **Living Arrangement Preferences of the Elderly in Orissa, India**
Akshaya Kumar Panigrahi

241 **Challenges and Pospects in the Measurement of Trade in Services**
Krushna Mohan Pattanaik

242 **Dalit Movement and Emergence of the Bahujan Samaj Party in Uttar Pradesh: Politics and Priorities**
Shyam Singh

243 **Globalisation, Democratic Decentralisation and Social Secutiry in India**
S N Sangita and T K Jyothi

244 **Health, Labour Supply and Wages: A Critical Review of Literature**
Amrita Ghatak

245 **Is Young Maternal Age A Risk Factor for Sexually Transmitted Diseases and Anemia in India? An Examination in Urban and Rural Areas**
Kavitha N

246 **Patterns and Determinants of Female Migration in India: Insights from Census**
Sandhya Rani Mahapatro

247 **Spillover Effects from Multinational Corporations: Evidence From West Bengal Engineering Industries**
Rajdeep Singha and K Gayithri

248 **Effectiveness of SEZs Over EPZs Structure: The Performance at Aggregate Level**
Malini L Tantri

249 **Income, Income Inequality and Mortality An empirical investigation of the relationship in India, 1971-2003**
K S James and T S Syamala

250 **Institutions and their Interactions: An Economic Analysis of Irrigation Institutions in the Malaprabha Dam Project Area, Karnataka, India**
Durba Biswas and L Venkatachalam

251 **Performance of Indian SEZs: A Disaggregated Level Analysis**
Malini L Tantri

252 **Banking Sector Reforms and NPA: A study of Indian Commercial Banks**
Meenakshi Rajeev and H P Mahesh

253 **Government Policy and Performance: A Study of Indian Engineering Industry**
Rajdeep Singha and K Gayithri

254 **Reproduction of Institutions through People's Practices: Evidences from a Gram Panchayat in Kerala**
Rajesh K

255 **Survival and Resilience of Two Village Communities in Coastal Orissa: A Comparative Study of Coping with Disasters**
Priya Gupta

256 **Engineering Industry, Corporate Ownership and Development: Are Indian Firms Catching up with the Global Standard?**
Rajdeep Singha and K Gayithri

257 **Scheduled Castes, Legitimacy and Local Governance: Continuing Social Exclusion in Panchayats**
Anand Inbanathan and N Sivanna

258 **Plant-Biodiversity Conservation in Academic Institutions: An Efficient Approach for Conserving Biodiversity Across Ecological Regions in India**
Sunil Nautiyal

259 **WTO and Agricultural Policy in Karnataka**
Malini L Tantri and R S Deshpande

260 **Tibetans in Bylakuppe: Political and Legal Status and Settlement Experiences**
Tunga Tarodi

261 **Trajectories of China's Integration with the World Economy through SEZs: A Study on Shenzhen SEZ**
Malnil L Tantri

262 **Governance Reforms in Power Sector: Initiatives and Outcomes in Orissa**
Bikash Chandra Dash and S N Sangita

263 **Conflicting Truths and Contrasting Realities: Are Official Statistics on Agrarian Change Reliable?**
V Anil Kumar

264 **Food Security in Maharashtra: Regional Dimensions**
Nitin Tagade

Price: Rs. 30.00 ISBN 978-81-7791-121-3

INSTITUTE FOR SOCIAL AND ECONOMIC CHANGE
Dr V K R V Rao Road, Nagarabhavi P.O., Bangalore - 560 072, India
Phone: 0091-80-23215468, 23215519, 23215592; Fax: 0091-80-23217008
E-mail: lekha@isec.ac.in; Web: www.isec.ac.in