PRODUCTIVITY GROWTH OF AGRICULTURE IN VIDARBHA

THESIS

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DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the thesis entitled, **"PRODUCTIVITY GROWTH OF AGRICULTURE IN VIDARBHA"** or part thereof has neither been submitted for any other degree or diploma of any university, nor the data have been derived from any thesis / publications of any university or scientific organization. The sources of material used and all assistance received during the course of investigation have been duly acknowledged.

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CERTIFICATE

This is to certify that the thesis entitled. **"PRODUCTIVITY GROWTH OF AGRICULTURE IN VIDARBHA"** submitted in partial fulfillment of the requirements for the degree of "Doctor of Philosophy in Agriculture" of Dr. Panjabrao Deshmukh Krishi Vidyapeeth. Akola. is a record of bonafide research work carried out by **Shubhangi Vijaykumar Alexander**, under my guidance and supervision. The subject of the thesis has been approved by the student's advisory committee.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

%	-	Per cent
^{0}C	-	Degree centigrade
A/P/Y	-	Area, Production and Yield
cm	-	Centimetre
CVZ	-	Central Vidarbha Zone
et al.	-	Et alia (and others)
etc.	-	Et cetera
EVZ	-	Easter Vidarbha Zone
Fig.	-	Figure
GSDP	-	Gross State Domestic Product
ha	-	Hectare
HYV	-	High Yielding Variety
i.e.	-	that is
IPI	-	Input Price Index
K	-	Potassium
Kg	-	kilogram
Km	-	Kilometre
Lit.	-	Litre
mm	-	Millimetre
N	-	Nitrogen
N.A.	-	Not available
NA	-	Not available
NCA	-	Net Cultivated Area
No.	-	Number
P	-	Phosphorus
pH	-	Potential hydrogen ions
Qtls.	-	quintals
R^2	-	Coefficient of Determination
Rs.	-	Rupees

CHAPTER – I

Introduction

CHAPTER I

INTRODUCTION

Agriculture is the backbone of Indian economy. It depends mostly on unpredictable behaviour of monsoon. India possesses 328 million hectares of land, out of which 143 million hectares is under cultivation and 123 million hectares under forest, pastures and waste land, rest is uncultivable, fallows grooves etc. 50 million hectares land has access to irrigation and over two third area of the cultivable land is under rainfed cultivation (India, 2007).

Indian agriculture is characterized by the fact that every patch of arable land is being utilized upto the saturation point and additional one which can be brought under cultivation is marginal. About 70 per cent of the population in the country is dependent on agriculture. Rural population is engaged in farming and its allied activities and as such their source of income is from agriculture. Agriculture therefore has immense role to play in the economy. The pace of economic development and raising the per capita income shall continue to influence significantly by the pace of agricultural development and its diversification.

Economic environment has changed considerably since independence through greater urbanization and planned agricultural development programmes of the nation. With the introduction of modern technology, high yielding variety, seeds, fertilizers, pesticides, labour saving devices and machines, improved cultural practices and additional irrigation facilities, the traditional equilibrium in agriculture is showing way to system of agriculture characterized by dynamic equilibrium. The relation between resources and products are changing. The marginal productivity analysis has gained the importance. Indian farmer who is well accustomed to traditional farming, takes long or time to adjust with the scenario of changing environment.

Agriculture being one of the major sectors associated with the country's populace, has attracted much attention since independence. It therefore, got the topmost priority in the Nation's Five Year Plans. The first two decades after

independence did not show much growth of agriculture sector. It was attributed to expansion of land area sown under different crops and not by technological changes. The shift of farming during prior to independence and post independence periods has an effect of the behaviour of the farmers who were more adherent to traditional farming. Because of the increasing pressure of population and stagnant agricultural productivity, the country was heavily dependent on imports of food grains for meeting the internal food demands.

Recent break through in agricultural productivity has made it possible to achieve technological and institutional changes. This has opened new dimensions of growth. State role as a powerful factor in the process of development was realized. The state by and large, has provided machinery and institutional network support with the help of which it was made possible to take agriculture out of the whirlpool of stagnation which it had been in for number of years. The green revolution is one of the worth noting success story of the post independence era. The impact of success was so much that India emerged as the role model for other developing countries. This transformation could be possible because of the introduction of advanced agricultural technologies coupled with the adoption of high yielding varieties of seeds, use of fertilizers, banking credits to the farmers and all other inputs helped in increasing the farm productions in early seventies and the trend continued since then. This has paved the way towards self-sufficiency of food grains. The production of food grains increased from 50 million tonnes to 210 million tonnes. The oilseed production also increased from 5 million tonnes to 26.70 million tonnes while pulses production raised to the tune of 13.92 million tonnes. Raw material for several agro based industries are supplied from agriculture sector. The total consumption of fertilizer increased to 15 million tonnes from 0.69 million tonnes. Gross irrigated area spread over to 69 million hectares from the 23 million hectares and high yielding crops spread over to 75 million hectares.

Agricultural production is seasonal and still dependent on vagaries of nature. The agricultural production is not uniformly distributed while the consumption is evenly spread over the year. In such circumstances, the planner and policy makers are confronted with the challenge to formulate a suitable agricultural production policy by which the desired growth of agricultural production can be achieved. In this direction, a positive

agricultural production policy plays an important role in stimulating production. In the process, the need for a sound empirical knowledge about the degree of agricultural productivity and technical change is quite imminent.

Maharashtra is an important state which is considered as one of the progressive state in India. It is second largest in the country both in population and geographical area. Since its formation in 1960, the state has secured higher growth rate vis a vis Indian economy for almost three decades and needs to move at a much faster pace. Planning commissions assessment indicate that the average annual growth rate for Maharashtra would be 7.4 per cent. The compound growth rate achieved during 1993-94 to 1999-2000 was 5.9 per cent. It was envisaged that the growth rate could be achieved by adopting comprehensive policy package and institutional reforms.

The performance of agriculture in the state did not prove to be much satisfactory during last many years. Even after deducting very unfavourable years for the crops, the state of Maharashtra has not come out of the whirlpool of stagnation. After the sever drought in early seventies, concentrated efforts have been made by the Government to enhance the agricultural production so as to make the state self sufficient and consequently it has partly succeeded in achieving through green revolution. Much is yet to be done. It is fact that the soil, topography, rainfall and climatic environment in Maharashtra are not very conducive to achieving higher crop yield in general. Nearly one third area of the state falls under rain shadow region where the rains are scanty and eratic and therefore, the drought has become a chronic feature of Maharashtra agriculture.

Geographically the state has 307.58 lakh hectares of land. Out of which 17.4 per cent and 57.7 per cent are under forest and the net area sown respectively. With the population pressure it may not be possible to bring any more acreage of land under cultivation. The population of the state is 9.67 crore (2001 census). Out of this nearly 58 per cent live in rural area. The decadal growth rate of population over the previous census (1991) is around 22.57 and 34.31 per cent in the rural and urban area respectively with the male, female ratio of 52:48 and overall literacy percentage around 67 per cent . The higher growth rate in the urban area, may indicate some shift of rural population to urban area, in search of work, effecting in the depletion of agricultural labour force of rural area (Directorate of Census Operation, M. S. 2001).

The performance of an economy is judged from the state income and per capita income. As per an advance estimate, the Gross State Domestic Product (GSDP) of Maharashtra at constant prices of 1993-94 was expected to grow at a higher rate of 6 per cent during 2001-02 as against the growth rate of 2.7 per cent in the previous year. The sectorial growth rates of GSDP were expected to be 5.1 per cent in primary sector (i.e. agriculture and allied), 3.9 per cent in secondary sector and 7.6 per cent in tertiary sector. The GSDP of the state in 2000-01 at constant prices (1993-94 was estimated at Rs. 1,67,075 crore as against 1,62,680 crore in 1999-2000. The preliminary estimate of Maharashtra State Income at current prices for 2000-01 was Rs. 2,27,893 crore and per capita income was Rs. 23,726. The states income and per capita income exceled many of the Indian states.

In country like India and the progressive state of Maharashtra where agriculture sector contributes major share of their income, will have great impact on the increase/decrease of per capita income and therefore agriculture continues to play an important role in raising the living standard of the people. Analytical studies related to agricultural growth would provide valuable information for future planning and projections of agricultural output. There are many factors such as introduction of high yielding varieties of seeds, increasing irrigation facilities, fertilizers and manures, better prices and market facilities for agricultural commodities that promote agricultural development. The adoption of cropping pattern optimally suited to the technological changes is also an important factor for augmenting growth of agriculture. An attempt therefore has been made to analyse the behaviour of cropping pattern for last three decades in Vidarbha.

Vidarbha is one of the important agrarin economic region of Maharashtra state which occupies nearly one third of the geographic area. There are three main agroclimatic zones viz., assured rainfall zone, moderate rainfall zone and high rainfall zone which spread over western, middle and eastern part of the region respectively. In assured rainfall zone, cotton, sorghum and pulses are the crops spread over five districts viz., Akola, Washim, Buldhana, Yavatmal, Amravati and occupy largest area in Vidarbha. In moderate zone predominant crops are sorghum and cotton, with third crop viz. soybean, groundnut and sunflower and wheat in *rabi* season. High rainfall zone is known for paddy

crops in *kharif* and *rabi* crop occupying eastern part of Nagpur district, Chandrapur, Bhandara, Gondia and Gadchiroli districts.

Vidarbha has 97.23 lakh hectares of geographical area in which 51.64 per cent area is under net area sown as against the 57 per cent in the state. Total gross cropped area is 60.70 lakh hectares which comes to 62.4 per cent of the total geographical area. Irrigation is less than 10 per cent and therefore farming in this region is mostly monsoon based. The vagaries of monsoon are highly responsible for fluctuation of crop yields, which results into economic miseries of farmers in the region. A ray of hope for better agricultural production is possible only when assured irrigation, banking facilities coupled with the technological known-how along with resource mobilization and best possible crop planning inclusive of optimum cropping pattern are made available.

Farming in India is characterized by wide differences in output and productivity growth performance between states and region. The productivity growth in Indian agricultural sector is highly essential, if agricultural output is to grow at a rapid and sustainable rate to meet the growing demands for food and raw materials, because the scope of increasing net cultivated area in the country is meagre. It is therefore, imperative that India has to depend upon improvements in the productive efficiency of factors as an important source of growth. Though productivity as a major source of growth has been an important theme of analytical enquiry in economics all along, it has gained a quantitative edge in recent years. The term productivity is used with reference to efficiency in production of land, labour and capital separately or jointly. The improvement in productivity can lessan the overall burden on the poor. Thus productivity is a necessary element in growth.

In recent years, productivity growth as focus of agricultural development programmes has assumed significance as growth due to area expansion has reached a plateau. Creation and sustenance of infrastructure are essential for augmenting farm productivity. Supportive sectors like markets, roads, mechanization and other infrastructure are necessary for realizing higher incomes than merely adopting new technology. The first phase in agricultural development is the development of primary technology in the form of new varieties, methods and practices. The second phase is in strengthening the supporting and complementary sectors. Technology alone can not

augment productivity, as infrastructure is crucial as well. Infrastructural, regional, agro-climatic and socio-economic factors have to be addressed to augment the farm productivity, as they are complementary to boost productivity of primary factors of production (Siddalingappa *et al.*, 2002).

Productivity is the main reason for economic growth. Some countries do better than others primarily because they are more productive. Also, the more productive a country is, the better it is able to compete in the world market by keeping low cost and also producing a superior inality product.

Productivity studies in India were most often assessed by measures of crop yield. These measures are expressed as product per unit of land. They have clear physical basis and allow both cross section and time series comparison. They are however incomplete as measures of economic efficiency, since, they do not consider use of factor other than land (i.e. labour, fertilizers, etc). Changes in use of these factors will cause a change in yields but a real cost. Thus yield measures can not be considered to be the true measures of efficiency. Moreover the yield measure or partial productivity measures have limitations as indicator of real productivity change as defined by 'shift' in a production function. (Evenson and Jha, 1973).

Increased use of inputs, to a certain extent, allows agricultural sector to move up along the production surface by increasing yield per unit area. Their use may also induce an upward shift in production function to the extent that a technological change is embodies in them. It has long been recognized that partial productivity measures, such as output per unit of individual inputs are of limited use as indicators of real productivity change as defined by a shift in a production function. Most studies focus on the estimate of the effects of technological change in agriculture as a whole or total crop production. Owing to non-availability of input allocation data on individual crops, this may overestimate or under estimate technological change which is one of the most important factors affecting crop production and is ought to be examined for individual crops.

One of the approaches to assess the performance of agricultural sector usually in practice would be through of estimating the growth patterns of certain related sensitive physical indicators. This not only helps in future planning but also is a way of evaluating past performance. At the current phase of agricultural transformation in the state vis-à-vis

scarcity of production resources, measurement of productivity and technical change assume great importance. In this context, it is necessary to understand the levels of resource use productivity of different inputs and their efficiency in production.

The American Agricultural Economic Association (AAEA) task force on measuring agricultural productivity concluded that 'the best approach to productivity measurement is the gross output to total input concept' (Thirtle and Bottomley, 1992). The measure usually employed is the Tornqvist-Theil. Index which is ideal for the homogenous translog production function. Specific productivity indices imply some assumption about the underlying production function. Specific productivity indices imply some assumption about the underlying production technology. Measurement of total factor productivity (TFP) is based on the economic theory of production, employing data on both quantities and prices. The movements along the production function are separated from shifts in the production function. Shifts in the production function are identified with changes in TFP. Agricultural sector should improve its productivity. However, inefficient production practices may also slow down the TFP growth.

The analytical inadequacies of the single factor productivity (SFP) measure led economist to evolve the TFP measures. The TFP index is composite measure of productivity, which relates output to all inputs simultaneously. The change in TFP index can be used as one measure of technical change. Earlier Laspyeres arithmetic indices were used most commonly to measure TFP (Maurvi Pandya and Shiyani, 2002). But most recent literature on TFP (Kumar and Mruthyunjay, 1992; Kumar and Rosegrant, 1994; Desai and Nambudri, 1997; Lal, 2001, etc.) has advocated and employed Tornqvist Theil or translog index in their study because of its superiority.

Recent experience show a slowdown in productivity growth of various crops or even some set backs (as in case of cotton) indicating that all is not well (Dhillon and Ali, 2002). This is given rise to some pertinent questions namely what is the direction of productivity?, What is the direction type of technical changes?, Are there economies of scale in agricultural production?, Are inputs efficiently utilized?, What is the growth in input and outputs? This needs elaboration of most of the TFP studies which concentrate on larger areas employing data at a national or state level, thus there exists misrepresentation of the results of a particular region. Thus the very need of studying TFP

at district level should be realized.

In this study an attempt has been made to understand the above raised issues. However, the specific objectives of the study are

1. To study the growth of inputs and productivity of crop production in different zones of Vidarbha.
2. To study the total factors productivity of selected crops in different zones of Vidarbha.
3. To study the determinants of total factor productivity in agriculture of Vidarbha.

CHAPTER – II

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

The present study is mainly an effort to estimate the productivity growth of agriculture in Vidarbha by considering various underlying factors. While carrying out any systematic research, it is necessary to have knowledge of the similar previous research work carried out by other researcher. Review of literature enables the investigator to acquire knowledge about the past work done in his/her area of research. In this chapter a review of relatively important studies relevant to the present analysis has been presented. A review of the past research helps in identifying the conceptual and methodological issues relevant to the study. This would unable the researcher to collect accurate data and information and subject them to sound reasoning and meaningful interpretations. Since the literature directly related to the current research is rather limited and as such studies relating to the other crops are also reviewed and highlighted herein. Keeping in view the objectives, the review is mainly centered around information on,

i) growth analysis.

ii) total factor productivity and its factors,

2.2 Growth analysis

Bansal (1972) used compound growth rate technique to study the production pattern of important crops in India for the period 1964-65 to 1970-71. The study observed an increasing trend in total food grains production and a decreasing trend in cotton production.

Sidhu and Sankhayan (1973) used linear and exponential type of trend equation to study the changes in cropping pattern due to green revolution in Punjab, for the period 1950-51 to 1970-71. The study indicated that there was positive correlation among growth rates of area and production for all crops grown in the state.

Narain (1977) used compound growth rate model for examining the growth performance of Indian agriculture for two decades between (1952-53 and 1972-73). He

observed an increase in sources of growth over time. However, there was decrease in the overall growth rate of agricultural production, mainly due to decline in the rate of expansion of cropped area.

Alagh *et al.* (1980) studied to estimate the trend growth rates for food grains, sugarcane, major oilseeds, cotton, jute and mesta for major states and for India as a whole for period I, 1960-61 to 1969-70 and period II 1969-70 to 1978-79. They found out that growth for all crops at the all India and most states levels were higher in period II as compared to period I.

Venkataramanan and Prahladachar (1980) studied the growth rates and cropping pattern changes in agriculture in six states viz., Punjab, Rajasthan, Uttar Pradesh, Bihar, Maharashtra and Andhra Pradesh during the period of 1950-51 to 1974-75. The results indicated that crop output growth in Punjab was large due to technological transformation especially because of spread of HYV crop and irrigation facilities. While in Rajasthan, increase of subsistence agriculture and growing in farming conditions were observed. Where as in Bihar nearly 2/3 of growth in crop output has contributed increase in yield. In Maharashtra, inferior cropping pattern and relatively low yield for most of the crops and percentage of net cropped area, irrigated was low.

Chengappa (1981) studied the growth rates of area, production and productivity of coffee in India using linear and exponential models. The exponential function was the best for estimating the compound growth rate for coffee.

Hazell (1984) assessed the sources of increased instability in cereal production in India and USA. The results indicated that recent growth of cereal production in India and US was accompanied by more than proportionate increase in the standard deviation of production. This study employed variance decomposition procedures using state-wise data on crop production to analyze the sources of increased instability. It was found that the covariance in production between states and crops was high in view of increased yield variability and a loss in off setting patterns of variables between crop yields in different states. These changes were associated with variable prices, high yielding technologies and a narrowing genetic base.

Rao and Rao (1986) studied the growth rates in area, production and yield per

hectare of barley and tobacco in India as compared with other barley growing countries of the world during the period of 1967 to 1989 and concluded that other countries have relatively lower contribution in the world production of barley and tobacco.

Sale (1987) studied the performance of principal crops in Maharashtra during the period 1956-60 to 1982-83. On the basis of estimated linear and compound growth rates of area, production and productivity of individual crops, the performance of *kharif* jowar and sugarcane was satisfactory, while performance of *rabi* jower and groundnut was unsatisfactory during the period. The higher growth rate in production of *kharif* jowar and sugarcane were partly due to area expansion and partly due to improvement in productivity. They observed that, inter-district disparities in performance of most of the crops were mainly due to variation in the extent of adoption of technological change in agriculture.

Walia *et al.* (1987) studied the growth analysis and trends of area, production and yield of potato in major potato growing states in India. For this study the secondary data for period of 30 years from 1950-51 to 1979-80 were divided into three decades and each for the major potato growing states of India, namely, Assam, Bihar, Madhya Pradesh, Uttar Pradesh, West Bengal and Himachal Pradesh. The study concluded that increase in area in all states are significant except for Punjab during 1960-61 to 1969-70 and Himachal Pradesh during the period 1970-71 to 1979-80. The growth rate of production was highest in Uttar Pradesh (19.99) followed by Madhya Pradesh. All states have positive growth of production while, decline in yield rates were observed in Bihar and Madhya Pradesh during 1950-51 to 1969-70.

Johl and Sidhu (1988) studied the changes in cropping pattern in India.The study observed that, the area under coarse cereals, *rabi* pulses and cotton decreased by 3.85, 0.78 and 0.33 per cent respectively in the triennium between 1972-73 and 1974-75. While the area under wheat and rice increased by 2.03 and 0.04 per cent replacing coarse cereals. However, area under total cereals declined by 1.78 per cent and this area was been shifted to *kharif* pulses, sugarcane and oilseeds. The authors suggested that deliberate policy to increase production of edible oils and sugarcane has marginally caused this situation.

Singh and Swarup (1988) analyzed the growth rate of area, yield and output of

important pulses of Himachal Pradesh during the period 1972-73 to 1981-82 and studied the growth rates of different elements to output of pulses of each district of state. The study concluded that the relative acreage under pulses decreased at the compound growth rate of 0.092 per cent annum, while absolute area under all pulses declined at the rate of 0.79 per cent per annum. Among the pulses, only lentil showed positive growth in productivity to the tune of 0.23 per cent per annum. The growth in cropping pattern of gram, blackgram and horsegram showed positive trend around 0.04 to 0.60 per cent per annum, respectively.

Venkateshwarlu *et al.* (1988) examined growth and productivity of banana in Andhra Pradesh for the period of 1967-68 to 1982-83. They used exponential trend equation. They found out constant, declining and increasing trends in area, production and productivity of the crop as a whole over the years. However, growth behaviour of banana showed better development with significant output growth of 4.5 per cent and positive productivity growth of 0.4 per cent per annum.

Pal and Sirohi (1989) identified the sources of instability in crops production and yield in different states in India between two periods, 1950-65 and 1966-84. The empirical findings of this study revealed that yield variance contributing largely to the variance in production of pulses and oilseeds and the same being increasing over time. After adoption of High Yielding Varieties (HYVs), the absolute variance increased on account of increased sensitivity on HYVs to inputs and weather, especially rainfall. The intensive use of irrigation led to comparatively stable production of food grains.

Mitra (1990) made an attempt to examine the growth of agricultural production in Maharashtra and its four regions for the period 1956-57 to 1984-85. The entire period of the study was divided into two sub periods for estimating the growth rates of area, production and yield of major crops. The author stated that annual compound rate of growth of agricultural production in the state as well as in all the regions specially that of food grains was relatively higher in twelve years period ending 1984-85 and thereafter nearly stagnant over sixteen years period ending 1971-72. The overall rate for the growth of production of food grains was around 2 per cent per annum which was mainly brought by growth in yield. Jowar, pulses also show a very slow rate of growth in production which is mainly brought out growth in area and yield.

Sharma and Gandhi (1990) examined the annual compound growth rates of food grain production in India for the periods of 1950 to 1984. It was found that growth rate of food production has declined during 1949-50 to 1964-65 while it was modestly accelerated during 1975-76 to 1983-84. However, the overall growth rate per annum was 2.6 which indicated a sustained recovery.

Verma (1990) conducted a study to find out the level of actual utilization of inputs by farmers in Akola district with respect to hybrid jowar (CSH-9) as against recommended level and he found that the use of nitrogen, potash and phosphorus was far below the recommendation, the utilization gap being 46.66 and 93.00 per cent, respectively. On an average per hectare utilization of labour was workout to be 49.00, 39.00 and 14.28 days for male, female and bullock labour, respectively. The per hectare production of hybrid jowar was 24.65 qtls, as against 48 qtls of potential production.

Mitra and Jena (1991) conducted study on growth rates of groundnut production in Orissa. For this purpose, the entire period of thirty-six year was divided into two parts viz. i) Period I 1950-53 to 1962-65, ii) Period II covers 1967-70 to 1983-86. Growth rates of the entire period i.e. from 1950-51 to 1985-86 were also studied. The study observed that the compound growth rate of area were 3.70 per cent, 9.83 per cent and 8.17 per cent in I, II and III period compound growth rate of production were 5.86 per cent, 9.76 per cent and 10.47 per cent respectively compound growth rate were 2.12 per cent, 0.16 per cent and 2.11 per cent.

Behura and Naik (1994) made an attempt to study the economic analysis of agricultural performance in Kalahandi district of Orissa state for the period from 1966/67 to 1990/91. They worked out compound growth rate of area and productivity of different crops. They observed that among all crops summer rice recorded the highest growth rate in area of 7.77 per cent while its productivity was declining by 2.14 per cent per annum because of suitable varieties in the district.

Jahagirdar and Ratnalikar (1996) studied the districtwise growth rates of area, production and yield of *kharif* jowar in Maharashtra. The study covered the period of 30 years i.e. from 1960-61 to 1989-90. The period of technological break through a consistent and positive growth was observed in area, production and yield. The compound growth rate of area indicated declining or inconsistent area allocation during

the decade. Undesirable trends in area, production and yield were observed in some of the districts.

Tripathy (1996) analyzed the growth and trends in the area, yield and production of rice in Orissa during post green revolution period. In most of the agriculturally developed districts, the growth rates of production of rice were low due to diversion of the area of rice to groundnut, pulses and other non-food grain crops. The higher growth rates of yield were attributed to the introduction of high yielding varieties of rice.

Kalyankar and Ghulghule (1997) examined the growth in the productivity of major crops among different divisions of Maharashtra State for the period from 1961 to 1994. They showed that per hectare productivity of paddy crop was comparatively higher in Konkan and Kolhapur division of western Maharashtra. The growth rates of total cereal productivity were highest in the Amravati division followed by Kolhapur division. Similarly higher growth rates were observed for productivity of total pulses in Nashik division while total oil seeds productivity increased with higher rate of growth in Nagpur division.

Sawant (1997) studied inter-regional patterns of growth for three major crop groups, namely cereals, pulses and oilseeds in addition to cotton. There was sustained moderate growth in cereals output right from 1967-68. In majority of the states, cereals output expanded at moderate (2.1% to 4%) to high rate (above 4%) of growth. In case of production of pulses, large number of states registered either negative growth or zero growth.

Sharma *et al.* (1997) conducted the study by examing the growth of total production in India. They observed that, area under rice was found to be the highest in Assam which was about 1.97 million hectares in 1970-71 and it increased by about 26 per cent over the period of two decades. The increase in total production of rice was notable and its yield almost doubled over the period. The area under maize was the highest in Jammu and Kashmir followed by Himachal Pradesh. The area under wheat, its production and yield were the highest in Himachal Pradesh followed by Jammu and Kashmir.

Shete *et al.* (1997) analyzed the nature of growth of agriculture among the four

regions of Maharashtra viz., Western Maharashtra, Konkan, Maharashtra and Vidarbha for the period from 1956-57 to 1989-90. They estimated compound growth rates of area, production and productivity of total cereals, pulses, oil seeds, sugarcane and cotton. The study observed that performance of agriculture in Maharashtra was mixed type among different regions. In oilseeds, Maharashtra continued to be a deficit state during the sixties and seventies.

Singh and Gupta (1997) examined the growth rates of area, production and productivity for the overall periods. They observed that the growth was statistically significant at one per cent level which also explains that the food grains production have increased significantly during this period. The growth rates of area for *Kharif* crops was either found to be negative or statistically non-significant.

Jagannathan (1998) studied the trends and patterns of agricultural growth of different crops in India. The study revealed that green revolution improved the growth in area, yield and thereby production of all crops at an increasing rate in the early phase. The study concluded that the public investment had to play a major role in the technological and infrastructure development for agricultural growth concentrating more on inter-crop and optimum utilization.

Anonymous (1999) studied the growth in agriculture production in India. The growth in agriculture production was about 3.9 per cent in 1998-99 as against drop of 6 per cent in the preceding year. Food grains production increased annually by 3.22 per cent during fifties mainly because of expansion in area under food grains. Sixties recorded a low annual growth of 1.72 per cent necessitating large scale of importance of food grains. Annual growth of 2.08 per cent was recorded during seventies. This decade was the turning point in the India's food grain policy and the path of self-sufficiency was marked by the revolutionary changes in the seed technology that pushed up productivity levels first in wheat and latter in rice in eighties. For determining changes in cropping pattern, the proportionate area under different crops was worked out for each category of size classes in a district for individual years i.e. 1962-63, 1963-64 and 1964-65. They found significant changes in a cropping pattern of the districts selected for study. According to him the changes in the cropping pattern and crop intensity were due to introduction of high yielding early varieties and improved agricultural technology.

2.2 Total factor productivity

Evenson and Jha (1973) analysed the contribution of the Indian agriculture research system to real productivity growth in agriculture. The total factor productivity gains in some parts of Indian agriculture have been truly extra ordinary but large regional disparities have emerged over time. The gains realized have not been associated exclusively with wheat and rice production or with the extent of irrigated acreage. The major determinants of productivity changes in Indian agriculture has been the Indian agricultural research system and the investment in the research system.

Christensen (1975) discussed the issues involved in implementation of total factors productivity concept. It was clear from his discussion that, the basic difference between the Laspeyres and the Tornqvist (and other superlative) index is that the Laspeyres index holds prices fixed at their base period levels, while the Tornqvist index uses the prices from both the base period and the comparison period. He concluded that many index number formulas not only approximate but represent exactly particular production function.

Patil and Jha (1978) studied changes in output, input and agricultural productivity growth in Maharashtra state from 1951-52 to 1971-72. Out of 25 districts 18 districts recorded positive output growth while, growth in inputs varied between 0.82 per cent and 2.82 per cent per annum in different districts. The average growth in inputs was nearly 1.84 per cent and a negligible growth in modern input was observed. Total factor productivity growth rates were positive in 14 districts and were between 0.85 per cent to 5.92 per cent per annum.

Douglas *et al.* (1982) developed index number procedure for comparison under very general circumstances. Malmqvist input, output and productivity comparison were defined for the structure of production with arbitrary returns to scale, substitution possibilities and biases in productivity change. Tornqvist input index is exact for the homogenous translog form, and thus is a superlative index. Tornqvist input index is also exact for the geometric mean of two Malmqvist input indices. Finally they concluded that the Tornqvist input index is best for the homogenous Translog form and thus is a

superlative index.

Ball (1984) revised procedure for calculating total factor productivity and measuring productivity growth in U.S. agriculture over the postwar years. The estimates reflected a disaggregated treatment of output and inputs and indexing procedures that do no impose restrictions on the structure of production. It was observed that productivity grew at an average annual rate of 1.75 per cent during 1948-79 period, compared with the figure of 1.70 per cent per year estimated by the U.S. Department of Agriculture.

Ball (1985) in another study used Tornqvist Theil indices of outputs and inputs to measure productivity growth over the post war period. The productivity indices were derived from a flexible multioutput - multifactor representation of the structure of production constrained to constant returns to scale. Total factor productivity grew at an average annual rate of 1.75 per cent compared with 1.70 per cent per year estimated by U.S. Department of Agriculture. The similar estimates of productivity growth overshadow some important differences in measurement of individual inputs.

Singh and Singh (1985) found that despite increase in income in the agricultural sector in Punjab due to recent technological breakthrough, the proportion of the rural population below the poverty line has increased. The study examined the relationship between growth in output and factor shares, particularly the relative share of labour vis-à-vis non labour input factor. The study noted that the relative share of labour in gross value of output, both in accounting sense and also from the point of view of its contribution to output, in general increased after an initial decline following the technological breakthrough in Punjab agriculture.

Adinarayana (1986) found significant increase in paddy productivity since introduction of high yielding varieties in Andhra Pradesh during the mid 1960s using production function analysis. The study showed that the relative value share of land declined while the value shares of labour, fertilizer and capital improved significantly. In case of wheat in Punjab, the input index changed little (account of increase in chemical and machinery inputs more than cancelled by a decline in labour and animal power units), the total factor productivity index is highly correlated with yield which was steadily grown over the year, particularly in 1980s on account of increasing labour productivity as a result of mechanization and also may relate to an increase in input efficiency as farmers

have learned how to manage the new technology better.

Bottomley *et al.* (1988) derived a total factor productivity (TFP) index for U.K. agriculture. Conceptual issue were stressed rather than the technical aspects of productivity measurement and emphasis was placed on the value judgment involved in data selection and manipulation. The study considered alternative derivations of TFP indices for U.K. agriculture from national income accounting data.

Bureau (1988) investigated the appropriateness of index of production and their sensitivity over the conventional methods. The different approaches to measurement were briefly summarized and compared with Pasche, Laspeyres, Fisher, Tornqvist and Superlative indices considering both chain and non chain versions. It was concluded that the Fisher and Tornqvist indices (in chain and non chain form) gave the best approximation to the evolution of French agriculture. Nevertheless, data imperfections made weighting difficult and calculations unsatisfactory.

Frank *et al.* (1988) studied the performance of industry using two main approaches, viz. Analysis of factor productivities and Estimation of total and variable cost functions. A non-parametric measure, TFP was used in addition to cost function, which allows that firms can not fully optimize some of their outputs instantaneously. The results indicated that labour productivity recorded a growth rate of 1.8 per cent per year while TFP grew by 0.7 per cent per year of which 0.45 per cent was due to economies of scale and 0.25 per cent was due to technical change. The mandatory pollution control requirement had retarded industry productivity growth by 0.25 per cent per year with the industry experiencing substantial economies of scale.

Lass and Weaver (1988) derived state level estimates of total factor productivity growth in agriculture for the Corn Belt region of the USA for the period 1950-82. A dual profit function approach was used for estimation. The rates of growth were found to vary across states ranging from 0.0143 to 0.0442. The results also supported the contention that growth rates declined during the seventies.

Guyomard (1989) compared and contrasted two approaches to total factor productivity growth and applied the same to French agriculture over the period 1960-84 in order to illustrate their merits. The first approach related to residual non-parametric

measurement of technical progress and total production. After outlining the basis of this method and describing the theory behind it, the methodology was applied to the recent history of French agriculture to give an annual average increase of 2 per cent. This figure is compared with the total annual production increase figure for other countries. The contribution of different factors and of technical progress to growth was observed via the Tornqvist index for final products. The second section used a parametric approach giving an annual growth rate attributed to technical progress at 4.97 per cent and growth of total productivity at 3.98 per cent.

Shamsudin *et al* (1989) estimated the trend in partial factor productivity of land, labour and capital as well as total factor productivity in Malaysia. Using time series data between 1960 and 1986, he analysed the trend in agricultural production, the productivity of land, labour, capital and total productivity of all inputs. The path of agricultural development in Malaysia was divided into three stages and was compared to other Asian countries. Results indicated that the agricultural production grew at 5.6 per cent over the period under consideration with labour having the fastest productivity growth followed by capital and land. It was projected that Malaysian agriculture will face shortage of labour and thus mechanization was suggested as the most appropriate strategy for the nineties.

Feng (1990) using total factor productivity (TFP) reviewed the efficiency change in Chinese agriculture since, 1949. The first part analysed the changed trend of TFP by dividing the 4 decades into 3 stages. The second part measured the share of TFP in total agricultural output growth. Part three discussed the basic patterns of TFP growth in general and the Chinese output pattern in particular.

Azam *et al.* (1991) emphasized that productivity growth is an important component of economic growth in research programme relating to agriculture and were found to have contributed to productivity growth. This study is one of the first to quantify the economic impacts of agricultural research in Pakistan employing both partial factor productivity and total factor productivity indices. A comparison of TFP changes in the Indian state of Punjab and Pakistan provinces utilizing comparable data and computational method have been made. This analysis is comparable to the studies in other countries usually referred to as TFP decomposition. Estimates of benefits based on

total surplus (producer plus consumer) were utilized to compute marginal internal rate of return (MIRR) to investment in research.

Becker and Guyomard (1991) stated that confrontation of productivity growth theory with reality has led to significant advances in both methodology and theory. The advanced duality theory established linkage between index number and production technology. The two concepts of Tornqvist productivity indices and econometric estimation of cost function were applied to French and German agriculture using sectoral data from 1961-84. For the whole period, the Tornqvist productivity indices documented for France worked out to 2 per cent which was higher when compared to German agricultural sector at 1.6 per cent per annum. The results further indicated declining productivity growth performance for France but accelerated rates for Germany.

Cooke and Sundqvist (1991) used Tornqvist input quantity indices to derive total and partial factor productivity measures for U.S. cotton across time, region and scale. The study indicated that total factor productivity of U.S. cotton increased by 2 per cent per year between 1974-1982. The partial productivity measures revealed that yield growth was about 6 per cent and input use increased by about 4 per cent per year.

Dolakia and Dolakia (1991) observed that developing countries have dramatically increased the agricultural output in the later half of the 20th century which were largely attributed to higher productivity of land and labour. This study focused on agricultural modernization of India, questioning whether it has actually raised agricultural growth rates and productivity levels. The nature and extent of modernization were evaluated taking into account the impact of Government policy. There was evidence to suggest that the green-revolution in the primary sector has led to significant increase in total factor productivity (TFP).

Kebede and Gujal (1991) analyzed the impact of the project on the productivity of important inputs and also on the disembodied technological change on these gains. The estimated production functions for selected crops (wheat, barely, maize, chickpea and beans), revealed that the total factor productivity was higher in five of the seven (crops) for the beneficiaries. Also, a significant disembodied technical change measured by the upward shift in the production function was observed in six of the seven crops. Beneficiaries of the project achieved an average increase of 12 per cent in

production as compared to non-beneficiaries. The actual increase ranged from 2 per cent for maize to 23 per cent for durra.

Luh and Stefano (1991) evolved a measure of productivity growth adjusted for deviations from the long-run equilibrium. An empirical application to U.S. agriculture permitted identifying the dynamic linkages between technical change and productivity growth in agriculture. Total factor productivity as dynamically measured grew at 1.50 per cent per annum. The combined effect of scale, quality adjusted input growth, and long-run disequilibrium, input use contributed only 3.44 per cent of the growth, while technical change dominated the growth of total factor productivity.

Evenson (1992) analyzed the determinants of changes in TFP in U.S. agriculture over the 1950-82 period. Separate measures for growth of crop and livestock sectors were attempted.s The study found that TFP growth has been highest in the crop sector. The combined crop and livestock sectors produced TFP growth rates well above those realized in the economy at large. Public sector agricultural research contributed to TFP growth in both the sectors. A distinction was made between pre-technology research and applied research. The study showed that those state research systems with highest investments in pre-technology science research contributed most to TFP growth. Investment in agricultural extension and farmers education also contributed to TFP growth. Similarly, research and development in private sector also contributed to TFP growth in the agricultural sector.

Kumar and Mruthyunjaya (1992) assessed the total factor productivity (TFP) growth in wheat production for the states of Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and Rajastan. The Tornqvist-divisia index was used to compute the total output, total input, TFP and input price indices for wheat grown in major states of India based on micro-level farm data for the post-green revolution period (1970-71 to 1988-89). The results showed that the technical change in wheat production benefited consumers relatively more than producers. The total factor productivity or technical change was found to contribute more than one third to total output growth. Market infrastructure, research and mechanization were indicated as the most important sources of growth in TFP. It was opined that the area under modern varieties has already reached the ceiling levels particularly in front-line states. Thus, the need for varieties was emphasized to

achieve breakthrough in yield levels.

Rosegrant and Evenson (1992) estimated the annual growth in TFP for the crops sectors in India, Bangladesh and Pakistan for the period 1957-88. In India, TFP grew relatively steadily over time with modest variation in growth rate over period, but large fluctuation due to weather variation, particularly large drops in TFP occurred in the severe draught years of 1965, 1966 and 1979. Variation in TFP around trend was due to nearly entirely to variation in output as total input use increase smoothly over time. With total output growth increasing at 3 per cent per annum, productivity growth has accounted for approximately one-third of total output in the Indian crop sector.

Sidhu and Byerlee (1992) analyzed trends using micro-level farm data to measure productivity growth in wheat by using an index of total factor productivity. Although farmers initially benefited from green revolution yet the surplus generated by increased productivity during the 1970s and 1980s resulted in benefiting the wheat consumers more rather than the producers. The changes calculated in TFP supported these findings, especially with regard to productivity gains arising from land saving compared to labour saving technologies. The empirical evidence indicated that future yields gain being high were not readily apparent. A more likely source of future productivity gains was expected from efficient use of inputs including fertilizer and water.

Thirtle and Bottomley (1992) studied indices of total factors productivity (TFP) which measures aggregated output per unit of aggregate input, providing a guide to the efficiency of agricultural production. This paper outlined the relationship between production functions and TFP indices. An index for the period 1967-90, constructed from the U.K. aggregate agricultural accounts showed that TFP grew at an average rate of 1.9 per cent per annum and an increased growth in TFP was observed since the U.K. joined the European Economic Community. At the aggregate level, this change was explained by increased aggregate output and decreased aggregate input in about equal proportions. Disaggregation shows the intensification effect of the common agricultural policy price regime. There has been rapid growth in the output of farm crops, relative to other enterprises, and in the use of agricultural chemicals.

Dholakia and Dholakia (1993) examined the sources of growth of total factor

productivity Indian agriculture for three periods : i) the pre-green revolution (1950-51 to 1966-67); ii) the initial phase of the green revolution (1966-67 to 1980-81 and iii) the modernization phase (1980-81 onwards). The study showed that total factor productivity growth in agriculture was the prime driving force behind the acceleration of overall growth in the Indian economy achieved during the 1980s. Technical progress as measured through TFPG has not been directly determined by capital, labour or capital per worker. Modern inputs such as HYV seeds, fertilizer and irrigation have successfully raised TFPG in Indian agriculture, particularly during the 1980s.

Thirtle *et al.* (1993) constructed an index of total factor productivity (TFP) for the Zimbabwean commercial agricultural sector. The TFP grew at impressive rate of 3 per cent per annum over the period 1970-89. It was pointed that despite the change in Government policy that directed resources towards the communal lands, the sale of commercial farms coupled with political uncertainty had no effect on the TFP growth rate. The disaggregation provided evidence that the commercial farmers have been reluctant to invest and the minimum wage legislation and other factors reduced employment in this sector.

David and Barker (1994) analyzed the trends in agriculture productivity and explained how institutional and policy reforms have affected productivity through their effects on the intensive structure and technological potential of land, labour and total factor productivity. Productivity growth was analyzed by agriculture output to those of inputs. Partial productivity was a major determinants of farm income and wages. The growth of rice output was decomposed to determine the relative contribution of expansion in cultivated area, cropping intensity and yield. The auther concluded that the country must invest in developing appropriate data for monitoring and analyzing growth in order to provide information, on policy changes and investment requirement necessary to sustain productivity growth in agriculture.

Kumar and Rosegrant (1994) analysed total factors productivity growth in different regions of India and examined the sources of productivity growth. Input index growth was observed 6 per cent per annum, while southern region registered the lowest growth rate of 1.1 per cent per annum. Southern region recorded the highest TFP growth rate of 1.85 per cent while western region showed negative TFP 0.98 per cent which was

due to wide fluctuations in weather. Market infrastructure, research, investigation and balanced use of fertilizers are the most important sources of growth in TFP.

Rosegrant and Evenson (1994) estimated the trends in TFP for the Indian crop sector. The growth in TFP was observed to be 1.13 per cent per annum during the period 1956-87. In the same period the total output grew at 2.25 per cent per annum while the growth in input was recorded at 1.11 per cent per annum. Thus, productivity growth accounted for just over one half of total output growth in the Indian crop sector. The decomposition of TFP revealed that public expenditure, expenditure on extension, irrigation and foreign private research had a significant and positive impact on TFP in all periods. The estimated effect of irrigation and literacy on TFP was strongly positive. The contribution of HYVs to TFP growth was modest at round of seven per cent. The returns to public agricultural research worked out at 53 per cent during the post green revolution period. The returns to public extension were high at 61 per cent for the entire period and 52 per cent for the final sub-period. It was clear that TFP growth was mainly due to investments, primarily in research, extension, markets and irrigation.

Khan (1995) studied total factor producivity and technical change in Karnataka agricuture. The analysis was performed for the state as a whole as well as for the 10 agro-climatic zones of Karnataka. Author has concluded that, the total factor productivity in Karnataka increased at the rate of 0.05 per cent per annum during the entire period of study. This trend was due to higher growth of output (0.38%) in relation to the growth of input use (0.33%). Further he concluded that, infrastructured development server as a base for growth of agricultural productivity and technological change.

Desai and Namboodiri (1997) developed a more comprehensive framework of price and non-price factors to understand the process of change in total factor productivity for the period 1966-67 to 1989-90. They defined technical change as growth in residual productivity, which is nothing but total factor productivity. The single most important determinant of total factor productivity is the government expenditure on agricultural research, education and extension.

Kalirajan and Shand (1997) examined the sources of output growth in Indian Agriculture for the period 1980 to 1990 state wise analysis. The study concluded that TFP

growth in the pre-reform period was negative in four out of fifteen states and at the end of the decade, it was small for those states where the contribution of TFP growth was positive. The contribution of technology to output growth declined substantially, particularly from 1988 to 1990. During the period of analysis technical efficiency increased slowly and it would be useful to identify the cause for such performance in technical efficiency.

Reddy (1997) studied inter-regional variations in the performance of paddy production in Andhra Pradesh during the period 1981-82 to 1991-92. The performance was assessed in terms of yield per hectare, unit cost and total factor productivity. The analysis showed that the relatively lower prices for modern inputs compared to traditional inputs, partly due to subsidies, has enabled farmers to substitute modern inputs for traditional inputs and thereby obtained higher yields at lower costs. Size of farm had no effect on costs and productivity and the spread of HYV technology across the regions. Public investment in agricultural infrastructure contributed significantly to improving total factor productivity.

Jha and Kumar (1998) dealt with the rice-wheat cropping system, which is spread in the most fertile regions covered predominantly in the states like Punjab, Harayana and Uttar Pradesh. The share of TFP in the growth rate of rice and wheat production was declining. The yield was more input based. The use of modern inputs like adoption of high yielding varieties, irrigation, chemical fertilizer, pesticide has already reached a very high level.

Birthal *et al.* (1999) revealed that livestock output growth grew at 2.59 per cent per annum over 1950-51 to 1995-96. The input index increased by 10.79 per cent per annum and TFP grew at about 0.8 per cent, implying that technical change contributed about 30 per cent in the overall growth over the last 45 years. Period wise results were more revealing. There was no TFP growth in the first period (1950-51 to 1970-71) implying no technical change. Output growth proceeded along the traditional production function and driven by growth in output was 1.3 per cent per annum. Since then output and TFP was increasing. The real swing started in 1980s when sectors output growth touched nearly 4 per cent and the TFP growth jumped to nearly 1.8 per cent contributing 45 per cent of the total output growth.

Mitra (1999) studied total factor productivity growth and technical efficiency for 15 major states in India. The total factor productivity growth (TFPG) in a large number of industries seems to have improved across most of the states during 1985-86 to 1992-93 as compared with the rates estimated for the period 1976-77 to 1984-85.

Patil *et al.* (1999) studied the factors affecting food grains productivity in Maharashtra. It was observed that there was a positive relationship between integrated land food grains, female labour. Hence, increasing irrigated area as well as amount of credit used could increase productivity. Educational standard of the people and replacement of female labour lead to an increase in mechanization would lead to an increase in productivity.

Surbhi Mittal and Lal (2001) worked out total factor productivity and examined the sources of productivity growth for wheat grown in major states of India. They found growth in TFP index as 0.9 per cent per annum. Cost per unit of wheat has declined steadily at an annual rate of 2.2 per cent. Research investment, quality of inputs and rural infrastructure are the most important determinants of TFP growth.

Renuka Pillai (2001) estimated productivity growth of paddy in West Bengal and Orissa. TFP was computed using Tornqvist Theil Divisia index while technical efficiency was computed using stochastic frontier model considering a Translog specification of production technology. In Orissa, the average annual growth in inputs, outputs and TFP indices show a steady increase at the rate of 1.11 per cent, 2.7 per cent and 1.5 per cent per annum, respectively during 1971-72 to 1992-93, while in West Bengal average annual growth rates were 2.42 per cent, 4.27 per cent and 1.75 per cent per annum. The study concluded that input productivity has indeed played an important role in the growth of inputs and TFP. They contributed significantly to the output growth in both the states.

Subariyanto and Thirtle (2001) measured total factor productivity for 18 Asian countries from 1965-96. TFP was measured by calculating the Malmqvist index with respect to the sequential frontier, which is appropriate when the cross section is relatively small. The results of the study showed that half the countries have experienced negative productivity growth, due to losses in technical efficiency combined with stagnation in technological progress.

Dhillon and Ali (2002) concluded that, indices of output and input have steadily increased throughout the period under study. The growth in TFP was negative during 1970-78 as during this period the adoption of modern inputs was higher than output growth. There was significant growth of factor productivity during 1979-86 and TFP index grew at the rate of 7.41 per cent per annum. The TFP growth rate during 1987-95 has declined to 1.25 per cent. The overall growth of TFP during 1970-71 to 1995-96 was 2.37 per cent. The study concluded that indices of output and input have steadily increased through out the period under study.

Maurvi Pandya and Shiyani (2002) examined the total factor productivity (TFP) growth in eight food crops of Gujarat using the input-output data from 1981-82 to 1998-99. Tornqvist Theil Index, superior to other indices, was used for computing total output index, total input index and the TFP index. A continuous increase in the productivity of all the crops under study was reported during 1960-61 to 1999-2000. Bajra crop registered a very high growth rate of TFP indicating technological change. Moderate technological change was found in case of wheat, maize and pulse crops. Jowar and pigeonpea registered a negative growth in TFP. The institutional infrastructure plays an important role not only in providing physical inputs but also in inducing technical change. For that, increasing investment in research and infrastructural facilities, and increasing input use efficiency are also necessary.

Siddalingappa *et al.* (2002) analysed factors affecting TFP in dry agro-climatic zones of Karnataka state. The study concluded that due to improvement in infrastructure, regional and agro-climatic and related factors contributed positively to the productivity of major crops as revealed by the increasing trends in TFP growth over the three periods. Growth in TFP lies in augmenting productivity under well irrigation. The per capita income of households and literacy emerged as the dominant factor of productivity in the state.

Singh and Pal (2002) studied sustainability of rice-wheat system in Eastern Uttar Pradesh. The study reported that growth in total factor productivity (TFP) was decelerating in the green revolution region practicing rice- wheat cropping system. The results showed that crop yields have become more stable over time and the system was moving towards specialization growth in the output and input.

Bhattarai and Narayanamoorthy (2003) analysed the factors contributing to multifactor agricultural productivity (Total factor productivity) and production growth in India. The study quantified the incremental benefits of major factor inputs (such as irrigation, crop technology and infrastructures) in over time variation of agricultural performance and agricultural productivity across the 14 major states of India for the period of 1970 to 1995. The study concluded that, two factors namely irrigation and rural literacy level played a very critical role in explaining the inter-state variation of the agricultural productivity (TFP index) in India, over the period of study, more than any other factor inputs.

Mukherjee and Kuroda (2003) focused on the question of convergence in total factor productivity (TFP) in 14 major agricultural states of India. They used Tornqvist Theil index for measuring TFP growth for the period of 1973-93. The study observed that the high performing states show a gradual movement towards the trends while the low performing states generally show more volatility.

Subrahmanyam and Satyashekhar (2003) examined the pattern of development of Andhra Pradesh agriculture and suggested a perspective for its development in the first decade of 21st century. The results of the study indicated that total factors productivity declined in the pre-green revolution period, as aggregate input growth was higher than aggregate output growth. Expenditure on agricultural research and extension is an important source for accelerating agricultural growth. The deceleration in output growth was due to attributed to slow growth of public investment in agriculture.

Ball *et al.* (2004) studied total factor productivity for 48 contiguous states for the 1960-99 period. Every state exhibits a positive and generally substantial average annual rate of TFP growth. The median TFP growth rate was 1.71 per cent per year. One third of the states have growth rates averaging more than 2 per cent per year. The wide disparity of growth rates over the 1960-99 period resulted in substantial changes in the rank order of the states.

Kumar *et al.* (2004) studied the total factor productivity (TFP) growth in the Indian fisheries sector. Divisia Tornqvist index was used for computing TFP for the inland and marine fisheries. The TFP annual growth was estimated to be 4.0 per cent for the aquaculture sector and 2.0 per cent for the marine sector. The investments made in

this sector have paid rich dividends, and the development of export market would be crucial to realize the gains from the technological progress.

Zhang and Fan (2004) conducted a causality test to investigate the relationship between productivity and infrastructure development using a panel data set at the district level in rural India from 1971 to 1994. Causal effect of roads and irrigation contribute to TFP growth. The demand effect of TFP on roads is less noticeable than on irrigation. The article once again confirms the large impact of infrastructure development on agricultural productivity. In addition to the impact on agricultural TFP, roads are important for poverty reduction through increased non-farm activities and migration. The results showed that infrastructural development in India is productive, providing supporting evidence to reverse the trend of declining investment in rural infrastructure.

Rao (2005) made an attempt to study the variations in the indices of total factor productivity in the crop sector, food grain crops and non-food grain crops and their contribution to the TFP in Andhra Pradesh during 1980-81 to 1999-2000. Tornqvist Theil Index was used to calculate the index of total factor productivity. The average annual index of total factor productivity during post reform period was found 5 per cent less than pre-reform period in the state in crop sector as a whole. While, in case of non-food grains, it was 9 per cent less than that of pre-reform period. TFP index was observed to be less than 100 during both the periods for food grains. The contribution of TFP to yield growth was computed as 31 per cent in the pre-reform period. An absolute decline (-37) was noted during the post-reform period in the crop sector of the state.

Lissita *et al.* (2005) analysed efficiency and TFP change of large agricultural enterprises using envelopment approach and productivity change by Malmqvist approach. The results of study indicated that decreased inefficiency was the main reason for declining TFP.

Suryabhushan (2005) studied TFP growth using malmqvist approach in India for Punjab, Haryana, Uttar Pradesh, Rajasthan and Madhya Pradesh for the period from 1982-83 to 1999-2000. The study concluded that technological progress has contributed mainly to the total productivity growth, however it was uneven for majority of wheat producing states.

Khobarkar (2005) analysed the performance of agriculture in Konkan region by measuring TFP indices at district levels. The study indicated that, for the entire period (1980-2000), the growth in total input index and total output index was 0.95 and 0.94 per cent per annum respectively, while, growth in total factor productivity index was negative (-0.0082). The TFP growth in Konkan region was negligible. The study concluded that over the year there was no development in agriculture especialy in foodgrains. However more efforts were made to develope horticulture sector in that region.

Hiremath (2006) analysed total factor productivity (TFP) for cotton, sorghum and soybean crop in Amravati district. Tornqvist Theil index number approach was used for calculating TFP. The annual growth rates of TFP were -1.23 per cent, 0.011 per cent and 1.07 per cent for cotton, sorghum and soybean crop, respectively. Analysis showed that growth in TFP was high in second period than the first period. Cost share showed that the rental value of land to be the highest contributor to the total cost in all the three crops. Female labour contributed more than male labour in cotton and vice versa in sorghum, while male and female labour contributed equally in soybean crop.

CHAPTER – III

Methodology

CHAPTER - III

METHODOLOGY

The success of any scientific research ultimately depends upon the research methods used. It is therefore necessary to adopt suitable and appropriate analytical methods in economic research also. Attempts have been made in this chapter to describe the methods, sources of data collection and various statistical tools used for testing the objectives of the present study. The study has been confined to Vidarbha region of the Maharashtra state. The Vidarbha region is broadly divided into three agro-climatic zones namely, Eastern Vidarbha Zone, Central Vidarbha Zone and Western Vidarbha Zone.

Eastern Vidarbha Zone includes the districts Chandrapur, Bhandara, Gondia and Gadchiroli while Central Vidarbha Zone comprises of districts Nagpur, Yavatmal and Wardha, Western Vidarbha Zone includes Buldhana, Akola, Washim and Amaravati districts.

Crops selected

From Central and Western Vidarbha Zone, crops like Cotton, Soybean, Jowar, Tur and Gram were selected for the study while Paddy being the dominating crop of Easter Vidarbha Zone was selected for the study.

Period of study

The study was carried from 1987-88 to 2004-2005. However, data pertaining to input utilization for soybean and paddy were available only after 1990.

Sources of data

Data pertaining to inputs used and their value were collected from Agriculture Prices and Costs Scheme, Department of Agricultural Economic and Statistics, Dr. PDKV, Akola.

Secondary data were obtained from various published sources. Following publications were referred for collecting the secondary data.

i. Epitome of Agriculture, Department of Agriculture, Maharashtra state.

ii. Season and Crops Reports, Department of Agriculture, Government of Maharashtra, Pune.

iii. Socio-Economic Review and District Statistical Abstract.

iv. Annual Reports from the office of of Joint Director of Agriculture (Nagpur and Amravati Division).

v. Yield gap Report, Directorate of Research, Dr. PDKV, Akola.

Analytical tools

i. Compound growth rates

The growth rates of area, production, productivity, input and output of selected crops were estimated for two sub-periods. The first period was 1987-88 to 1995-96 and second period from 1996-2004. These growth rates were estimated using following exponential model.

$$Y = ab^x e^u$$

Where,

Y = Dependent variable

a and b = Parameters

x = Period (in years)

u = Error term

The above equation is reduced to the following linear function, on taking logarithms on both sides..

$$\log Y = \log a + X (\log b) + u$$

Compound growth rate was estimated by -

$$CGR = [\text{Antilog} (\log b) - 1] \times 100$$

Analysis of Total Factor Productivity (TFP)

Analysis of total factor productivity attempts to measure the amount of increase in total output which is not accounted for by increase in total inputs. Changes in the TFP index can be used as one of the measure of the effects of the technological change. Partial productivity measures such as output per unit of individual inputs have limitations as indicators of real productivity change. A TFP index that measures the growth in net output that is not accounted for by the growth of basic inputs factors such as land, labour and capital measure of productivity, which relates output to all inputs simultaneously.

Various methods have been used for computing the TFP index (Christensen, 1975). Tornqvist-Theil index is considered as the superior index for calculating total factor productivity (Rosegrant and Evenson, 1994).

The Divisia-Tornqvist index is used for computing the total output, total input, input price and total factor productivity indices.

For calculating input indices and price indices, the following inputs were considered in the study.

1. Male labour (days/ha)
2. Female labour (days/ha)
3. Bullock labour (days/ha)
4. Machine labour (days/ha)
5. Seed (kgs/ha)
6. Manure (qtls/ha)
7. Fertilizer (kgs/ha)

N

P

K

8. Insecticide (lits./ha)

9. Rental value of land (Rs./ha)

Main produce and byproduce were taken into account while calculating output index.

Tornqvist-Theil Divisia Chained Index Number Approach

Total output, total input, TFP and input price indices were calculated as follows.

Total Output Index (TOI)

$$TOI_t / TOI_{t-1} = \Pi_j (Q_{jt} / Q_{jt-1})^{(R_{jt} + R_{jt-1}) / 2}$$

Total Input Index (TII)

$$TII_t / TII_{t-1} = \Pi_j (X_{it} / X_{it-1})^{(S_{it} + S_{it-1}) / 2}$$

Input Price Index (IPI)

$$IPI_t / IPI_{t-1} = \Pi j (P_{it} / P_{it-1})^{(S_{it} + S_{it-1}) / 2}$$

Where,

R_{jt} = Share of output j in total revenue

Q_{jt} = Output j

S_{it} = Share of input i in the total input cost

X_{it} = Quantity of input i

P_{it} = Price of input i, in period t

For productivity measurement over a long period of time, chain indexes for successive time period is preferable with chain-linking. An index is calculated for two successive periods t and t-1 over the whole period to T (samples from time t=0 to t=T) and the separate indexes are then multiplied together.

$$TOI(t) = TOI(1) \cdot TOI(2) \ldots\ldots TOI(t-1)$$
$$TII(t) = TII(1) \cdot TII(2) \ldots\ldots TII(t-1)$$
$$IPI(t) = IPI(1) \cdot IPI(2) \ldots\ldots IPI(t-1)$$

Total factor productivity index (TFP)

$$TFP_t = (TOI_t / TII_t)$$

Data as input quantity and its value were available for all inputs except insecticide. Therefore input quantity prices were worked out directly for each of them. However, for the insecticides, data was available only in value terms. Therefore an indirect method was used to compute their quantity indices. First, the value indices were prepared which were then divided with respective price indices (Maurvi Pandya and Shiyani, 2002).

The average annual growth rate were calculated by taking average of index of second year minus index of previous year. However growth in the total factor productivity was calculated by taking substraction of growth in output index to the input index.

Factors influencing TPF

The influence of infrastructural, socio-economic variables and technological factor on the productivity of crops in the different zones of Vidarbha region was estimated using log linear regression model as follows : The time series data from 1987 to 2004 were considered for the study

$$Ln\ Y = Ln\ a + b_1 \ln X_1 + b_2 \ln X_2 + \ldots\ldots + b_7 \ln X_7$$

Where,

Y = TFP

bi = Elasticities

X_1 = Total amount of loan (short term + medium term + long term loans) sanctioned by commercial banks, regional rural banks and cooperative banks, primary agricultural and cooperative societies and primary agricultural and land development banks per thousand hectare of Net Cultivated Area (in Rs. lakhs).

X_2 = Number of irrigation pump sets per '000' ha of Net Cultivated Area.

X_3 = Number of tractors per '000' ha of Net Cultivated Area.

X_4 = Proportion of net cropped area under irrigation.

X_5 = Road density (Kilometer per '000' ha of Net Cultivated Area)

X_6 = Annual rainfall (mm)

X_7 = Proportion of net cropped area under high yielding varieties.

CHAPTER – IV

Agro-Economic Features of Vidarbha Region

CHAPTER IV

AGRO-ECONOMIC FEATURES OF VIDARBHA REGION

This chapter is devoted to the agro-economic features of the Vidarbha region. The agro climatic conditions differ from place to place and even in close vicinity also, it may or may not be identical. It is therefore proposed to outline some of the main agro economic and geographical features of Vidarbha region. This will also help in the interpretation of the results and drawing inferences.

Maharashtra state includes six revenue division *viz.*, Mumbai, Pune, Nashik, Aurangabad, Amravati and Nagpur. Vidarbha includes Amravati and Nagpur revenue division. Vidarbha includes eleven districts *viz.*, Buldhana, Akola, Washim, Amravati, Yavatmal, Wardha, Nagpur, Bhandara, Gondia, Chandrapur and Gadchiroli. Washim and Gondia are newly formed districts bifurcating Akola and Bhandara, respectively. The Vidarbha is broadly divided into three agroclimatic zones based on precipitation, temperature, soil and cropping pattern. These are Eastern, Central and Western Zones. The present study is confined to the Vidarbha region and comprising Eastern, Central and Western Zones of Vidarbha region.

4.1 Location

Vidarbha is more or less centrally situated in Indian peninsula. It is the eastward part of Maharashtra, spread over from Buldana district in the west to Gondia district in the east and it is around 450 km long and 250 km in width. It is placed between 21^0 - 46^0 and 17^0 - 56^0 North latitude and 80^0 - 50^0 and 70^0 - 57^0 longitudes. It is bounded by M.P. state on the north and on the south Parbhani and Nanded districts of Aurangabad revenue divisions of Maharashtra known as Marathwada region, and on the east part of Andhrapradesh and Chattisgarh states and on the west Aurangabad and Jalgaon districts of Maharashtra.

Fig. 1 : District map of Maharashtra

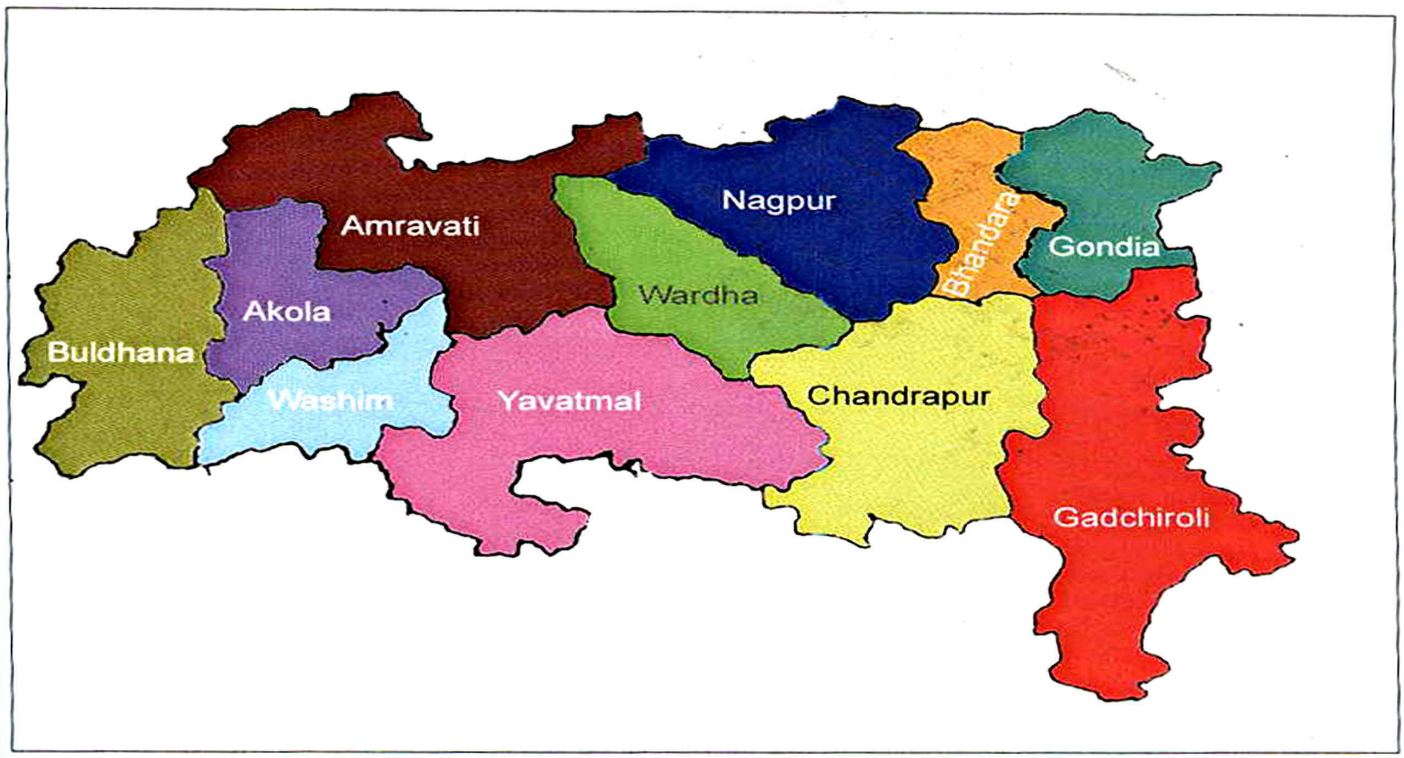

Fig. 2 : District map of Vidarbha

4.2 Geographical area

Out of the total geographical area (307.58 lakh hectares) of the state, Vidarbha covers 97.23 lakh hectares which is around 31.28 per cent of the state. Vidarbha is bigger than many small existing states in the country in area and population. It is divided into two revenue divisions (Amravati and Nagpur) and presently has 11 districts with 118 talukas (Cenus 2001). Gondia district is recently formed by bifurcating Bhandara districts and Washim district bifurcating Akola district in 1999.

4.3 Population

As per 2001 census total population of Vidarbha is 204.66 lakhs, which is 21 per cent of the state. The rural population varies from 35.64 per cent in Nagpur district to 93.07 per cent in Gadchiroli, indicating majority of population lives in rural area. The overall child population ranges from 12.20 to 15.68 per cent of the total population. Literacy percentage varies from 50.87 per cent in Gadchiroli district to 73.56 per cent in Nagput district. Density of population is minimum 67 persons per sq.km. in Gadchiroli to 410 persons in Nagpur district. Number of cultivators, agriculture labours and laboures in allied agricultural activities are 21.4, 35.6 and 24.79 per cent respectively of the state figures.

Table 4.1. Population statistics of various districts of Vidarbha (2001)

Name of the districts	Popula-tions (lakhs)	Rural popula-tion percentage	Literacy percen-tage	Persons per sq.km.	No. of cultivators	No. of agricultural labours	No. of labours in allied agricultural activities
Buldhana	22.26	78.74	64.8	230	3,29,063	3,66,6587	8,068
Akola	16.29	61.60	70.2	301	2,41,226	4,69,292	7,984
Washim	10.19	82.54	62.64	197			
Amravati	26.06	65.50	71.9	213	1,91,194	4,65,474	13,077
Yavatmal	24.60	81.67	63.24	181	2,49,570	4,94,163	12,946
Wardha	12.30	73.60	70.66	195	1,25,214	2,07,916	7,200
Nagpur	40.51	35.64	73.56	410	2,14,646	2,80,181	23,424
Bhandara	12.00	84.56	68.27	323	3,83,544	3,15,159	18,008
Gondia	9.69	88.05	67.67	172			
Chandrapur	20.77	67.63	63.52	195	2,42,426	2,64,959	18,076
Gadchiroli	9.99	93.07	50.87	65	2,01,192	1,03,151	8,198
Vidarbha	204.66	73.87	63.30	209	21,78,075 (21.4)	29,67,053 (35.6)	1,16,981 (24.79)
Maharashtra	967.52	57.60	77.27	314	1,01,72,100	83,13,223	4,71,731

(Source : Directorate of Census Publication 2002)

Note : Figures in parenthesis are percentages to the state

4.4 Pattern of land holding

Table 4.2. Pattern of distribution of land holding and area in Vidarbha in 2000-01

(Area in ha)

Sr. No.	Size group	Number	Area
1)	Marginal (0 to 0.99 ha)	6,41,850 (26.61)	2,43,071 (5.86)
2)	Small (1 to 1.99 ha)	8,84,890 (36.69)	7,18,639 (17.34)
3)	Semi medium (2 to 3.99 ha)	5,82,384 (24.15)	13,58,091 (32.78)
4)	Medium (4 to 9.99 ha)	2,87,292 (11.91)	16,27,554 (39.29)
5)	Large 10 and above)	15,061 (0.62)	2,14,695 (5.1)
	Total	**24,11,283** (100.00)	**41,62,050** (100.00)
	Average size of holding (ha)		1.73

(Source : Yield Gap Report, Directorate of Research, Dr. PDKV, Akola.)

The pattern of distribution of land holding and area in Vidarbha is presented in

Table 4.7 from the Table it can be seen that the average size of land holding in Vidarbha was 1.73 hectare in 2000-01. The total number of cultivator was 24,11,283 and area was 41,62,050 hectare.

4.5 Topography

Vidarbha forms the part of the Deccan plateu. The terrain is mostly plane known as Nagpur-Berar plane. Gondia and eastern parts of Bhandara and Chandrapur districts are said to be the parts of Chhatisgarh plane. Northern part of the region is bound by ranges of Satpura extending through part of Jalgaon taluka of Buldhana district, Melghat plateau (Dharni and Chikhaldara Taluka) known as Gavilgad hills and northern part of Morshi taluka of Amravati districts. This Satpuda plateau have an elevation of 90 to 200 meters. Some of its ranges extend to the northern portion of Katol, Saoner and Ramtek talukas of Nagpur district and Arvi taluka of Wardha district. On the Southern side of the region lies the Ajantha hills forming plaeau in Chikhali and Mehekar talukas of Buldhana district extending in Washim and Mangrulpir talukas of Washim district and Pusad, Darwha and part of Yavatmal, Kelapur and Wani talukas of Yeotmal districts. Eastern portion of the region *viz.*, Chandrapur, Bhandara and Gondiya districts have many hills as offshoots of Satpura ranges forming the eastern upland natural zone. Some of the important hill ranges are Sircond near Sironcha, Gadulghad ranges (Chimur and Mul hills), Surjagarh ranges in Chandrapur district and Gaimukh, Ambagad, Gaikhuri and Pratapgarh ranges in Bhandara district. On the western side there are ranges of Ajantha hills.

Main rivers of the region are Painganga arising from Ajanta mountain following east ward as a south boundary of the region and its tributaries, Wardha flowing to south east direction along with its tributaries and almost dividing the region into two parts. Vianganga river flowing southernly direction and divide Chandrapur district in approximately two halves creating Chandrapur and Gadchiroli districts and have several tributaries. Tap flows on western border give rise to Tapti through. The river valley area of Painganga, Wainganga, Wardha, Purna, Tapi which are flowing through Vidarbha give rise to fertile and productive plane.

4.6 Soils

Soils are classified as vertisols derived from trap rocks. They have varying depth depending upon its physiography. Most of the soils are calcarious, thoroughly base saturated and fairly well supplied with potash and phosphate but low in organic matter and nitrogen. The pH is alkaline and varies from 7.5 to 8.0. Soils deeper than 1.5 meter and clayey in texture pose problem of temporary water logging and are saline to certain extent. Such conditions occur in Purna valley. There are six broad categories of soils in Vidarbha i.e. very shallow soil, shallow black soil, medium black soil, deep black soils, yellow brown soils and salt affected soils.

4.6.1 Very shallow soils

These soils are less than 7.5 cm deep with brown colour. Texture is medium to coarse. The soils are well drained capacity to available water is low. pH ranges 7 to 8. Organic carbon, N and available P are low while available K is medium.

4.6.2 Shallow black soils

These soils are 7.5 to 25 cm deep with dark brown in colour. Texture is medium. The soil are well drained with low available water capacity. pH ranges 7.5 to 8.5. Organic carbon, N and available P are low while the available K is high.

4.6.3 Medium deep black soils

These are 25 to 50 cm deep with dark brown to grayish brown in colour. Moderately well drained with low available water capacity. Texture is medium, pH ranges 7.5 to 8.5. Organic carbon, N and available Pare low where as available K is high. The soils are calcarious in nature.

4.6.4 Deep black soils

These are 50 to 100 cm deep and above with dark grayish to very dark grayish brown in colour. Texture is fine. The drainage is restricted with moderately high available water capacity. the pH ranges from 7.5 to 8.5. Organic carbon, N and available P are low to medium while available K is high to very high. These soils are generally calcarious in nature.

4.6.5 Yellow brown soils

These soils are moderately deep to deep say 50-100 cm, eroded with low available water capacity. They are well drained the pH varies from 6.5 to 7.5 N and available P are low while available K is medium to high.

4.6.6 Salt affected soils

These soils are mainly found in Purna Valley which spread over to Amravati, Akola and Buldhana districts. These exist all along both the sides around 10 to 45 km in width and about 150 km in length affecting about 547 villages in Amravati, Akola and Buldhana districts. These soils are very deep with fine texture having imperfect drainage. Water holding capacity is very high. Clay content ranges from 52 to 70 per cent. The pH is 7.7 to 9.4. The soils are mostly normal at horizon and the problem of salinity increases with depth. Landform is mainly plain.

4.7 Climate and rainfall

The climate of the region is tropical monsoon type and characterized by three distinct seasons *viz.*, summer : with dry and hot whether from March to June, rainy season : warm and rainy from June to September and winter : dry with mild cold from November to February. The mean annual maximum and minimum temperatures are 34^0C and 20^0C, respectively. High temperature to the extent of 45^0C or more are observed during May, while low temperature of about 8 to 10^0C are recorded in the month of December and January. The annual rainfall varies from 750 to 1700 mm distributed over 40 to 70 days. About 80 to 85 per cent of the mean annual rainfall is being received during June to September. Based on precipitation of the region, three zones can be distinctly grouped viz., assured rainfall zone, receiving 750 to 950 mm rainfall, medium rainfall zone with 950 to 1250 mm rains and high rainfall zone having 1250 to 1700 mm rainfall annually.

4.8 Land use classification

The land utilization information of Vidarbha region is presented in Table 4.2. It is evident from the Table that the total geographical area of Vidarbha is 97.23 lakh hectares as against 307.58 lakh hectares of the Maharashtra. The net sown area is 49.96 lakh hectares i.e. 51.39 per cent of the total geographical area in region. This is followed by the land under forest (28.05%), permanent pastures and grazing land (5.86%) and land

under non agricultural use (5.69%). The barren and uncultivable land accounts 2.03 per cent, cultivable waste land accounts 2.05 per cent, current fallows land 2.62 per cent, other fallows land 1.61 per cent and land under miscellaneous trees crops and grooves 0.66 per cent. Area sown more than once is 10.29 lakh hectares i.e. 10.58 per cent of total geographical area of Vidarbha.

Table 4.3. Land use classification

Sr. No.	Particular	Area ('00' ha)	Percentage to total geographical area
1.	Total geographical area	97233	100
2.	Area under forest	27275	28.05
3.	Barren and uncultivable land	1981	2.03
4.	Land under non agricultural use	5539	5.69
5.	Cultivable waste land	1999	2.05
6.	Permanent pasture and grazing land	5697	5.86
7.	Land under miscellaneous trees crops and grooves	645	0.66
8.	Current fallows	2550	2.62
9.	Other fallows	1572	1.61
10.	Net sown area	49975	51.39
11.	Area sown more than once	10291	10.58
12.	Total cropped area	60262	61.98

(Source : Epitome of Agril. Part II, 2002)

4.9 Cropping pattern of Vidarbha region

Cropping pattern of Vidarbha region is presented in Table 4.3. From Table 4.7, it can be seen that cotton is a major crop occupying 26.17 and 21.17 per cent in 2000-01 and 2004-05 of the gross cropped area. Area under paddy is 11.07 per cent in 2000-01 and 11.15 per cent in 2004-05, means, the area under paddy is slightly increase in 2004-05 However area under cotton is decreased in 2004-05 compared to 2000-01. The area under soybean (15.26%) increased by 22.03 per cent in 2004-05. Area under *kharif* jowar is 11 per cent in 2000-01, which is declined in 2004-05 (8.64%).

Table 4.4. Cropping pattern of Vidarbha region

Sr. No.	Crops	2000-01	2004-05
1.	Rice	6674.00 (11.07)	6720.00 (11.15)
2.	Wheat	1648.00 (2.73)	1111.00 (0.72)
3.	*Kharif* jowar	6627.00 (11.00)	5209.00 (8.64)
4.	*Rabi* jowar	820.00 (1.36)	488.00 (0.10)
5.	Bajra	230.00 (0.38)	112.00 (0.19)
6.	Other cereals	589.00 (0.98)	NA
7.	Tur	5049.00 (8.380	5233.00 (8.68)
8.	Gram	1761.00 (2.92)	2076.00 (1.32)
9.	Other pulses	6467.00 (10.73)	4512.00 (7.49)
10.	Groundnut	371 (0.62)	147.00 (0.15)
11.	Soybean	9199.00 (15.26)	13276.00 (22.03)
12.	Safflower	220.00 (0.37)	106.00 (0.06)
13.	Sunflower	251.00 (0.42)	85.00 (0.04)
14.	Cotton	15770.00 (26.17)	13085.00 (21.17)
15.	Sugarcane	221.00 (0.37)	135.00 (0.03)
16.	Other crops	4369.00 (7.25)	NA
17.	Gross cropped area	60266.00 (100.00)	60266.00 (100.00)

Note : Figures in parentheses are percentage to the gross cropped area
NA – Not available

(Source : Yield Gap Report, Directorate of Research, Dr. PDKV, Akola.)

4.10 Irrigation

Irrigation is one of the means to assure protection of crop from failure of monsoon. The State Government sanctioned number of major, medium and minor irrigation projects to explore the optimum irrigation potentials and established Maharashtra irrigation commission to streamlined and speeding the works.

Table 4.5. Area irrigated by different sources in different districts of Vidarbha in year 1996-97

(Area in 00 ha)

Name of district	Source of irrigation		Net area irrigated	Area irrigated more than once	Gross area irrigated
	Surface and other sources	Well			
Buldhana	17	361	378	90	468
Akola	42	229	271	108	379
Amravati	29	601	630	185	815
Yavatmal	66	431	497	180	677
Wardha	27	194	221	101	322
Nagpur	537	565	1102	321	1423
Bhandara	1669	262	1931	292	2223
Chandrapur	905	134	1039	117	1156
Gadchiroli	516	30	546	59	605
Total Vidarbha	**3808**	**2807**	**6615**	**1453**	**8068**
Total Maharashtra	10280	20594	30874	6814	37688

(Source : Epitome of Agri. Part II 2002)

From Table 4.4 it is observed that net area irrigated in Vidarbha is 6.62 lakh hectare as against 30.87 lakh hectare area of Maharashtra. Surface and other sources of irrigation is higher (3.81 lakh hectares) than well irrigation (2.81 lakh hectares) in Vidarbha. Area irrigated more than once is 1.457 hectares and gross area irrigated is 8.01 lakh hectares as against 37.68 lakh hectares in Maharashtra.

Further, it can be seen from Table 4.4 that Bhandara has the highest area under surface irrigation followed by Chandrapur, Nagpur and Gadchiroli. However, Amravati district has more area under well irrigation followed by Yavatmal, Buldhana and Akola. Wardha district lag behind both in well and in surface irrigation.

Table 4.6. Irrigated area under principal crops in Vidarbha

(Year 1998-99)

Sr. No.	Name of the crop	Irrigated area (00 ha)	
		Vidarbha	Maharashtra
1.	Rice (*kharif*)	3032 (4.99)	3187 (1.43)
2.	Rice (summer)	215 (0.35)	334 (0.15)
3.	Wheat	1555 (2.56)	7368 (3.35)
4.	Gram	274 (0.45)	2405 (1.08)
5.	*Kharif* groundnut	-- (0.00)	109 (0.49)
6.	Summer groundnut	142 (0.23)	1348 (0.60)
7.	Sugarcane	171 (0.28)	6093 (2.75)
8.	Bajra	-- (0.00)	1170 (0.53)
9.	*Kharif* jowar	-- (0.00)	51 (0.02)
10.	*Rabi* jowar	-- (0.00)	3727 (1.68)
11.	Cotton	-- (0.00)	652 (0.29)
	Total irrigated area under crops	5389 (8.87)	26444 (11.93)
	Total cropped area	60705 (100.00)	2,21,547

(Source : Epitome of Agriculture Part II - 2002)

Note : Figures in parentheses are percentages to the total cropped area.

Out of the total cropped area in Vidarbha and the state the principal crops irrigated were 8.87 and 11.93 per cent respectively. Irrigated area under rice (kharif) is 4.99 per cent followed by wheat in Vidarbha region. In Maharashtra, area under irrigation is higher in wheat crop i.e. 3.35 per cent followed by sugarcane.

4.11 Agro-climatic zones

The Vidarbha is broadly divided into three agroclimatic zones based on precipitation, temperature, soil and cropping pattern. There are Eastern, Central and Western Vidarbha Zones.

4.11.1 a) Eastern Vidarbha Zone (EVZ)

This one consists of Nagpur, Chandrapur, Gondia, Bhandara and Gadchiroli districts. The total geographical area is 35.11 lakh ha. The average annual rainfall is about 1250-1700 mm receives in 60 to 70 rainy days. The average annual temperature ranges from 24^0C to 30^0C . The soils are mainly derived from mixed parent rocks like granite-gneiss and schist. These are yellowish brown to red in colour, having pH around 6 to 7. Paddy is the predominant crop associated with Sesamum, linseed, gram and *rabi* jowar in *rabi* season. This zone is rich in forest covering about 50 per cent area with natural vegetation finding species Acacia Catachu (Khair), Terminalia Chebula (Teak), Acacia catachu (Khair), Terminalia chebula (Hirda), Terminalia belarica (Bhihada), Hardwicka binata (Anjan), Azadirachta indica (Neem), Zizipus sp. (Ber), etc.

b) Central Vidarbha Zone (CVZ)

This zone consists of Yavatmal, Wardha and part of Nagpur district having 29.67 lakh ha geographical area with an annual average rain fall of 950 to 1250 mm in 50 to 65 days. The average annual temperature ranges from 26^0C to 38^0C. The soil are mainly derived from basalt rock and black in colour. The main crops grown are cotton, soybean, pigeonpea, jowar in *khariff* season an wheat and gram in *rabi*. The natural vegetation comprises of Teak, Babul, Hiwar, Khair, Palas, Sisoo, etc. Substantial area is under orange cultivation.

c) Western Vidarbha zone (WVZ)

This zone consists of Buldhana, Akola, Washim, Amravati districts and part of Yavatmal district. The total geographical area is around 32.44 lakh ha with an annual precipitation of 750-950 mm with 48-60 rainy days. The average annual temperature ranges from 26^0C - 40^0C. The soils of this zone are chiefly derived from Deccan traps with pH range of 7.5 to 8.5. The major crops are cotton, pigeonpea, groundnut, jowar, sunflower, safflower, wheat gram, etc. The natural vegetation found in this zone are palas, babul, khair, anjan, behada, etc.

4.11.2 Agroclimatic zones based on precipitation

Precipitation as a criteria for zonation has become conspicuously dominant because of the availability of rainfall data. Relatively on a smaller region, total precipitation, its intensity and periodicity forms a more reliable and convenient criteria for identifying major agro-climatic zones. Temperature variations, although a major parameters to climate become less conspicuous on a small region. With a given sets of temperature variations, rainfall variations become conspicuously dominant in shaping nature of soils, vegeation, farming systems and crops. Another advantage of choosing precipitation as a criteria for zonation is the availability of rain fall data. Based on this the following Agro-climatic zones are grouped.

1) Assured Rainfall *Kharif* Crop Zone (ARK)
2) Moderate Rainfall Zone (MR)
3) High rainfall Zone (HRM)
4) Moderate to High rainfall Zone (MHRH)

4.12 Crop zones and cropping pattern

Crops grown in a locality depending on its feasibility, productivity and needs. Usually when dominant crops occupy more than 70 per cent of the gross cropped area in a given locality forms the major crop occupied by different crops. Crop patterns of any place is a function of climatic elements, their periodicity in terms of seasons, nature of soils, physiography and man introduced factors like use of fertilizers, irrigation, etc. Amongst the climatic factor, the precipitation. its distribution and periodicity has a greater determinant value. Based on these the major crop zones are given below.

4.12.1 Cotton-sorghum (CS) zone

This is the larges crop zone spreading over five districts *viz.*, Buldhana, Akola, Amravati, Yavatmal and Wardha and comprising 21 Tahsils. This zones predominant single crop is cotton, occupying about 33 to 57 per cent of gross cropped area, followed by sorghum with 18.36 per cent are. These two crops together constitute major crop pattern on 16 tahasils and forms two crops zones. The second one has one additional crop

may be wheat, pulse or rice. The distinction between the two is slight. Only *rabi* crop grown in the zone is wheat and Tahsils, having more than 3 per cent gross cropped area under wheat are in Khamgaon tahasil of Buldhana district and in Akola districts tahasils *viz.*, Akola, Balapur, Akot, Murtizapur and Washim.

4.12.2 Sorghum-cotton zone (S.C.)

Predominant crop is *kharif* sorghum followed by cotton. This occupies three talukas each of Buldhana and Nagpur districts. The third crop to form major crop pattern may be safflower in Buldhana districts, wheat and groundnut in Nagpur district. Other crops are pulses and wheat.

4.12.3 Multi crop zone (MC)

Minimum four crops are considered to form major crop pattern. This is further divided in to two subzones *viz.*, (a) *Kharif* crop dominated, and (b) *Rabi* crop dominated. The first (a) sub zone includes Melghat taluka in Amravati district and Ramtake taluka in Nagpur and Rajura taluka in Chandrapur district. The (b) sub zone Warora taluka in Chandrapur district and Umrer taluka in Nagpur district. This zone fairly keeps the continuity (except Melghat taluka) and indicates the marginality of *kharif* and *rabi* crops as it is located on the boundry of moderate rainfall zone and high rainfall zone.

4.12.4 Rice zone (RI)

This one is situated at the eastern part of the region comprising Bhandara district, middle and eastern part of Chandrapur district receiving high rainfall. The zone may be further divided in three sub zones depending upon the predominat crop together with rice (a) Rice pulse sub zones has rice as predominat crop with *rabi* pulses covering Gondia and Sakoli talukas of Bhandara district. (b) rice sorghum sub zone has rice and in *rabi* jowar. This is found in Bramhapuri, Gadchiroli, Sironcha of Chandrapur district and part of Bhandara district. (c) Sorghum-rice zone. This exist in Chandrapur tahasil of Chandrapur district.

4.13 Districtwise per capita income in Vidarbha

Per capita income in Vidarbha is presented in Table 4.6. It can be seen that, the per capita income of Maharashtra in 2000-01 at current prices was Rs. 21,871 while it

was Rs. 16,042 in Vidarbha. Per capital income of Vidarbha in 2003-04 at current prices was Rs. 21,240 and Maharashtra was Rs. 26,386. Per capita income of Nagpur district was highest in 2000-01 and 2003-04 i.e. Rs. 24,754 and Rs. 33,700. respectively. Followed by Chandrapur and Akola districts.

Table 4.7. Districtwise per capita income in Vidarbha

Sr. No.	District	2000-01	2003-04
1)	Buldhana	12,442	17,542
2)	Akola	15,331	19,875
3)	Washim	14,700	19,172
4)	Amravati	18,543	21,622
5)	Yavatmal	14,519	19,055
6)	Wardha	17,272	24,121
7)	Nagpur	24,754	33,700
8)	Bhandara	15,033	21,554
9)	Gondia	14,742	17,777
10)	Chandrapur	18,325	25,684
11)	Gadchiroli	10,819	13,536
12)	Vidarbha	16,042	21,240
13)	Maharashtra	21,871	26,386

(Source : Yield Gap Report, Directorate of Research, Dr. PDKV, Akola.)

CHAPTER – V

Results and Discussion

CHAPTER V

RESULTS AND DISCUSSION

The analytical inadequacies of the single factor productivity (SFP) measures have led the economist to evolve the total factor productivity measures. The change in TFP index is a composite measure of productivity, which relates output to all inputs simultaneously. The change in TFP index can be used as one measure of technical change. Earlier Laspeyres arithmetic indices were used most commonly to measure TFP (Maurvi Pandya and Shiyani 2002). But most recent literature on TFP (Kumar and Mruthynjay 1992, Kumar and Rosegrant 1994, Desai and Nambudri 1997, R.C.Lal 2001 etc.) advocated and employed Tornqvist Theil or Translog index in their study because of its superiority.

Zoneswise analysis of compound growth rates of area, production and yield as well as input and output growth rates, Tornquist-Theil Divisia Index of Output, Input and Total Factor Productivity and their annual growth rate, cost shares of inputs in production of crop and analysis of factors of influencing Total Factor Productivity were calculated and presented in this section.

5.1. Performance of agriculture in different regions of Vidarbha

The performance of agriculture in respect of cropping pattern and compound growth rates of area, production, and productivity for different crops of Eastern Vidarbha Zone (EVZ), Central Vidarbha Zone (CVZ), and Western Vidarbha Zone (WVZ) were studied and results obtained are presented in following tables.

5.1.1 Cropping pattern of agriculture

5.1.1.1 Eastern Vidarbha Zone (2004-05)

Cropping pattern of Eastern Vidarbha Zone is presented in Table 5.1.

Table 5.1. Cropping pattern of Eastern Vidarbha Zone (2004-05)

Sr. No.	Crop	Area (00' ha)	Percentage to gross cropped area
1.	Paddy	6164	57.23
2.	Wheat	241	2.24
3.	*Kharif* jowar	107	0.99
4.	*Rabi* jowar	224	2.08
5.	Bajra	NA	NA
6.	Tur	391	3.63
7.	Gram	218	2.02
8.	Other pulses	524	4.86
9.	Groundnut	10	0.09
10.	Soybean	1773	16.46
11.	Safflower	2	0.02
12.	Sunflower	NA	NA
13.	Cotton	500	4.64
14.	Sugarcane	15	0.14
	Gross cropped area	**10771**	**100.00**

(Source : Yield Gap Report, Directorate of Research, Dr. PDKV, Akola.)
Note : NA- Not available

From Table 5.1, it could be seen that paddy is a dominating crop in Eastern Vidarbha Zone. The area under paddy was 6.16 lakh hectares which was 57.23 per cent of gross cropped area. Next to paddy, soybean occupied area of 1.77 lakh hectares which was 16.46 per cent of gross cropped area. The share of other pulses worked out to 4.86 per cent in this zone. Wheat and gram were important *rabi* crops found in the Eastern Vidarbha Zone which occupied 2.24 per cent and 2.02 per cent of the gross cropped area respectively. The area under tur was 3.63 per cent. The area under *rabi* jowar (2.08) was more than *kharif* jowar (0.99%). The area under cotton was 0.5 lakh hectares which was 4.64 per cent of the gross cropped area. Whereas, sugarcane is another cash crop after cotton which occupied 0.14 per cent area of the gross cropped area. while the area under groundnut and safflower (0.09% and 0.02%) was negligible.

5.1.1.2 Central Vidarbha Zone (2004-05)

Cropping pattern of Central Vidarbha Zone is presented in Table 5.2 as under :

Table 5.2. Cropping pattern of Central Vidarbha Zone (2004-2005)

Sr. No.	Crop	Area (00' ha)	Percentage to gross cropped area
1.	Paddy	457	2.32
2.	Wheat	465	2.35
3.	*Kharif* jowar	1808	9.17
4.	*Rabi* jowar	60	0.30
5.	Bajra	36	0.18
6.	Tur	2321	11.77
7.	Gram	698	3.54
8.	Other pulses	917	4.65
9.	Groundnut	106	0.54
10.	Soybean	6066	30.77
11.	Safflower	6	0.03
12.	Sunflower	2	0.01
13.	Cotton	5079	25.76
14.	Sugarcane	81	0.41
	Gross cropped area	**19713**	**100.00**

(Source : Yield Gap Report, Directorate of Research, Dr. PDKV, Akola.)

It could be seen from Table 5.2 that, soybean is a main crop in the Central Vidarbha Zone. The area under soybean was 6.07 lakh hectares which was 30.77 per cent of the gross cropped area. Next to soybean, cotton occupied 5.08 lakh hectares area which was 25.76 per cent of the gross cropped area. Tur is a another important pulse crop grown in this zone, occupying 2.32 lakh hectares area which was 11.77 per cent of the gross cropped area. The share of other pulses worked out to 4.65 per cent.

Among cereal crops, *kharif* Jowar contributed more area i.e. 1.81 lakh hectares which was 9.17 per cent of the gross cropped area. Wheat and gram were major rabi crop in the CVZ which occupied 2.35 and 3.54 per cent area respectively. The area under rice, *rabi* jowar and bajara were 2.32, 0.30 and 0.18 per cent respectively of the gross cropped area. Sugarcane is another cash crop next to cotton and it occupied 0.41 per cent of the gross cropped area while, area under safflower and sunflower were negligible (0.03% and 0.01 % respectively).

5.1.1.3 Western Vidarbha Zone (2004-05)

It could be seen from Table 5.3 that, the cotton occupied an area of 7.42 lakh

hectares which was nearly 29.45 per cent of total gross cropped area. Soybean, which was another important crop next to cotton occupied 21.57 per cent of gross cropped area. Among cereals, *kharif* jowar occupied major area i.e.3.29 lakh hectares which was 13.07 per cent of the gross cropped area. The share of other pulses worked out to 15.62 per cent. While, the area under tur was 10.00 per cent of the gross cropped area. The area under other crops were found to be less than 10 per cent of the gross cropped area.

Cropping pattern of Western Vidarbha Zone is presented in Table 5.3

Table 5.3. Cropping pattern of Western Vidarbha Zone (2004-2005)

Sr. No.	Crop	Area (00' ha)	Percentage to gross cropped area
1.	Paddy	101	0.40
2.	Wheat	405	1.61
3.	*Kharif* jowar	3294	13.07
4.	*Rabi* jowar	204	0.81
5.	Bajra	76	0.30
6.	Tur	2521	10.00
7.	Gram	1160	4.60
8.	Other pulses	3936	15.62
9.	Groundnut	31	0.12
10.	Soybean	5437	21.57
11.	Safflower	98	0.39
12.	Sunflower	83	0.33
13.	Cotton	7423	29.45
14.	Sugarcane	39	0.15
	Gross cropped area	**25205**	**100.00**

(Source : Yield Gap Report, Directorate of Research, Dr. PDKV, Akola.)

In general, paddy dominated Eastern Vidabha Zone while soybean is a dominating crop in Central Vidarbha Zone, fallowed by cotton. In the Western Vidarbha Zone, cotton is the important crop followed by soybean.

5.1.2. Growth rates of area, production and yield of major crops in different zones of Vidarbha

Compound growth rates of area, production and yield of major crop in different Zone of Vidarbha are presented in following Tables. The growth rates are

worked out for two sub period and overall period. Period I included from 1987-88 to 1995-96, period II included from 1996-97 to 2004-05 and overall period included from 1987-88 to 2004-05.

5.1.2.1 Eastern Vidarbha Zone

Compound growth rates of area, production and productivity of major crops in Eastern Vidarbha Zone were estimated and presented in Table 5.4

Table 5.4 Compound growth rates of area, production and yield of major crops in Eastern Vidarbha Zone (EVZ)

Crops	A/ P/Y	Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
Paddy	A	2.43*	0.94***	0.59*
	P	7.43	3.29	0.28*
	Y	5.06	0.52	1.33
Cotton	A	1.34*	0.75	1.30***
	P	5.53**	0.70	0.84
	Y	17.28***	7.25	3.00
Soybean	A	49.82***	7.90***	22.76**
	P	60.94***	4.06	28.01***
	Y	10.85***	2.70	7.00***
Jowar	A	3.25***	15.13***	8.58***
	P	3.23	12.99***	7.83***
	Y	1.72	5.60*	0.16
Tur	A	4.04***	0.27	2.19***
	P	1.97	0.48	2.40
	Y	1.31	6.92	2.81
Gram	A	0.63	0.74	0.33
	P	4.65	0.97	0.11
	Y	4.06	4.03	2.56*

*** Indicate significance at 1% level
** Indicate significance at 5% level
* Indicate significance at 10% level

Paddy

Paddy is a most dominating crop in Easter Vidarbha Zone. The growth rate of area under paddy was found 0.59 per cent which was significant for overall period of study, whereas, in period I, the growth rate was 2.43 per cent which further reduced decline significantly to 0.94 per cent in period II. The growth rate of production of paddy was observed non-significant during both the period and overall period of study. The growth rate of production was 7.43 per cent during period I declined in period II to 3.29 per cent. While the growth rate of yield during all the periods were non-significant.

Cotton

It could be seen from Table5.4 that, at overall period, the growth rate of area under cotton was 1.30 per cent. which was significant. In period I, the growth rates of area under cotton was 1.34 per cent, which was reduced to 0.75 per cent during second period. The same trend was observed in production also. The growth rate of production which was 5.53 per cent, in period I decline to 0.70 per cent in period II. At overall level, the production growth rate was 0.84 per cent and non significant. The growth rate of yield in period I was 17.28 per cent, which was significant which was declined during II i.e. 7.25 per cent and non-significant. In all, the growth rate was 3.00 per cent over the years, which was non-significant.

Soybean

The growth rate of area under soybean was 49.82 per cent during Period I which was tremendously decreased to 7.90 per cent significantly during Period II. The reason might be due to low prices as well as low productivity. However, the overall growth rate of area under soybean worked out to 22.76 per cent.

As far as growth rates of production and productivity was concerned the same picture like area was observed. At over all level, the growth rates of production and productivity were 28.01 per cent and 7.00 per cent respectively. In general, the area, production and productivity of soybean decreased over the years.

Jowar

In the first period there was significant growth i.e.3.25 per cent in area under jowar crop which increased in second period to 15.13 per cent significantly. At overall level, the growth rates of area under jowar was 8.58 per cent. The growth rates of area under jowar was 7.83 per cent, which was significant during overall period of the study. During period I, the growth rate of production was 3.23 per cent which was non significant, whereas it increased to 12.99 per cent in second period. Also the growth rate of yield which was 1.72 per cent in the second period of study. At overall level, the growth rate of yield worked out to 0.16 per cent over the years.

Tur

Tur being the important pulse crop, its area over the years increased by 2.19 per cent which is significant. While during first period, it growth rate was 4.04 per cent, however during second period, it declined sharply to the extent of 0.27 per cent. In respect of production, the growth rate was 2.40 per cent which was non significant during period of study. In first period, it was 1.97 per cent decline to 0.48 per cent in second period and in both the period, the growth rate of yield was 2.81 per cent which was non significant. However, during first period, it was 1.31 per cent and increased to 6.92 per cent during second period, and both were non-significant.

Gram

The overall growth rate of area under gram was 0.33 per cent, which was found non-significant. The growth rate was 0.63 per cent during first and second period of study. During both the periods growth was non significant. Thereby indicating that the area under growth was more or less constant through out the periods. At overall level, the growth rate of production was 0.11 per cent which is non-significant. While, it was 4.65 per cent in period I and decrease to 0.97 per cent in period II, so far as growth rate of yield was concerned, it was 2.56 per cent over the years. During the first period, the growth rate was 4.06 per cent which was decreased to 4.03 per cent in second period. In both period the growth rate was non significant. It indicate the stagnancy in the yield of gram.

5.1.2.2 Central Vidarbha Zone (CVZ)

The compound growth rates of area, production and yield of major crops grown in Central Vidarbha Zone are presented in the Table 5.5.

Table 5.5. Compound growth rates of area, production and yield of major crops in Central Vidarbha Zone (CVZ)

(in per cent)

Crops	A/P/Y	Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
Cotton	A	0.37	2.49**	0.44
	P	7.13**	3.07	2.06
	Y	5.74**	5.41	2.55**
Soybean	A	26.46***	4.70**	14.67***
	P	39.97***	4.46*	19.67***
	Y	11.65**	2.01	4.39***
Jowar	A	4.82***	6.39***	5.63***
	P	6.11**	8.19**	6.82***
	Y	0.17	3.10	0.98
Tur	A	4.73***	1.24***	1.84***
	P	3.98	4.12	3.64***
	Y	2.03	4.33	1.69
Gram	A	6.51**	1.31	3.36***
	P	9.74*	4.59	4.40**
	Y	2.47	3.45	0.85
Paddy	A	2.50***	3.17**	1.23**
	P	1.48	3.22	0.74
	Y	4.29	1.20	0.06

*** Indicate significance at 1% level
** Indicate significance at 5% level
* Indicate significance at 10% level

Cotton

It could be seen from Table 5.5 that, at overall period, the growth rate of area under cotton was 0.44 per cent which was non significant. In first period, the growth rate was 0.37 per cent which was increased significantly to 2.49 per cent during second period. This indicate that the growth in area under cotton was more or less same over the period of study.

The growth rate of production of cotton crop was 7.13 per cent during period

I decline to 3.07 per cent in period II. At overall level, the growth rate of production was 2.06per cent which was non significant. The growth rate of yield of cotton crop was 2.55 per cent which was significant at overall period of the study. While, it was 5.74 per cent in first period and 5.41 per cent in second period. This indicates that, growth in yield was more or less constant in second period while, the growth rates of yield was increased in period I and over a period of study.

Soybean

The growth rate of area under soybean was 14.67 per cent which was significant at overall period of study. During first period, it was 26.46 per cent which was decline significantly at 4.70 per cent in second period. The growth rate of production was 19.67 which was significant during period of study. The growth rate of production in period I was 39.97 per cent which was significant. However, it was decreased significantly to 4.46 per during period II. The growth rate of yield of soybean was 4.39 per cent which was significant during overall period of study while, in period I, it was 11.65 per cent which was significant and decline non significantly at 2.01 per cent in period II. This indicates that, at overall period of study, the growth rates of area, production and yield were increased significantly.

Jowar

Jowar being the important cereal crop of this region showed significant growth to the extent of 4.82 per cent during first period, which was increased to 6.39 per cent during second period. As far as, for overall period is considered, it decreased to 5.63 per cent. The growth rate of production was 6.82 per cent which was significant during overall period of study. While, In first period, the growth rate was 6.11 per cent which was increased to 8.19 in second period and both the period the growth rate of production significant. The growth rate of yield was found to be 0.17 and 3.10 per cent in first and second period respectively. However in both the periods, it was non significant. At overall level, the growth rate of yield under jowar was 0.98 per cent.

Tur

The growth rate of area under tur was found 1.84 per cent which was significant during period of study. While in first period, it was 4.73 per cent which

decline to 1.24 per cent, but in second period and for both the periods growth rate was significant. This indicate that, the growth rate of area under tur increased in overall period of study. At the overall level, the growth rate of production of tur was 3.64 per cent which was significant. In first period, it was 3.98 per cent which increased to 4.12 per cent but in both the periods it was found to be non significant. At the overall level, the growth rate of yield was 1.69 per cent which was non significant while it was 2.03 per cent in first period increased to 4.33 per cent in second period. This indicate that, the growth rate of yield of tur was more or less same during period of study.

Gram

The growth rate of area under gram was found 3.36 per cent which was significant at overall period of study. Whereas, in period I, the growth rate was 6.51 per cent which declined non significantly at 1.31 per cent in period II. The growth rate of production was 4.40 per cent which was significant at overall period of study. While in period I, the growth rate of production was 9.74 per cent, which was significant and decline non significantly to 4.59 per cent in period II. The growth rate of yield of gram was 0.85 per cent at overall level of study. In first period, the growth rate of yield was 2.47 per cent and in second period it was 3.45 per cent, further it was observed that, the growth rate of yield at overall level in both the periods were non significant. Thus, it is concluded that, the growth rate of area and production of gram were increased while its yield was more or less same at overall level of study.

Paddy

The growth rate of area under paddy was 2.50 per cent during period I which was increased to 3.17 per cent significantly during period II. However the overall growth rate of area under paddy was worked out to 1.23 per cent. As far as, the growth rate of production of paddy, it was 1.48 per cent in period I and 3.22 per cent in period II while, it was 0.74 per cent at overall period of study. The growth rates were non significant at overall level as well as during both the periods. The growth rate of yield of paddy during overall period was 0.06 per cent while, during period I and period II, the growth rates were 4.29 and 1.20 per cent respectively.

5.1.2.3 Western Vidarbha Zone

The compound growth rates of area, production and yield of major crops in Western Vidarbha Zone are presented in Table 5.6.

Table 5.6. Compound growth rates of area, production and yield of major crops in Western Vidarbha Zone (WVZ)

(in per cent)

Crops	A/P/Y	Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
Cotton	A	0.70	5.53***	1.70***
	P	9.60**	2.12	0.58
	Y	7.99*	8.33	4.11**
Soybean	A	36.68***	14.22***	25.30***
	P	54.74***	12.55**	31.67***
	Y	21.49***	3.02	8.96***
Jowar	A	4.84***	4.16***	4.34***
	P	1.74	8.06***	4.55***
	Y	3.59	2.56	3.62***
Tur	A	3.04***	1.44***	1.60***
	P	1.38	0.06	1.68
	Y	1.59	3.51	4.26
Gram	A	7.32	0.68	4.26***
	P	13.81*	3.42	5.24**
	Y	6.01	1.56	2.60*
Paddy	A	4.78***	2.81	6.16***
	P	0.78	6.06	5.79***
	Y	4.37	7.96	2.22

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

Cotton

Cotton is an important cash crop in the Western Vidarbha Zone. From Table 5.6 it is observed that, at overall level, the growth rate of area under cotton was 1.70 per cent which was significant, whereas, in first period the growth rate was 0.70 per cent

which was non significant and increased significantly to 5.53 per cent in second period.

As far as, the growth rate of production of cotton was 9.60 per cent which was significant during period I and decreased to 2.12 per cent during period II. However, the overall growth rate of production worked out to 0.58 per cent. The growth rate of yield was 7.99 per cent during period I and 8.33 per cent during period II. However at overall level, the growth rate of yield was 4.11 per cent and significant.

Soybean

It could be seen from Table 5.6 that at overall period, the overall growth rate of area under soybean was 25.30 per cent which was found to be significant. However, the growth rate was 36.68 per cent during first period and declined to 14.22 per cent during second period. At overall level, the growth rate of production was 31.67 per cent which was significant while, it was 54.74 per cent in period I which tremendously decreased to 12.55 per cent and for both the periods, it was significant. In first period the growth rate of yield was 21.49 per cent which was significant. However, it decreased to 3.02 per cent in during second period

Jowar

The overall growth rate of area under jowar was 4.34 per cent which was found significant. The growth rate was 4.84 per cent during first period which was nearly equal during second period (4.16%) and for both the periods it was significant.

As far as growth rate of production was 1.74 per cent which was increased significantly to 8.06 per cent. At overall level, the growth rate of production was 3.62 per cent which was significant. During period I, the growth rate of yield was 3.59 per cent and 2.56 per cent during period II and which was non significant during both the periods of study. At overall level, the growth rate of yield was 3.62 per cent which was significant.

Tur

It could be seen from Table 5.6 that, the growth rate of area under tur was 1.51 per cent and which was significant at overall level. While, the growth rate of area was 3.04 per cent in period I which was declined to 1.44 per cent in period II. The growth rate of production was 1.38 per cent during period I and it was declined to 0.06 per cent

during second period. While it was 1.68 per cent at overall level. It is observed that growth in production ot tur was more or less same during periods of study. During period I the growth rate of yield was 1.59 per cent and 3.51 per cent in period second. At overall level the growth rate of tur was 4.26 per cent.

Gram

At overall level, the growth rate of area under gram was 4.26 per cent which was significant. In first period, there was non significant growth i.e., 7.32 per cent and 0.68 per cent in second period. The growth rate of production was 5.24 per cent which was significant at overall period of study. While it was 13.81 per cent in first period which declined to 3.42 per cent in second period. The growth rate of yield was 6.01 per cent in period I and 1.56 per cent in period II and in both the periods it was non significant. At overall level the growth rate of yield was worked out to 2.60 per cent which was significant over the years.

Paddy

The growth rate of area under paddy was 6.16 per cent at overall level which was significant. However, during first period it was 4.78 per cent declined to 2.81 per cent in second period. At overall level, the growth rate of production was 5.79 per cent which was significant. While, it was 0.78 per cent and 6.06 per cent in period II. During both the periods growth rate was non significant. As far as the growth rate was 2.22 per cent over the years. During first period the growth rate was 4.37 per cent and 7.96 per cent in second period. In both the periods as well as at overall level the growth rate was non significant. It indicate that, the growth of output of paddy was more or less same.

5.2 Growth of inputs and outputs

In order to examine the relationship between input growth and output growth, the cropwise growth rates of inputs and output were worked out and presented in tables.

5.2.1 Eastern Vidarbha Zone

Paddy

The growth rates of inputs and output of paddy in EVZ for the period 1991-92 to 2004-05 were estimated and results presented in Table 5.7.

Table 5.7. Growth rates of inputs and output of paddy

(in per cent)

Sr.	Inputs and Output	Growth rates		
		Period I (1991-95)	Period II (1996-2004)	Overall Period (1991-2004)
	Output (qtl/ha)	6.81*	5.24*	0.23
	Inputs			
1.	Seed (kg/ha)	0.26	2.22	0.17
2.	Human labour (days/ha)			
	i) Male	5.71***	0.69	0.31
	ii) Female	2.38**	1.74	0.29
3.	Bullock labour (days/ha)	2.10**	2.26	1.96***
4.	Machine labour (days/ha)	45.53**	19.79	30.73***
5.	Manures (qtl/ha)	2.72	1.33	1.81**
6.	Fertilizers (kg/ha)			
	i) N	7.02**	3.77	1.72
	ii) P	7.56	10.08*	2.06
	iii) K	10.50	6.37	0.38
7.	Insecticides (lit/ha)	14.08	20.50	16.91
8.	Rental value of land (Rs/ha)	0.31	7.32***	5.14***

*** Indicate significance at 1% level
** Indicate significance at 5% level
* Indicate significance at 10% level

It could be seen from Table 5.7 that, at overall period, the growth rate of output was 0.23 per cent which was non significant. This indicate that, the growth in output was more or less same over the years. However during the first period, it increased significantly (6.81 %) and the same speed of growth was observed during second period also (5.24%). The higher growth during first period was due to green revolution and thereafter its effect came down during second period. At overall level among different inputs used in production of paddy, the growth rate of inputs like, bullock labour machine labour, rental value of land and manures were significantly increased over the years. As regard to input like insecticides, its use over the years was more or less same which was non significant.

As regards to growth of inputs like human labour, bullock labour, machine

labour and nitrogenous fertilizers were concerned it was increased significantly during the first period of study. While its use were more or less same during second period which was indicated by the non significant growth in inputs except rental value of land, which increased to the extend of 7.32 per cent.

Soybean

The growth rates of inputs and output of soybean in EVZ for the period 1987-88 to 2004-05 were estimated and presented in Table 5.8

Table 5.8. Growth rates of inputs and output of soybean

(in per cent)

Sr. No.	Inputs and Output	Growth rates		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	2.31	5.90	0.93
	Inputs			
1.	Seed (kg/ha)	14.95***	0.34	6.30***
2.	Human labour (days/ha)			
	i) Male	16.21***	20.03***	5.66*
	ii) Female	10.11**	1.50	0.72
3.	Bullock labour (days/ha)	3.83	0.53	2.28***
4.	Machine labour (days/ha)	14.36*	2.79	3.96
5.	Manures (qtl/ha)	1.48	6.05	5.02***
6.	Fertilizers (kg/ha)			
	i) N	21.03***	4.35	4.86**
	ii) P	15.22*	0.30	8.72***
	iii) K	13.65	2.52	13.52***
7.	Rental value of land (Rs/ha)	11.38**	11.12*	6.54***

*** Indicate significance at 1% level
** Indicate significance at 5% level
* Indicate significance at 10% level

As observed from Table 5.8 that, the growth rate of output was 0.93 per cent which was non significant over a period of time. During period I, it was 2.31 per cent increased to 5.90 per cent during second period. However, in both the period growth was non significant. This indicates that, the output was more or less same during the study. As regards to the growth rates of female labour and machine labour, it was non significant over a period of study. While the growth rate of seed (6.30 %), bullock labour (2.28%),

manures (5.02%), fertilizers and rental value of land were highly significant over a period of time. This indicate that, input used in production of soybean increased over the years.

During period I growth rate of seed, male labour, female labour, machine labour, nitrogen, phosphorus and rental value of land were observed significant, amongst these inputs, the growth rate of seed (14.95 %), male labour (16.21 %) and nitrogenous fertilizer (21.03 %) were found to be highly significant. This indicate that, the growth rate of this inputs in first period were increased sharply in production of soybean.

During period II, the growth rate of male labour and rental value of land were found significant. However, the growth rate of male labour (20.03%) was found highly significant. This indicate that, the use of male labour increased rapidly during second period, while the use of all other inputs were more or less same in this period.

Jowar

The compound growth rates of inputs and output of jowar were estimated for the period 1987-88 to 2004-05 and presented in Table 5.9.

Table 5.9. Growth rates of inputs and output of jowar

(in per cent)

Sr. No.	Inputs and output	Growth rate		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	5.26	2.92	1.38
	Inputs			
1.	Seed (kg/ha)	19.87 ***	0.54	2.10*
2.	Human labour (days/ha)			
i.	Male	1.23	3.12	0.07
ii.	Female	3.03	5.19	2.52
3.	Bullock labour (days/ha)	1.96	7.24**	2.49**
4.	Machine labour (days/ha)	14.92**	4.93	1.42
5.	Manures (qtl/ha)	5.23*	26.78***	8.29***
6.	Fertilizers (kg/ha)			
i.	N	1.87	20.78	13.25***
ii.	P	4.56**	10.50	4.01*
iii.	K	4.04*	14.57	8.76***
7.	Rental value of land (Rs/ha)	3.96	3.19	5.52***

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

Table 5.9 revealed that, the overall growth rate of output was found to be 1.38 per cent which was non significant and the same was 5.26 and 2.92 per cent in period I and period II respectively which were also non significant. This indicates that growth in output of jowar was more or less same in different periods and over the year of study. Among inputs used in production of jowar growth rate of seed, bullock labour, manures, fertilizers and rental value of land were found significant thereby, indicating that the use of these inputs over the years increased significantly. While the use of human labour and machine labour were more or less same.

During first period, the growth rate of seed, machine labour, manures, phosphorus and potash were found significant indicating their use during this period were increased significantly. However, its use decreased during second period except machine labour. The use of manures (26.78%) and bullock labour (7.24%) increased significantly during this period.

Tur

The growth rates of inputs and output of tur in EVZ were computed for year 1987-88 to 2004-05 and are presented in Table 5.10

It could be seen from Table 5.10 that, the growth rate of output was found 4.66 per cent which was highly significant in overall period of study. However, it was non significant during period I (7.10%) and period II (0.11%). This indicates the output of tur in EVZ increased rapidly over the years. However, its production were more or less same in both the periods. The inputs like male labour, phosphorus and rental value of land were found significant over the years. Whereas, the use of other inputs did not change over the same years.

During the first periods, the growth rate of seed, human labour, fertilizers and rental value of land were found significant. Thus it indicates that use of these inputs in production of tur were increased while, the growth of others inputs were more or less same. During period II, the growth rate of seed, machine labour, manures and insecticides were increased significantly.

Table 5.10.Growth rates of inputs and output of tur

(in per cent)

Sr.	Inputs and output	Growth rate		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	7.10	0.1	4.66**
	Inputs			
1.	Seed (kg/ha)	2.18*	5.26**	0.33
2.	Human labour (days/ha)			
i.	Male	17.80**	3.45	11.11***
ii.	Female	11.74**	3.66	2.02
3.	Bullock labour (days/ha)	4.75	5.17	0.57
4.	Machine labour (days/ha)	15.99	11.02**	3.23
5.	Manures (qtl/ha)	8.44	19.36***	2.84
6.	Fertilizers (kg/ha)			
i.	N	24.97**	6.47	3.73
ii.	P	29.85***	4.70	5.24*
iii.	K	32.19***	7.78	0.44
7.	Insecticides (lit/ha)	9.96	14.43***	1.79
8.	Rental value of land (Rs/ha)	21.73***	1.34	11.49***

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

Gram

The growth rates of inputs and output of gram in EVZ were worked out and are presented in Table 5.11

It is revealed from Table 5.11 that, the growth rate of output was 3.79 which was significant in overall period of study while, during first period, it was 5.47 per cent and during second period, it was 6.21 per cent and for the period it was non significant, this indicates that gram output was increased during over the years of the study. The growth rate of machine labour (14.27%), and female labour (2.87) were significant during overall period while, the growth rate of seed, male labour and bullock labour were non

significant.

Table 5.11. Growth rates of inputs and output of gram

Sr.	Inputs and output	Growth rate		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	5.47	6.21	3.79**
	Inputs			
1.	Seed (kg/ha)	1.76	3.28	0.77
2.	Human labour (days/ha)			
i.	Male	8.11	6.11	2.36
ii.	Female	6.82	2.14	2.87**
3.	Bullock labour (days/ha)	0.44	0.38	1.09
4.	Machine labour (days/ha)	30.55**	41.27***	14.27***
5.	Rental value of land (Rs/ha)	16.86***	7.51	11.36***

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

The period wise analysis of the growth rates indicate that, during in first period, machine labour and rental value of land found significant. As regards to the growth rate of other inputs were non significant. During period II, machine labour was found highly significant (41.27%), indicating use of this inputs increased rapidly in production of gram in EVZ.

5.2.2 Central Vidarbha Zone

Cotton

The growth rates of inputs and output of cotton are presented in Table 5.12

It could be seen from Table 5.12 that at overall period, the growth rate of output was 0.82 per cent which was non significant. This indicated that the growth in output over the years was more or less stagnant. However, during the first period it was 4.01 per cent and in second period 3.05 per cent and both the periods it was non significant. The results of the study indicated that the growth in output was higher in first period and thereafter it was more or less same during overall period.

Table 5.12. Growth rates of inputs and output of cotton

(in per cent)

Sr. No.	Inputs and output	Growth rate		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	4.01	3.05	0.82
	Inputs			
1.	Seed	1.15	1.99	3.13***
2.	Human labour (days/ha)			
i.	Male	7.52***	5.75*	0.41
ii.	Female	1.87***	3.59	0.45
3.	Bullock labour (days/ha)	0.25	0.45	0.13
4.	Machine labour (days/ha)	3.35	9.28	6.97***
5.	Manures (qtl/ha)	6.15***	3.52	3.31***
6.	Fertilizers (kg/ha)			
i.	N	6.16***	0.45	3.37***
ii.	P	7.23***	2.38	3.11***
iii.	K	6.88***	3.08**	3.76***
7.	Insecticides (lit/ha)	16.19	6.44	2.85
8.	Rental value of land (Rs/ha)	19.30***	5.19	8.69***

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

At overall level, among the different inputs used in production of cotton, the growth of inputs like seed, machine, labour, manures, fertilizers and rental value of land were significantly increased over the years. As regards to inputs like human labour, bullock labour, and insecticides, its use over the year was more or less same. During period I, the growth of inputs like human labour, manures, fertilizers and rental value of land were increased significantly. While the growth rates of male labour and potash were increased significantly during the second period of study, while the use of all others inputs were more or less same.

Soybean

The growth rates of inputs and output of soybean in CVZ were estimated for the period 1987-88 to 2004-05 and presented in Table 5.13.

Table 5.13. Growth rates of inputs and output of soybean

(in per cent)

Sr. No.	Inputs and output	Growth rate		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	6.93*	2.55	2.20**
	Inputs			
1.	Seed	14.02***	0.16	4.86***
2.	Human labour (days/ha)			
i.	Male	6.32**	7.11***	3.19**
ii.	Female	1.95*	2.74**	0.76*
3.	Bullock labour (days/ha)	7.08***	2.15*	2.55***
4.	Machine labour (days/ha)	3.48	12.71**	7.40***
5.	Manures (qtl/ha)	11.06**	2.30	2.93
6.	Fertilizers (kg/ha)			
i.	N	12.51***	1.60	5.80***
ii.	P	7.11*	3.13	8.19***
iii.	K	6.87	6.62	3.68
7.	Insecticides (lit/ha)	4.56	39.37*	19.03***
8.	Rental value of land (Rs/ha)	16.47***	6.74*	8.04***

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

It could be seen from Table 5.13 that, at overall period, the growth rate of output of soybean crop was 2.20 per cent which was significant indicate, the growth in output of soybean was increase over the period. However during first period, it increased significantly (6.93%) which declined non significantly during second period. The higher growth during first period was due to green revolution and thereafter its effect came down during second period.

At overall level, among the different inputs use in production of soybean, the growth of all inputs were increased significantly over the years except in manures and potash, it was found non significant.

During period I, the growth rate of seed (14.02%), male labour (6.32%) female labour (1.95%), bullock labour (7.08%), manures (11.06%), nitrogen (12.51) and P (7.11%) and rental value of land (16.47%) were observed to be significant. Among these inputs, the growth rate of seed, bullock labour and nitrogenous fertilizers were found highly significant. Thus, it indicated that the growth of these inputs increased sharply. However, growth of machine labour, potash and insecticide were non significant.

During period II, the growth rates of human labour, bullock labour, machine labour, insecticide and rental value of land were found to be significant, while the growth rate of male labour increased rapidly during second period of study and use of seed, manures and fertilizers were more or less same.

Jowar

Growth rates of inputs and outputs of jowar in CVZ were estimated for period 1987-88 to 2004-05 and results are presented in Table 5.14.

Table 5.14. Growth rates of input and output of jowar

(in per cent)

Sr. No.	Inputs and output	Growth rate		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	2.82	0.28	0.65
	Inputs			
1.	Seed	0.80	1.17	0.62*
2.	Human labour (days/ha)			
i.	Male	2.16	1.71	0.55
ii.	Female	1.34	0.33	0.08
3.	Bullock labour (days/ha)	1.65**	0.11	0.06
4.	Machine labour (days/ha)	2.39	4.07	2.45
5.	Manures (qtl/ha)	13.80**	13.58	7.64**
6.	Fertilizers (kg/ha)			
i.	N	5.74***	4.19**	1.89**
ii.	P	6.11**	1.13	1.79**
iii.	K	6.45***	3.75	1.88
7.	Rental value of land (Rs/ha)	13.67***	5.50	8.66***

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

As observed from Table 5.14 that, the growth rate of output was 0.65 per cent which was non significant over a period of study while in first period, it was 2.82 per cent

declined to 0.28 per cent in second period. However, in the both the period it was non significant. This indicates that output was more or less same during periods of study. As regards to growth rate of manures, nitrogenous fertilizers and rental value of land were significant while, the growth rates of human labour, machine labour and potash were non significant over a period of time.

As regards to the growth of inputs like bullock labour, manures, fertilizers and rental value of land were increased significantly during the first period while its use were more or less same during second period which was indicated by non significant growth in inputs except in nitrogenous fertilizers which was increased to the extent of 4.19 per cent.

Tur

The growth rates of inputs and output of tur in CVZ were estimated for the period 1987-88 to 2004-05 and presented in Table 5.15

Table 5.15. Growth rates of inputs and output of tur

(in per cent)

Sr. No.	Inputs and output	Growth rate		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	2.70	2.74	3.17**
	Inputs			
1.	Seed	0.51	0.65	0.46
2.	Human labour (days/ha)			
i.	Male	2.70	0.58	1.07
ii.	Female	0.87	0.7	0.68
3.	Bullock labour (days/ha)	0.38	0.59	0.52
4.	Machine labour (days/ha)	7.13	5.33	1.49
5.	Manures (qtl/ha)	4.43*	14.86*	4.28
6.	Fertilizers (kg/ha)			
i.	N	13.21***	4.42	3.60**
ii.	P	12.30**	2.09	4.80***
iii.	K	1.60	6.78	3.25
7.	Insecticides (lit/ha)	12.87	7.61	6.27*
8.	Rental value of land (Rs/ha)	8.22**	3.69	8.57***

*** Indicate significance at 1% level

** Indicate significance at 5% level

*Indicatesignificanceat10%level

It could be seen from Table 5.15 that, at overall period, the growth rate of output was 3.17 per cent which was significant. This indicate the growth in output was

increased over the years. However, during first period, it was 2.70 per cent and the same speed of growth was observed during second period i.e. 2.74 per cent and for both the periods it was non significant.

At overall level, among the different inputs use in production of tur, the growth of inputs like N, P insecticides and rental value of land were significantly increased over the years while, use of other inputs were more or less same. As regards to the growth of inputs like manures, N, P and rental value of land were increased significantly during the period I while its use were more or less same during second period except in manures, its growth was increase to the extent of 14.86 per cent.

Gram

The growth rates of inputs and output of gram in CVZ were estimated and results were presented in Table 5.16.

Table 5.16. Growth rates of inputs and output of gram

(in per cent)

Sr. No.	Input and output	Growth rate		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	3.87	0.06	0.34
	Inputs			
1.	Seed	1.49*	5.17**	1.06*
2.	Human labour (days/ha)			
i.	Male	6.86	3.57	2.34
ii.	Female	2.27	3.28	0.47
3.	Bullock labour (days/ha)	2.72	9.37**	4.31***
4.	Machine labour (days/ha)	1.11	11.09	6.21
5.	Fertilizers (kg/ha)			
i.	N	35.26	8.48	13.08**
ii.	P	20.07	28.31	16.25**
iii.	K	14.72	1.77	8.54**
6.	Rental value of land (Rs/ha)	3.34	4.28	6.80***

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

Tables 5.16 revealed that, at overall period, the growth rate of output was 0.34 per cent which was non significant. Thus it indicate that the growth in output was more or less same over the years. However during period I, it was 3.87 per cent and during second period it was 0.06 per cent and for both the periods it was non significant.

As regards to growth of inputs like seed, bullock labour, fertilizers and rental value of land were increased significantly over the years while inputs like human labour and machine labour were more or less same which was indicated by non significant growth rate in these inputs over the period of study.

In first period, the growth rate of seed was 1.49 per cent which was significant while growth of other inputs used in production of gram was non significant. This indicates that, use of these inputs were more or less same, while in second period, the growth of inputs like seed and bullock labour were significantly increased.

5.2.3 Western Vidarbha Zone

Cotton

The growth rates of inputs and output of cotton in WVZ were estimated for the period 1987-88 to 2004-05 and presented in Table 5.17.

It could be seen from Table 5.17 that at overall period, the growth rate of output was 1.36 per cent which was non significant. This indicated that the growth in the output of cotton was more or less same over the years. However, during first period, it was 1.64 per cent and during second period, it was1.24 per cent and both the period growth rate was non significant.

At overall level, among different inputs used in production of cotton, the growth rate of inputs like human labour, bullock labour, machine labour and rental value of land were significantly increased over the years. As regards to inputs like seed, manures, fertilizers and insecticides, its use over the years were more or less same, which was indicated by non significant growth in use of these inputs.

Table 5.17. Growth rates of inputs and output of cotton

(in per cent)

Sr.	Inputs and output	Growth rate		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	1.64	1.24	1.36
	Inputs			
1.	Seed	1.15	5.79	2.00
2.	Human labour (days/ha)			
i.	Male	0.25	0.10***	3.58***
ii.	Female	0.40	1.28	1.01***
3.	Bullock labour (days/ha)	0.39	3.40*	1.47***
4.	Machine labour (days/ha)	1.68	10.98**	6.47***
5.	Manures (qtl/ha)	2.14	7.08**	0.67
6.	Fertilizers (kg/ha)			
i.	N	5.42***	5.30***	1.02
ii.	P	3.28	2.15*	1.58
iii.	K	7.67	10.72**	1.01
7.	Insecticide (lit/ha)	16.67	13.00*	1.92
8.	Rental value of land (Rs/ha)	16.60***	1.68	8.78***

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

As far as to growth of inputs like, N and rental value of land were increased significantly during the first period of study while, growth of male labour, bullock labour, machine labour, manures and fertilizers were significant during second period of study.

Soybean

The growth rates of inputs and output of soybean in Western Vidarbha Zone were estimated for the period 1993-94 to 2004-05 and presented in Table 5.18.

As revealed from Table 5.18 that, the overall growth rate of output was found to be 3.31 per cent which was significant while, it was 0.30 per cent in first period and 0.35 per cent in second period and for both the period, it was non significant. This indicated that growth of output was increased over a period of study while, it was more or less same during both the period.

At overall level, among the different inputs use in production of soybean, the growth inputs like manures, seed, male labour, bullock labour, phosphorus and rental value of land were significantly increased over the periods. However, the growth of inputs like female labour, N and K were more or less same.

Table 5.18. Growth rates of inputs and output of soybean

(in per cent)

Sr. No.	Inputs and output	Growth rate		
		Period I (1993-95)	Period II (1996-2004)	Overall Period (1993-2004)
	Output (qtl/ha)	0.30	0.35	3.31*
	Inputs			
1.	Seed	3.24*	1.36	1.93***
2.	Human labour (days/ha)			
i.	Male	6.96	0.51	2.13*
ii.	Female	8.88	0.62	2.01
3.	Bullock labour (days/ha)	0.29	4.11	3.58***
4.	Machine labour (days/ha)	17.59**	3.49	1.26
5.	Manures (qtl/ha)	3.36	2.54	9.25*
6.	Fertilizers (kg/ha)			
i.	N	3.39	0.39	2.82
ii.	P	13.78**	1.98	3.55*
iii.	K	28.21	1.74	2.71
7.	Insecticide	6.93	14.82**	4.99
8.	Rental value of land (Rs/ha)	4.15	10.61	7.28***

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

As regards to the growth of inputs like seed, machine labour and P were increased significantly during first period while in second period growth of insecticide was found significant.

Jowar

Compound growth rates of inputs and output of jowar were worked out and presented in Table 5.19.

As observed from Table 5.19 that, at oveall level, the growth rate of output was 0.38 per cent which was non significant and same were 2.25 and 1.23 per cent respectively in period I and period II which were also non significant. This indicates the growth in output of jowar was more or less same in different periods as well as over the years of study. Among inputs used in the production of jowar, the growth of inputs like, male labour, machine labour, bullock labour, manures, P, and rental value of land were significantly increased over the years. While the use of seed, female labour, N, K and insecticides were more or less same.

Table 5.19. Growth rates of inputs and output of jowar

(in per cent)

Sr.	Inputs and output	Growth rate		
		Period I (1987-95)	**Period II (1996-2004)**	**Overall Period (1987-2004)**
	Output (qtl/ha)	2.25	1.23	0.38
	Inputs			
1.	Seed	0.31	1.56	0.15
2.	Human labour (days/ha)			
i.	Male	2.94*	1.10	2.36***
ii.	Female	0.99	0.55	0.57
3.	Bullock labour (days/ha)	0.70	0.55	0.77***
4.	Machine labour (days/ha)	1.24	1.46	2.60***
5.	Manures (qtl/ha)	2.22	0.71	5.9**
6.	Fertilizers (kg/ha)			
i.	N	5.38***	3.11**	0.92
ii.	P	0.26	1.36	2.56***
iii.	K	10.19*	9.79***	0.90
7.	Insecticide	25.86	26.24***	1.85
8.	Rental value of land (Rs/ha)	15.69***	2.86	8.30***

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

During first period, the growth rate of male labour, nitrogenous fertilizers, K and rental value of land were found significant, indicating their use in this period were

increase significantly. However, the growth rate of N, K and insecticides were found to be significant during second period while, use of other inputs were more or less same.

Tur

The growth rates of inputs and output of tur crop in Western Vidarbha Zone were estimated for the period 1987-88 to 2004-05 and are presented in Table 5.20.

Table 5.20. Growth rates of inputs and output of tur

(in per cent)

Sr. No.	Inputs and output	Growth rate		
		Period I (1987-95)	Period II (1996-2004)	Overall Period (1987-2004)
	Output (qtl/ha)	0.90	5.25	4.00**
	Inputs			
1.	Seed	1.21	0.71	0.88
2.	Human labour (days/ha)			
i.	Male	2.25*	3.14	0.53
ii.	Female	2.66	1.73	0.82
3.	Bullock labour (days/ha)	0.64	0.41	0.48
4.	Machine labour (days/ha)	7.72*	3.94	4.27***
5.	Manures (qtl/ha)	7.39**	3.61	0.29
6.	Fertilizers (kg/ha)			
i.	N	5.82***	5.08***	1.79**
ii.	P	0.98	0.45	3.05***
iii.	K	15.73***	3.44	2.37
7.	Insecticide	8.08**	1.18	0.16
8.	Rental value of land (Rs/ha)	13.95***	3.85	10.69***

*** Indicate significance at 1% level
** Indicate significance at 5% level
* Indicate significance at 10% level

It could be seen from the Table 5.20 that, the overall growth rate of output was found 4.00 per cent which was significant and the same were 0.90 per cent in period I and 5.25 per cent in period II and for both the periods it was non significant, therefore it is concluded that, growth in output of jowar increased over a period of study while it was more or less same during both the periods of study.

As regards to the growth of inputs like machine labour, nitrogenous fertilizers,

phosphorus and rental value of land were increased significantly over the years while, the growth rate of seed, human labour, bullock labour, manures, potash and insecticides were non significant at overall period of study.

Among the different inputs use in production of tur, the growth of inputs like male labour, machine labour, manures, N, K, insecticides and rental value of land were found to be increased significantly during first period while its use were more or less same during second period which was indicated by non significant growth in inputs except nitrogenous fertilizers which was increased significantly to the extent of 5.08 per cent.

Gram

The compound growth rates of inputs and output of gram in Western Vidarbha Zone for the period 1987-88 to 2004-05 presented in Table 5.21.

Table 5.21. Growth rates of inputs and output of gram

(in per cent)

Sr.	Inputs and output	Growth rate		
		Period I (1987-95)	**Period II (1996-2004)**	**Overall Period (1987-2004)**
	Output (qtl/ha)	4.19	1.14	3.06*
	Inputs			
1.	Seed	0.41	1.71	0.56
2.	Human labour (days/ha)			
i.	Male	9.92	14.58	8.42***
ii.	Female	4.70	0.99	6.69***
3.	Bullock labour (days/ha)	1.24	7.99***	5.41***
4.	Machine labour (days/ha)	18.28***	8.70	14.58***
5.	Fertilizers (kg/ha)			
i.	N	8.16	10.38	12.42***
ii.	P	14.15*	16.86	8.86
iii.	K	15.07	1.28	6.16*
6.	Insecticide	1.39	5.71	3.36*

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

As revealed from Table 5.21 that, at overall period, the growth rate of

output was 3.06 per cent and which was significant. This indicate that, the growth in output was increased over the years. However, during first period, it was 4.19 and 1.14 per cent in second period and for both the period it was found to be non significant.

At overall level, among the different inputs use in production of gram, the growth in inputs like human labour, bullock labour, machine labour and nitrogen and phosphorus insecticides and rental value of land were significantly increased over the years. While use of all others inputs were more or less same over a period of study.

Further it is observed that, the growth of inputs like machine labour, and phosphorus were increased significantly in the first period, while the growth of bullock labour found significant during second period.

5.3 Inputs Share in total cost

The share of individual inputs in total cost of production were worked out and results are presented in the following tables.

5.3.1 Eastern Vidarbha Zone

Paddy

Paddy is a dominating crop in the Eastern Vidarbha Zone. Area under paddy was 6.16 lakh hectare which was above 50.23 per cent of the gross cropped area. However, data available from 1991 onwards therefore the share of individual input in total cost of paddy for the period 1991-92 to 2004-05 were computed and are presented in Table 5.22.

Table 5.22 revealed that, the share of rental value of land worked out to 25.29 per cent which was higher among all the inputs followed by female labour (18.23%), bullock labour (12.47%) and male labour (12.47%). However, the share of female labour was more than male labour in production of paddy, similarly the share of bullock labour was more than machine labour. Seed and manures accounts 7.37 and 6.80 per cent respectively in total cost, while the share of fertilizers was 11.96 per cent. However, the share of insecticides in total cost was very less in paddy.

Table 5.22. Inputs share in total cost of paddy

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	7.37
2.	Human labour	
	i) Male	12.47
	ii) Female	18.23
3.	Bullock labour	12.47
4.	Machine labour	3.56
5.	Manures	6.80
6.	Fertilizers	
	i) N	7.11
	ii) P	4.39
	iii) K	1.46
7.	Insecticides	0.84
8.	Rental value of land	25.29

*** Indicate significance at 1% level
** Indicate significance at 5% level
* Indicate significance at 10% level

The result of the analysis showed that, the share of rental value of land in total cost was higher than that of all other inputs.

Soybean

The share of different inputs in total cost of soybean for the period 1987-88 to 2004-05 were worked out and are presented in Table 5.23.

It revealed from Table 5.23 that, rental value of land contributes 26.55 per cent shares in total cost followed by bullock labour (16.73%), seed (15.21%) and female labour (14.04%). The contribution of male labour was found to be 7.35 per cent which was nearly half of the share of female labour. Similarly machine labour accounts 6.18 and 16.73 per cent respectively. The shares of manures and fertilizers were 4.91, and 9.03 per cent respectively. While, the share of insecticide was found negligible.

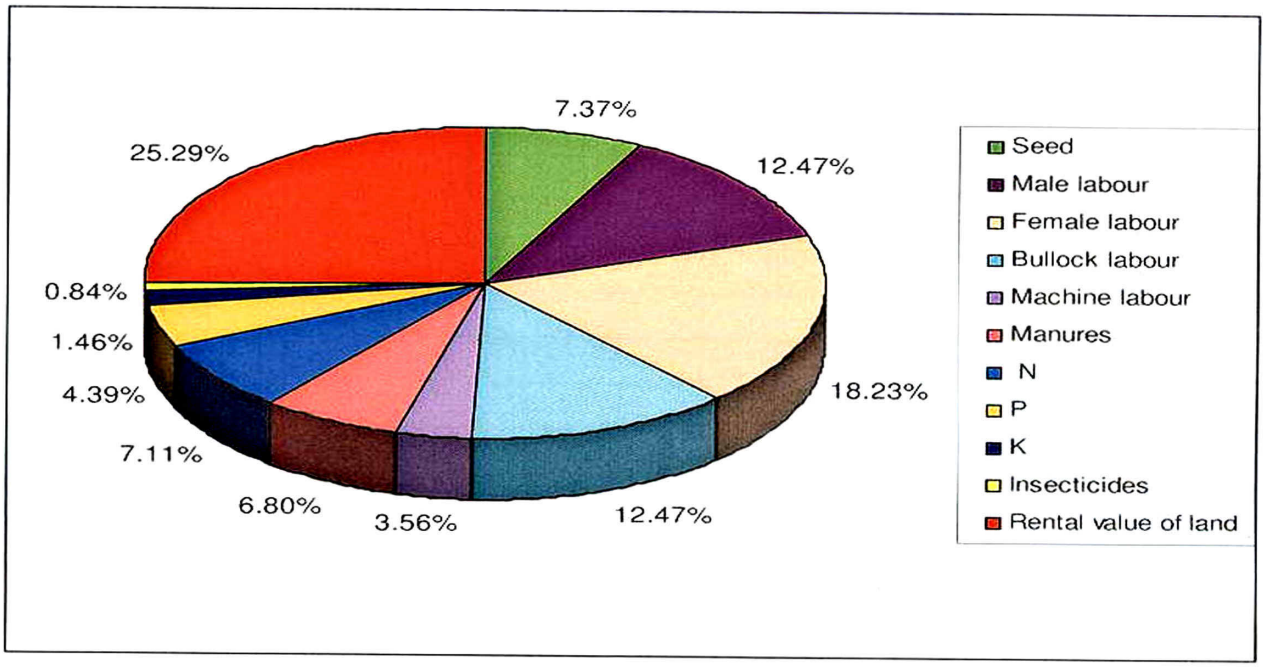

Fig. 3 : Inputs share in total cost of paddy

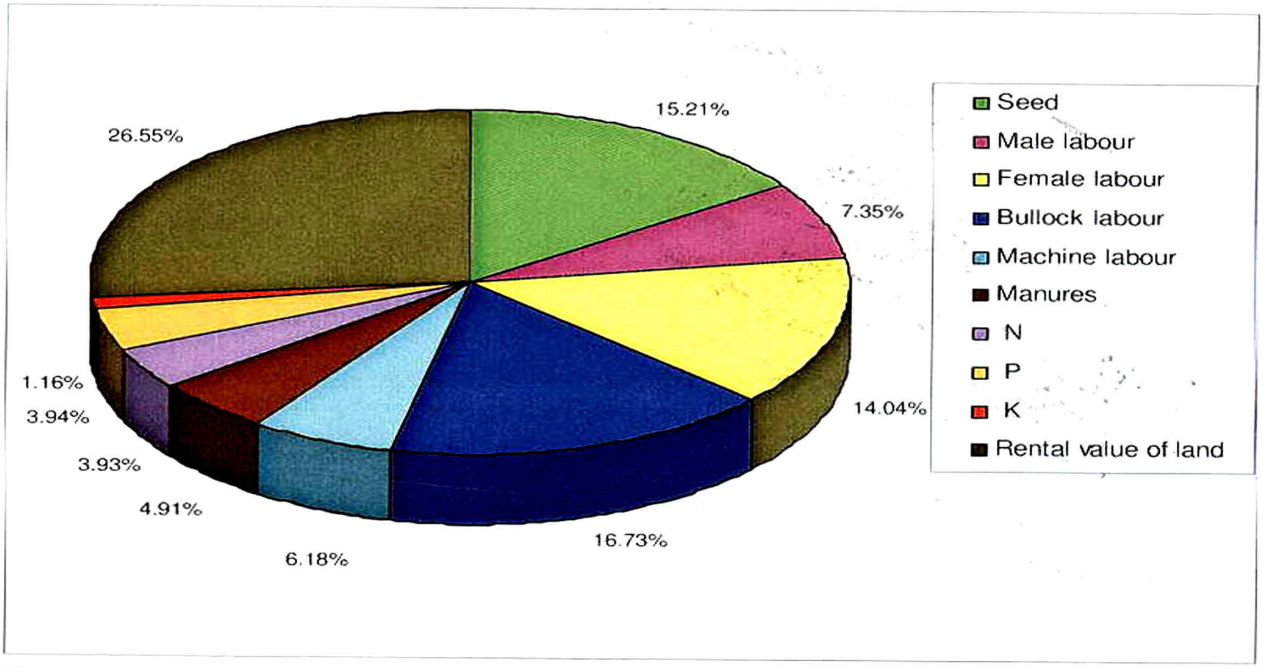

Fig. 4 : Inputs share in total cost of soybean

Table 5.23.Inputs share in total cost of soybean

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	15.21
2.	Human labour	
	i) Male	7.35
	ii) Female	14.04
3.	Bullock labour	16.73
4.	Machine labour	6.18
5.	Manures	4.91
6.	Fertilizers	
	i) N	3.93
	ii) P	3.94
	iii) K	1.16
7.	Rental value of land	26.55

*** Indicate significance at 1% level
** Indicate significance at 5% level
* Indicate significance at 10% level

Thus it is concluded that, the maximum share was towards rental value of land.

Jowar

The average share of individual inputs in the total cost of jowar crop in Eastern Vidarbha Zone for the period 1987-88 to 2004-05 are presented in Table 5.24

Table 5.24 revealed that, the higher share in total cost was observed in bullock labour (25.49%) fallowed by rental value of land (22.23%). As far as, the share of human labour is concerned, it was 20.81 per cent. While the share of other inputs were less than 10 per cent.

Table 5.24. Inputs share in total cost of jowar

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	5.99
2.	Human labour	
	i) Male	6.47
	ii) Female	14.34
3.	Bullock labour	25.49
4.	Machine labour	4.34
5.	Manures	6.60
6.	Fertilizers	
i.	N	8.47
ii.	P	4.18
iii.	K	1.90
7.	Rental value of land	22.23

Tur

The shares of individual input in total cost of tur are presented in Table 5.25.

The inputs share in the production of tur shows that, the rental value of land registered highest share i.e. 29.83 per cent in total cost followed by bullock labour (19.51%) and female labour (15.31%) . The shares of female labour was found to be more than the share of male labour (6.46%). The share of machine labour, seed and manures were found to be 6.36, 1.66, 5.37 per cent respectively.

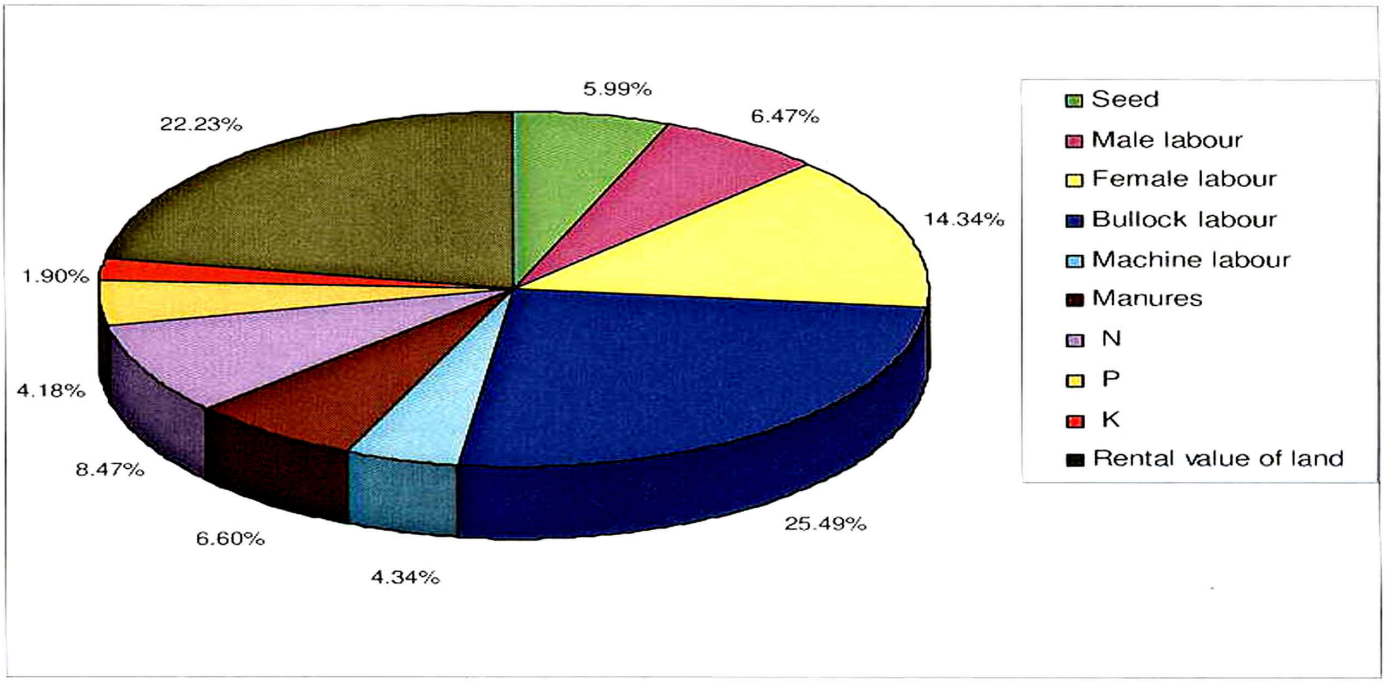

Fig. 5 : Inputs share in total cost of jowar

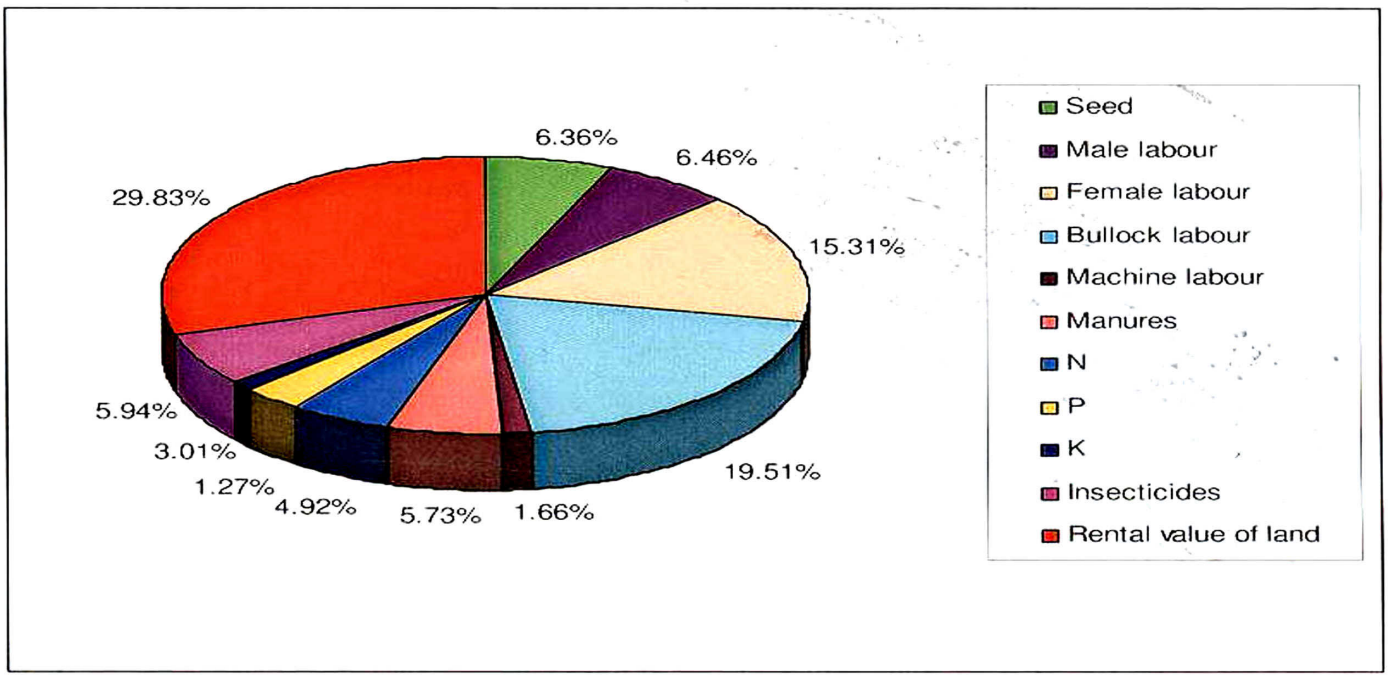

Fig. 6 : Inputs share in total cost of tur

Table 5.25. Inputs share in total cost of tur

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	6.36
2.	Human labour	
i.	Male	6.46
ii.	Female	15.31
3.	Bullock labour	19.51
4.	Machine labour	1.66
5.	Manures	5.73
6	Fertilizers	
i.	N	4.92
ii.	P	3.01
iii.	K	1.27
7.	Insecticides	5.94
8.	Rental value of land	29.83

The result of the study indicated that over the years, the share of rental value of land, bullock labour and female labour were increased steeply in the total cost.

Gram

The use of inputs like, manures, fertilizers and insecticide was negligible in cultivation of gram in EVZ and therefore, it was not considered in the present study.

Table 5.26. Inputs share in total cost of gram

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output (qtl/ha)	100.00
1.	Seed (kg/ha)	26.09
2.	Human labour (days/ha)	
i.	Male	10.54
ii.	Female	0.67
3.	Bullock labour (days/ha)	28.02
4.	Machine labour (days/ha)	6.22
5.	Rental value of land (Rs/ha)	28.45

It could be seen from Table 5.26 that, rental value of land accounts 28.45 per cent share in total cost of gram followed by bullock labour (28.02%) and seed (26.09%). However, the share of female labour in total cost was very less (0.67%).

The analysis of the study indicates that among the different inputs, the share of rental value of land, bullock labour and seed were found higher in total cost.

5.3.2 Central Vidarbha Zone

Cotton

The shares of individual input in total cost of cotton for the period 1987-88 to 2004-05 were worked out and presented in Table 5.27.

The weights for each of the inputs were computed from their shares in total cost. From the Table 5.27 revealed that, the share of rental value of land worked out 24.31 per cent which was higher among different inputs followed by female labour (19.80%) and bullock labour (17.11%) and seed (10.40%). However, the share of female labour was found more than male labour. Similarly the share of bullock labour was more than machine labour. The share of manures and insecticides accounts 4.25 and 5.53 per cent respectively in total cost while the share of fertilizers were 12.34 per cent.

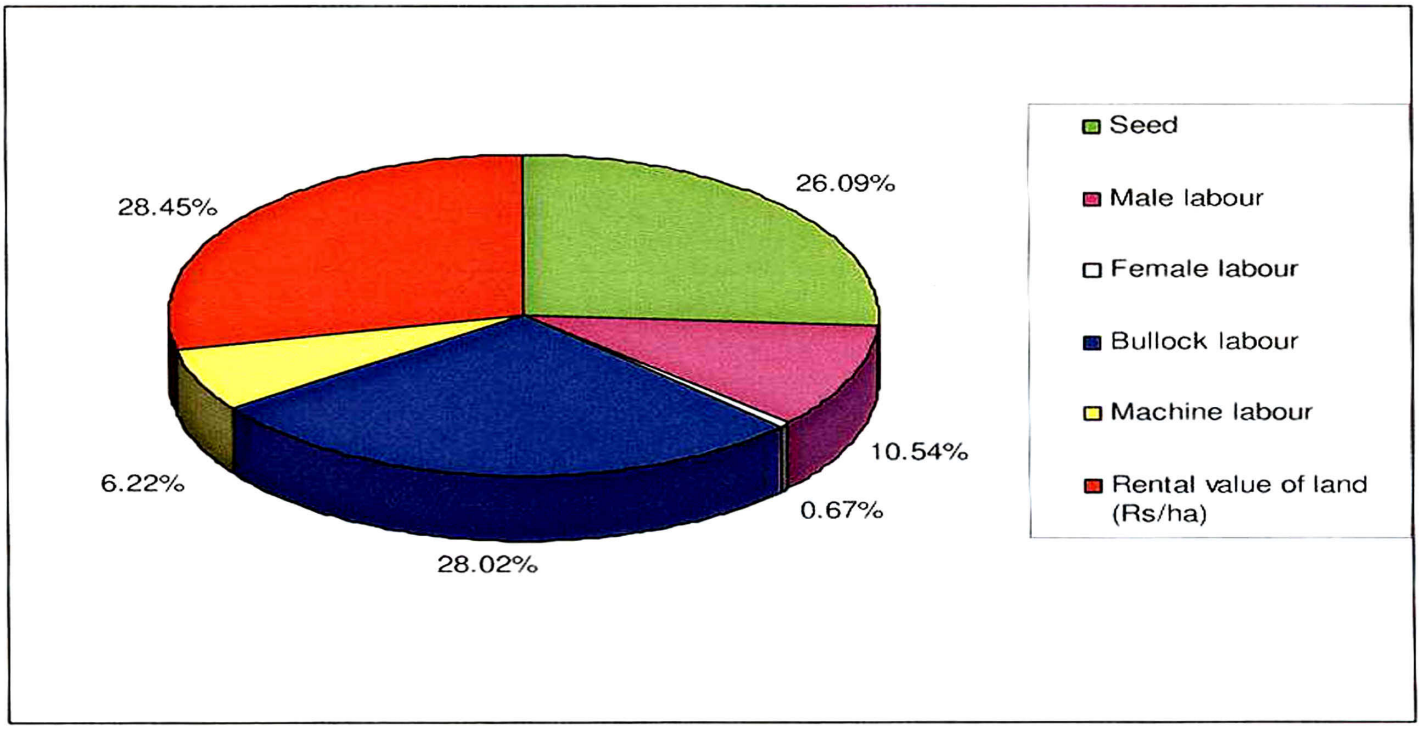

Fig. 7 : Inputs share in total cost of gram

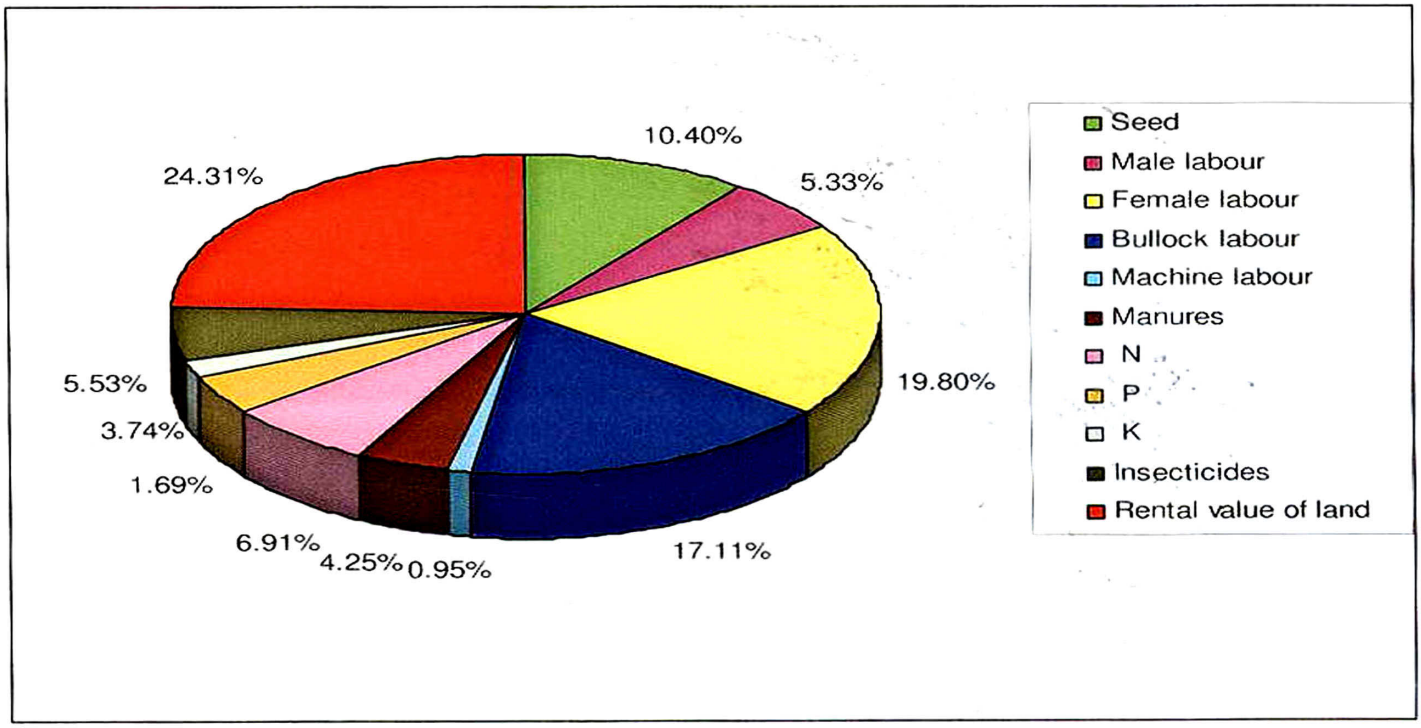

Fig. 8 : Inputs share in total cost of Cotton

Table 5.27. Inputs share in total cost of cotton

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	10.40
2.	Human labour	
	i) Male	5.33
	ii) Female	19.80
3.	Bullock labour	17.11
4.	Machine labour	0.95
5.	Manures	4.25
6.	Fertilizers	
	i) N	6.91
	ii) P	1.69
	iii) K	3.74
7.	Insecticides	5.53
8.	Rental value of land	24.31

The result of the analysis showed that, the share of rental value of land in total cost was higher than that of all other inputs.

Soybean

The shares of different inputs in total cost of soybean were worked out and are presented in Table 5.28.

As revealed from Table 5.28 that, the rental value of land contributes major share i.e. 26.75 per cent in total cost followed by bullock labour (16.24%), seed (15.41%)and female labour (13.31%). The contribution of male labour was found to be 7.45 per cent which was nearly half to the share of female labour. Similarly machine labour and bullock labour account 7.31 and 16.24 per cent respectively. The share of manures N, P and K accounts 2.68, 3.32, 5.83 and 1.23 per cent respectively while the shares of insecticides was found negligible during period of study.

The result of the analysis showed that, the share of rental value of land in total cost was higher than all other inputs while, the share of insecticide was lowest in soybean crop.

Table 5.28. Inputs share in total cost of soybean

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	15.41
2.	Human labour	
	i) Male	7.45
	ii) Female	13.31
3.	Bullock labour	16.24
4.	Machine labour	7.31
5.	Manures	2.68
6.	Fertilizers	
	i) N	3.32
	ii) P	5.83
	iii) K	1.23
7.	Insecticides	0.47
8.	Rental value of land	26.75

Jowar

The average shares of different inputs in total cost of jowar for the period 1987-88 to 2004-05 are presented in Table 5.29.

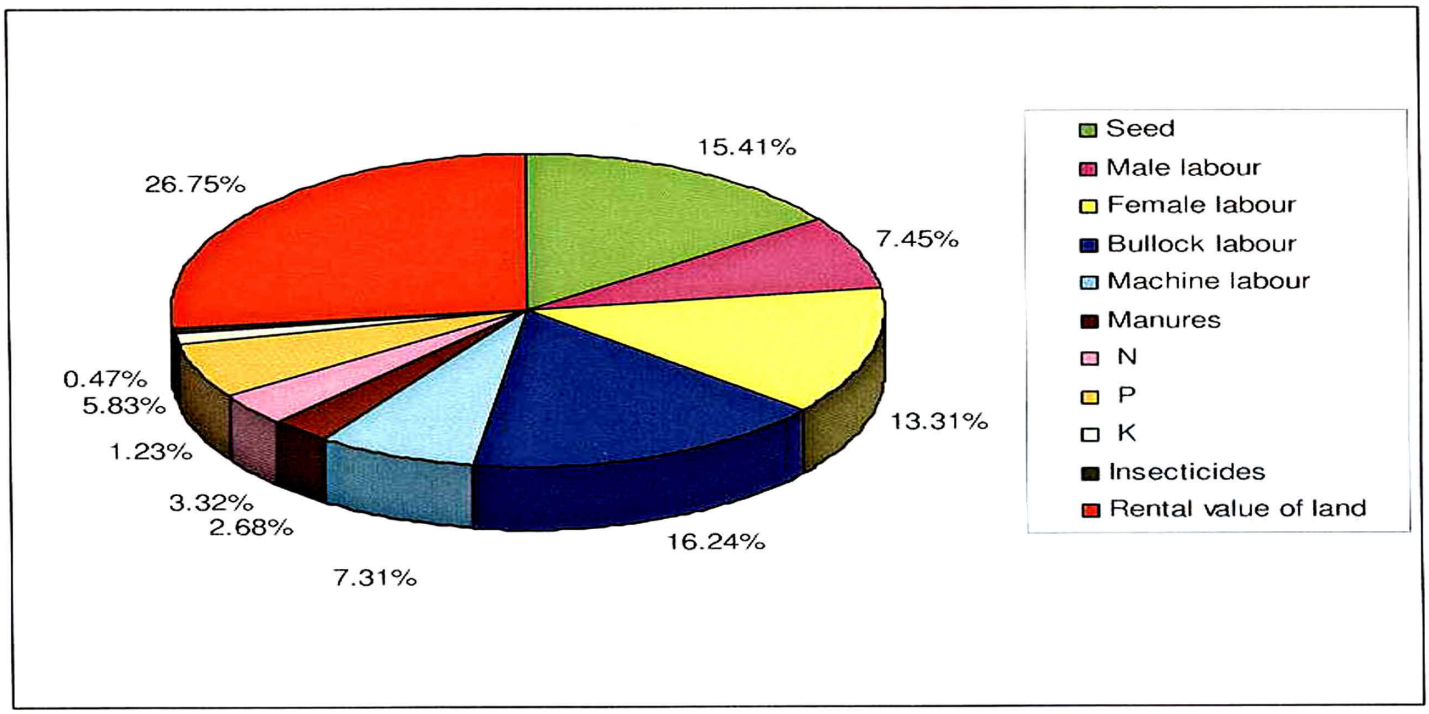

Fig. 9 : Inputs share in total cost of Soybean

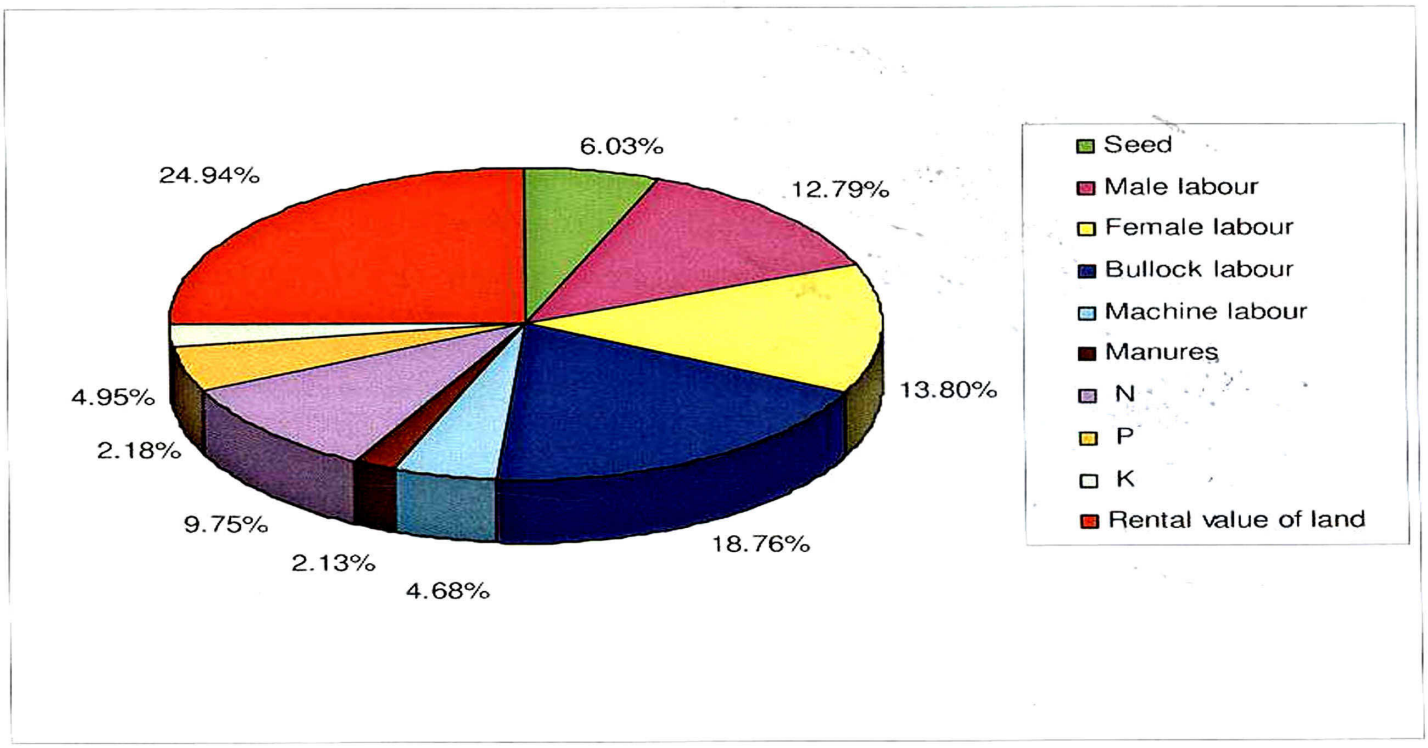

Fig. 10 : Inputs share in total cost of Jowar

Table 5.29. Inputs share in total cost of jowar

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	6.01
2.	Human labour	
	i) Male	12.75
	ii) Female	13.76
3.	Bullock labour	18.71
4.	Machine labour	4.67
5.	Manures	2.12
6.	Fertilizers	
	i) N	9.72
	ii) P	4.94
	iii) K	2.17
7.	Rental value of land	24.87

Table 5.29 revealed that, the higher share in total cost was observed in rental value of land (24.87%) fallowed by bullock labour (18.71%), female labour (13.76%) and male labour (12.75%). Contribution of female labour and male labour were found equal to the total cost in jowar. As far as, the shares of other inputs were less than 10 per cent.

From the above Table, it is concluded that, the share of rental value of land in total cost was higher than that of all other inputs whereas share of insecticide was found to be negligible in production of jowar.

Tur

Average share of individual inputs in total cost for cultivation of tur for the period 1987 to 2004 was estimated and presented in Table 5.30.

Table 5.30. Inputs share in total cost of tur

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	5.78
2.	Human labour	
	i) Male	11.61
	ii) Female	16.59
3.	Bullock labour	18.18
4.	Machine labour	1.99
5.	Manures	3.68
6.	Fertilizers	
	i) N	4.84
	ii) P	2.89
	iii) K	1.27
7.	Insecticide	3.26
8.	Rental value of land	29.91

The inputs share in the cultivation of tur (Table 5.30) shows that, rental value of land registered highest share i.e. 29.91 per cent followed by bullock labour (18.18%), female labour (16.59%) and male labour(11.61%). Contribution of female labour was more than male labour in total cost of tur, while the share of machine labour accounts 1.99 per cent share which was very less as compared to bullock labour. The share of seed and manures were 5.78 and 3.68 per cent respectively. However the shares of N, P and K accounts 4.84, 2.89 and 1.27 per cent respectively in total cost of tur.

The result of the study indicates that, over the years the share of rental value of land, bullock labour and female labour were increased steeply in total cost.

Gram

The shares of different input in total cost of gram are presented in Table 5.31.

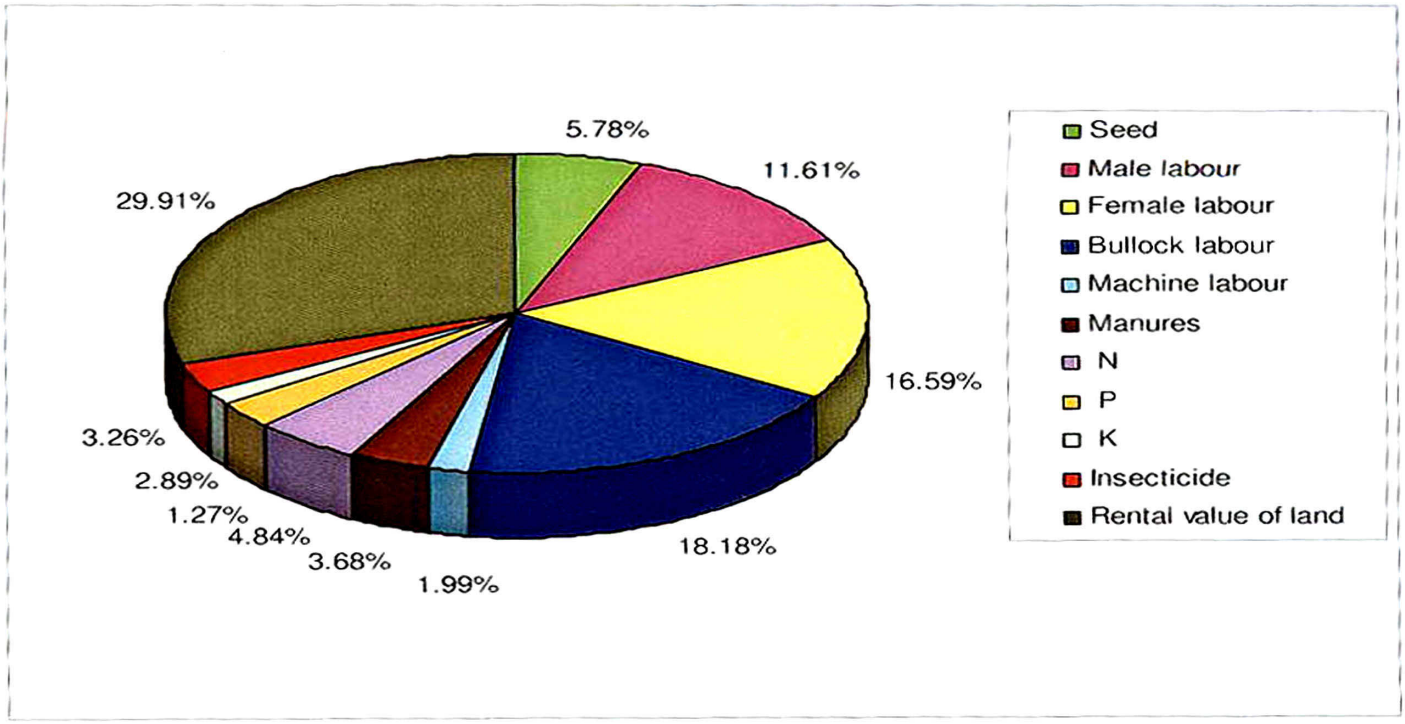

Fig. 11 : Inputs share in total cost of tur

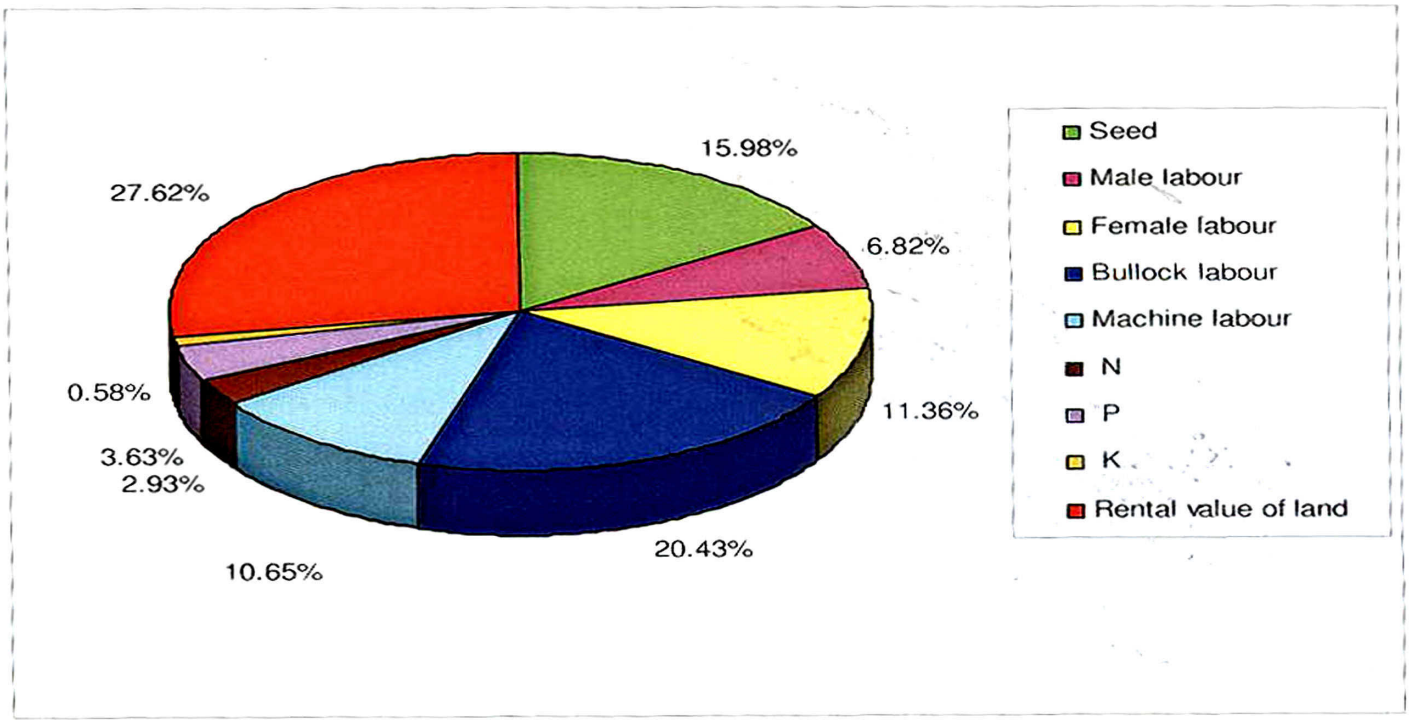

Fig. 12 : Inputs share in total cost of gram

Table 5.31. Inputs share in total cost of gram

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	15.98
2.	Human labour	
	i) Male	6.82
	ii) Female	11.36
3.	Bullock labour	20.43
4.	Machine labour	10.65
5.	Fertilizers	
	i) N	2.93
	ii) P	3.63
	iii) K	0.58
6.	Rental value of land	27.62

It could be seen from Table 5.31 that, the rental value of land contributes 27.62 per cent in total cost fallowed by bullock labour (20.43%) and seed (15.98%). The contribution of male labour (6.82%) which was near about half to the share of female labour. Similarly machine labour and bullock labour accounts 10.65 and 20.43 per cent respectively. The share of N, P and K were 2.93, 3.63 and 0.58 per cent respectively while the share of manures and insecticides was found negligible in total cost of gram.

Thus it is concluded from study that, the maximum share of total cost was towards rental value of land.

5.3.3. Western Vidarbha Zone

Cotton

The share of inputs in total cost of cotton were estimated and presented in Table 5.32

Table 5.32. Inputs share in total cost of cotton

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	8.66
2.	Human labour	
	i) Male	7.59
	ii) Female	19.65
3.	Bullock labour	16.57
4.	Machine labour	2.98
5.	Manure	4.62
6.	Fertilizers	
	i) N	6.52
	ii) P	4.17
	iii) K	0.87
7.	Insecticide	3.98
8.	Rental value of land	24.18

Table 5.32 revealed that, the share of rental value of land worked out to 24.18 per cent which was higher among different inputs followed by female labour (19.65%) and bullock labour (16.57%). However, the share of female was found more than male labour (7.59%) in the production of cotton. Similarly, the share of bullock labour was more than machine labour (2.98%). Seed and manures accounts 8.66 and 4.62 per cent respectively in the total cost. While, the shares of fertilizer and insecticide were 11.56 and 3.98 per cent respectively.

The result of the analysis showed that the share of rental value of land in total cost was higher than that of other inputs while the share of potash was lower in production of cotton.

Soybean

The share of inputs in total cost of soyabean were worked out and presented in Table 5.33

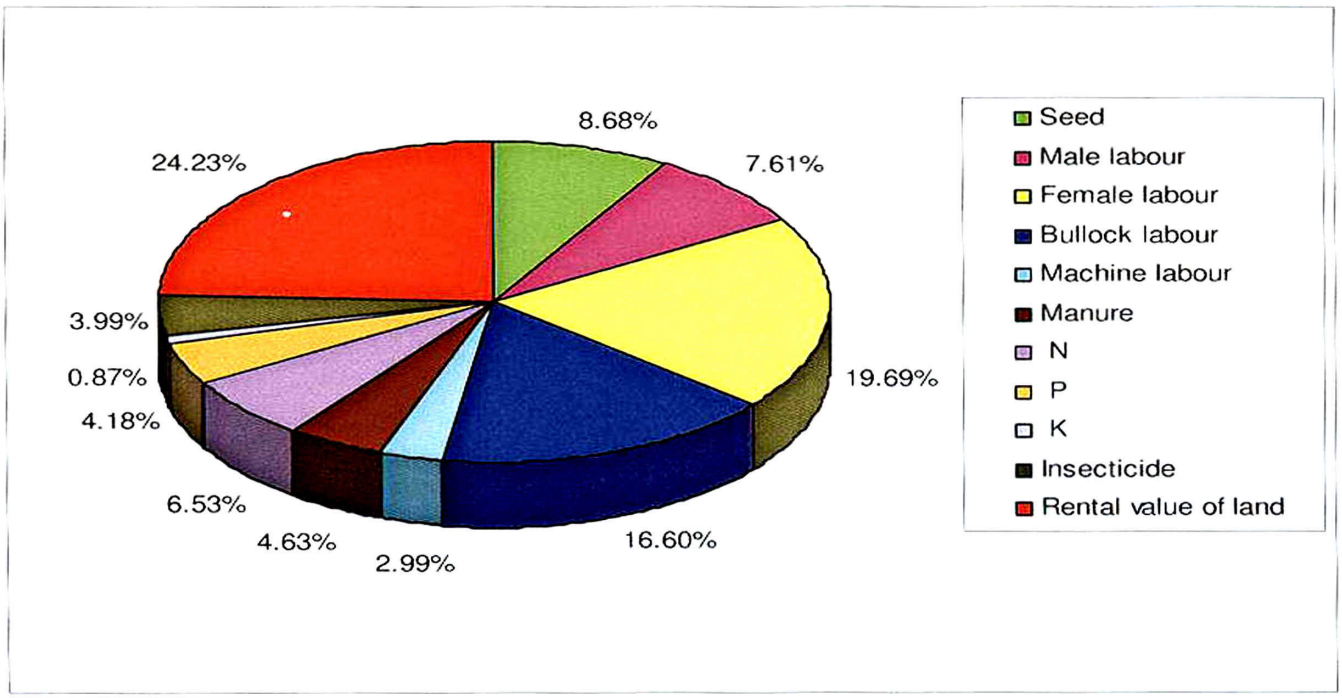

Fig. 13 : Inputs share in total cost of cotton

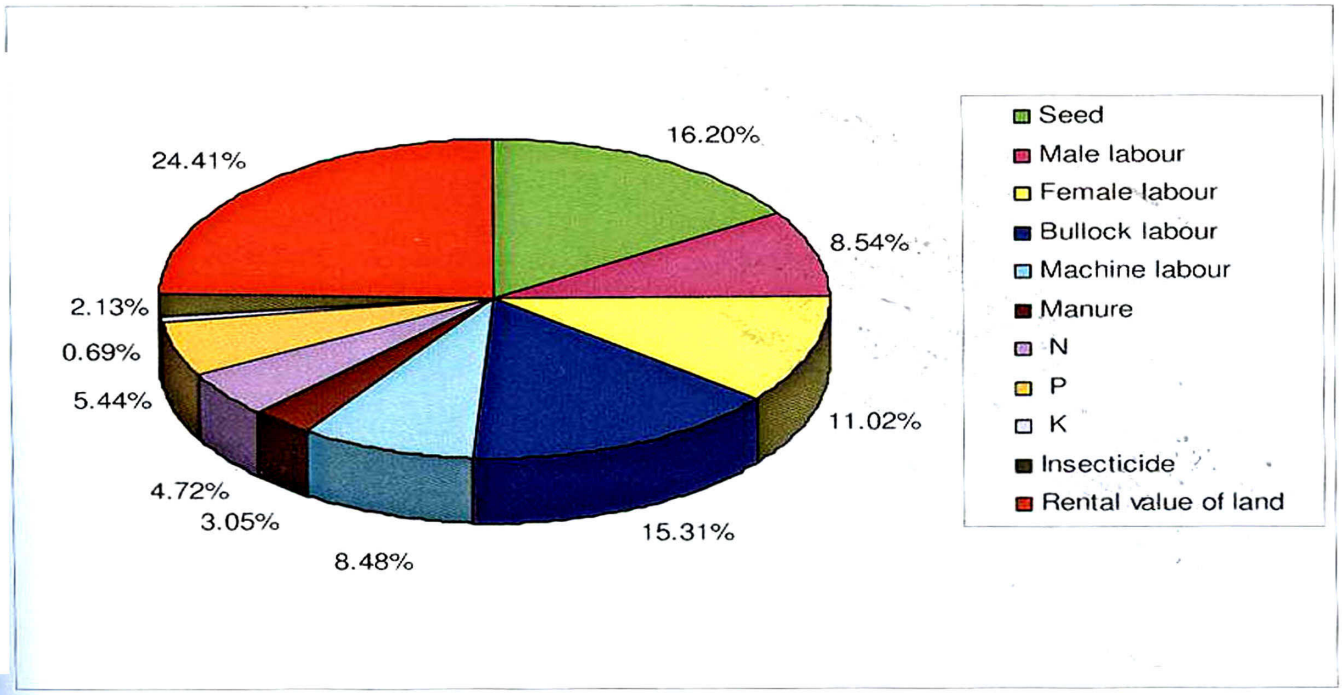

Fig. 14 : Inputs share in total cost of soybean

Table 5.33. Inputs share in total cost of soybean

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	16.20
2.	Human labour	
	i) Male	8.54
	ii) Female	11.02
3.	Bullock labour	15.31
4.	Machine labour	8.48
5.	Manure	3.05
6.	Fertilizers	
	i) N	4.72
	ii) P	5.44
	iii) K	0.69
7.	Insecticide	2.131
8.	Rental value of land	24.41

It could be seen from Table 5.33 that the higher share in total cost was observed in rental value of land (24.41%) followed by seed (16.20%), bullock labour (15.31%) and female labour (11.02%). As far as the share of fertilizesr is concerned it was 10.85 per cent while the share of other inputs were less than 10 per cent in total cost.

From the above Table it is concluded that the share of rental value of land, seed and human labour were higher than other inputs.

Jowar

The average share of inputs were worked out and presented in Table 5.34

Table 5.34. Inputs share in total cost of jowar

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	6.27
2.	Human labour	
	i) Male	13.96
	ii) Female	12.68
3.	Bullock labour	17.69
4.	Machine labour	8.02
5.	Manure	2.04
6.	Fertilizers	
	i) N	9.31
	ii) P	4.70
	iii) K	1.11
7.	Insecticide	0.17
8.	Rental value of land	25.29

The inputs share in the cultivation of jowar shows that, rental value of land registered highest share (25.29%) followed by bullock labour (17.69%), male labour (13.96%) and female labour (12.68%). The share of machine labour was 8.02 per cent which was near about half to the share of bullock labour in total cost while the share of other inputs were less than 10 per cent in total cost.

The result of the analysis showed that the share of rental value of land in total cost was higher than that of other inputs.

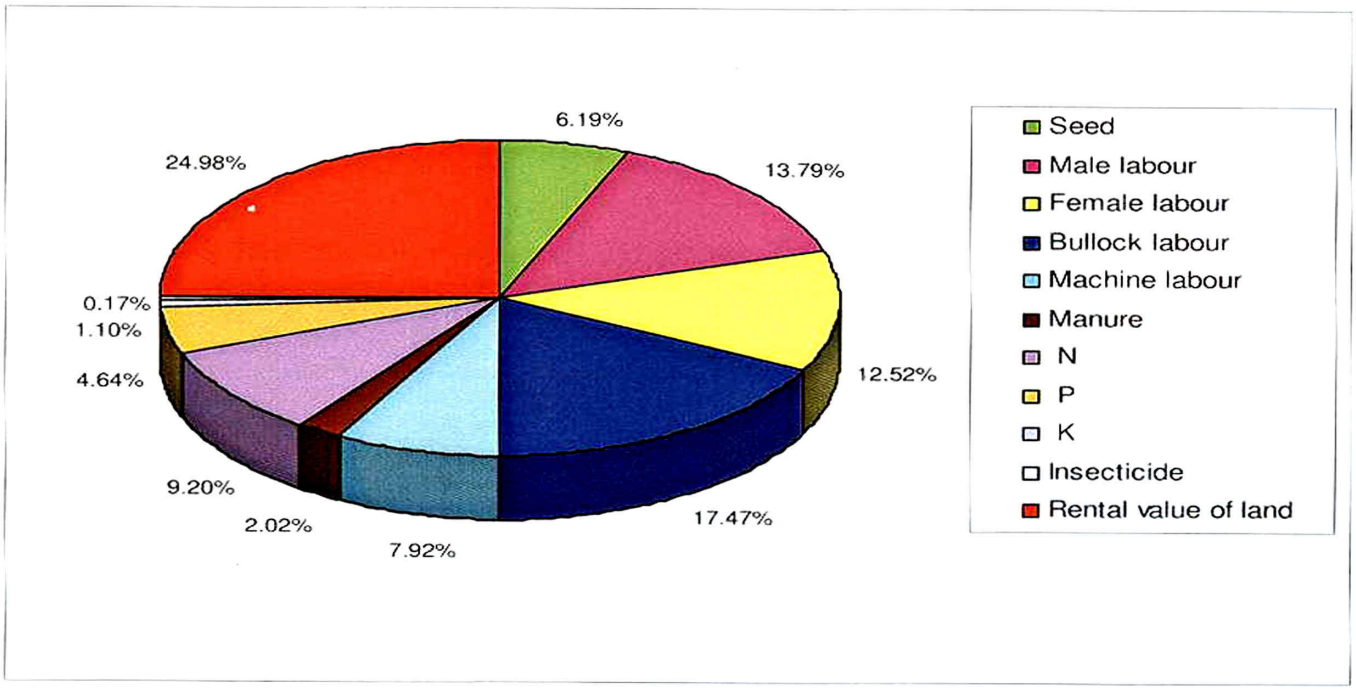

Fig. 15 : Inputs share in total cost of jowar

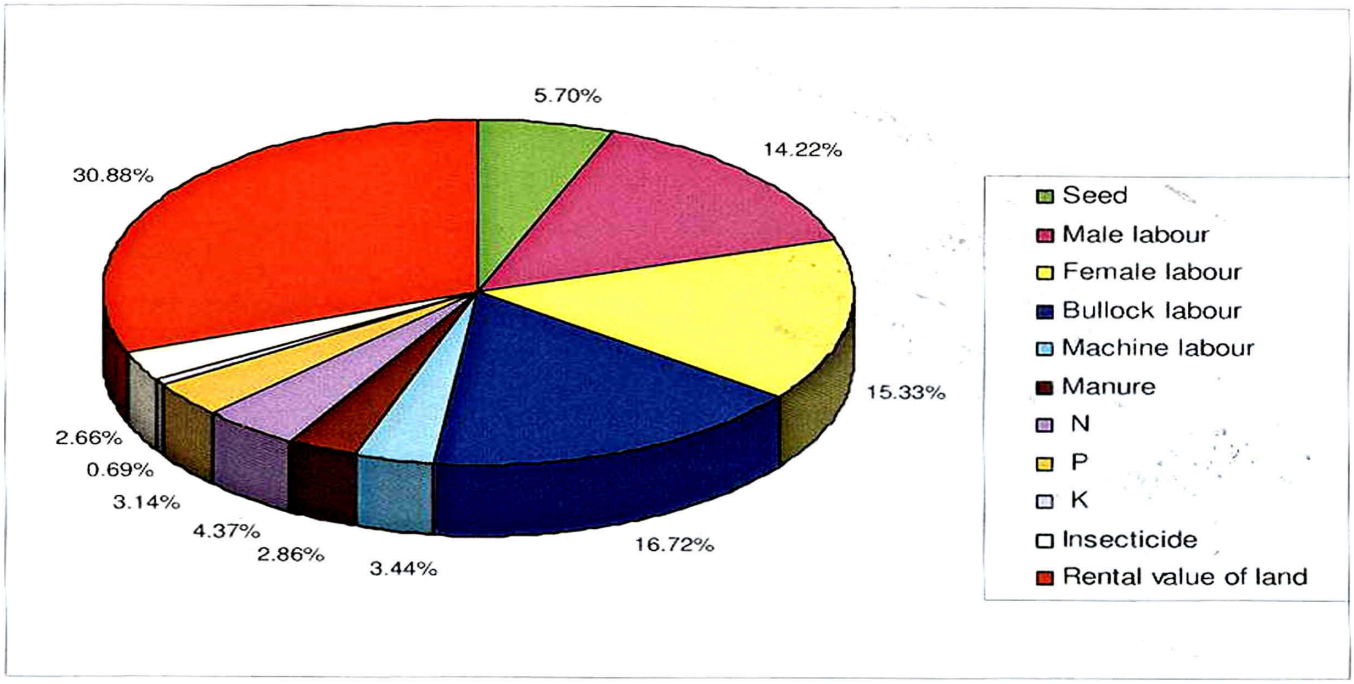

Fig. 16 : Inputs share in total cost of tur

Tur

The shares of different inputs in total cost of tur for the period 1987-88 to 2004-05 are presented in Table 5.35.

Table 5.35. Inputs share in total cost of tur

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	5.70
2.	Human labour	
	i) Male	14.22
	ii) Female	15.33
3.	Bullock labour	16.72
4.	Machine labour	3.44
5.	Manure	2.86
6.	Fertilizers	
	i) N	4.37
	ii) P	3.14
	iii) K	0.69
7.	Insecticide	2.66
8.	Rental value of land	30.88

As revealed from Table 5.35 that the rental value of land contributes 30.88 per cent in total cost followed by bullock labour (16.72%), female labour (15.33%) and male labour (14.22%). The contribution of machine labour (3.44%) was found to be very less as compared to bullock labour. The share of seed was 3.14 per cent in total cost while fertilizer accounts 8.20 per cent share in total cost.

Thus it is concluded from the Table that, the maximum share was found towards the rental value of land.

Gram

The average shares of individual inputs in total cost of gram are presented in Table 5.36.

Table 5.36. Inputs share in total cost of gram

(in per cent)

Sr. No.	Particulars	Input share in total cost
	Output	100.00
	Inputs	
1.	Seed	17.03
2.	Human labour	
	i) Male	7.58
	ii) Female	8.63
3.	Bullock labour	17.23
4.	Machine labour	11.63
5.	Fertilizers	
	i) N	4.80
	ii) P	4.02
	iii) K	0.45
6.	Rental value of land	28.64

It could be seen from Table 5.36 that the share of rental value of land worked out to 28.64 per cent which was higher among different inputs followed by bullock labour (17.23 %) and seed (17.03 %). The share of female labour was 8.63 per cent which was somewhat higher than male labour (7.58%). Similarly machine labour accounts less share (11.63%) as compared to bullock labour. The share of fertilizers was found 9.27 per cent in total cost.

The result of the analysis showed that the share of rental value of land, seed and bullock labour accounts maximum share in total cost of gram.

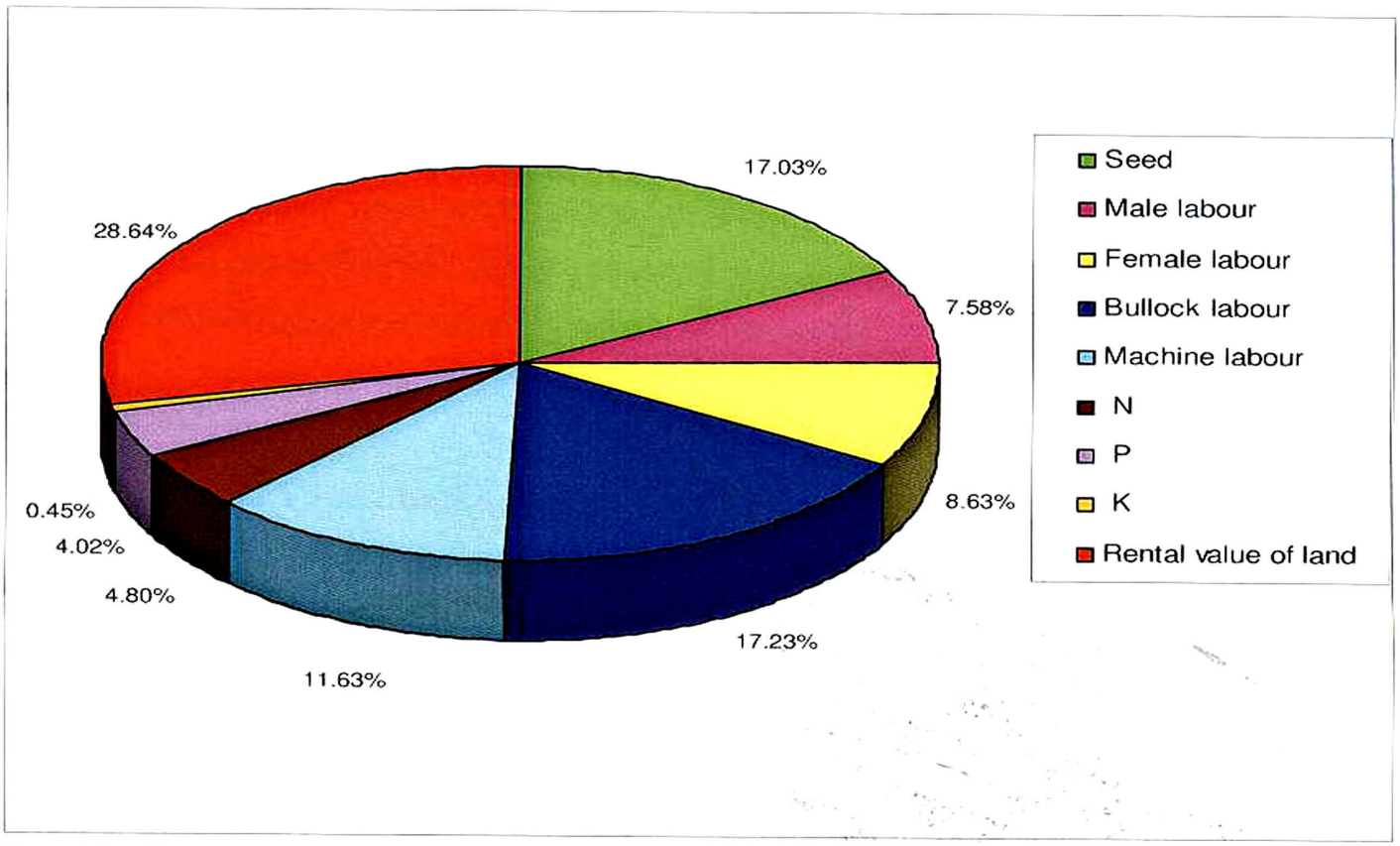

Fig. 17 : Inputs share in total cost of gram

5.4 Measurement of total factor productivity :

A sustained growth in agriculture leads to development which in turn is critically dependent upon the growth in agricultural productivity and technological change. However, productivity is dictated by factors such as technical change, scale economies and efficiency in factor use. In order to examine the behaviours of agricultural productivity in different zones of Vidarbha, Tornqvist Theil Divisia Chained. Index approach was preferred because of its superiority over other function (Diewert, 1975). The indices obtained by this method provide consistent aggregation of inputs and output under the assumption of competitive behaviour, constant return to scale, Hicks neutral technical change and input-output separately. Using this, the total factor productivity index for different zones of Vidarbha were estimated. As explained in methodology the total period of study (1987-88 to 2004-05) was divided in two periods i.e. Period I (1987-88 to 1995-96) and Period II (1996-97 to 2004-05). The results obtained are presented below zonewise.

5. 4.1 Eastern Vidarbha Zone :

The cropwise growth in output, input and total factor productivity (TFP) were estimated and presented in Table 5.37 to Table 5.41.

Paddy :

The analysis of growth in output, input and total factor productivity of paddy from the year 1991-92 to 2004-05 is presented in Table 5.37.

Table 5.37 : Tornqvist – Theil Divisia Index of output, input and TFP of paddy.

Year	Output index	Input index	TFP
1992-93	100.00	100.00	100.00
1993-94	81.27	103.12	78.82
1994-95	71.03	105.75	67.17
1995-96	91.03	100.38	90.69
1996-97	60.60	95.69	63.33
1997-98	72.69	101.53	71.60
1998-99	72.65	114.63	63.37
1999-2000	95.25	107.72	88.42
2000-01	45.28	110.02	41.16
2001-02	117.12	100.67	116.34
2002-03	50.41	131.48	38.34
2003-04	122.26	84.57	144.56
2004-05	38.71	99.47	38.92

It could be seen from Table 5.37 that, over the entire period of study, the output recorded a declining growth while during the same period, input use index also showed decline growth. The total factor productivity index decreased in the first period and slightly increased for few years of second period. However, for the entire period of study, recorded decline in growth of total factor productivity was observed except for 2001-02 and 2003-04.

The analysis of the study indicated that the decline in total factor productivity was not only due to low growth in output but also due to increased in use of inputs.

The output index was more than 100 in the year 2001-02 (117.12) and 2003-04 (122.26) while in the remaining years it was less than 100. Lowest output index was observed during the year 2004-05 (38.92), 2000-01 (45.28) and 2002-03 (50.41). As regards to input index, it was highest in the year 2002-03 (131.48) and lowest in the year 2003-04 (84.57). At overall level input index was found to be more or less same.

The total factor productivity was found to be more than 100 in the year 2001-

02 (144.56) and 2003-04 (116.34), since during these years, the output index was more than input index. The lowest total factor productivity was observed during 2002-03 (38.4) and 2004-05 (38.92).

Table 5.37a : Average annual growth rates of output, inputs and TFP indices of paddy

Year	Output index	Input index	TFP
Overall period	-5.11	-0.04	-5.07
Period I	-4.56	2.44	-7.0
Period II	-5.66	-2.53	-3.13

As regards to average annual growth rates of output, input and total factor productivity of paddy (Table 5.37 a) indicated that the growth of total factor productivity at -5.07 per cent per annum is a resultant of output growth at -5.11 per cent per annum minus the input growth at the rate of -0.04 per cent per annum. Similar results were obtained by Vanita Khobarkar (2006). In the first period, growth in output index was negative (-4.56%) while growth in input index was positive (2.44%) i.e. growth in input index was higher than growth in output index, therefore growth in the total factor productivity was negative (-7.00%). While, during second period, growth in output index was -5.66 per cent per annum whereas growth in input index was -2.53 per cent per annum therefore growth in total factor productivity also negative (-3.13%).

Thus, it is observed from tables that, among fourteen years, only two years are said to be best years i.e. 2001-02 and 2003-04, where output index was more than input index. The reason might be that, during these year the actual rainfall was higher than normal rainfall and number of rainy days were more as compared to other years. The year 2002-03 and 2004-05 were said to be bad years for production of paddy because in these year actual rainfall as well as number of rainy days were also less. Thus the negative factor productivity of paddy over the years might be due to adverse climatic condition and technology.

Soybean :

Total input index, total output index and total factor productivity (TFP) were estimated for the years 1987-88 to 2004-05 and presented in Table 5.38 and average

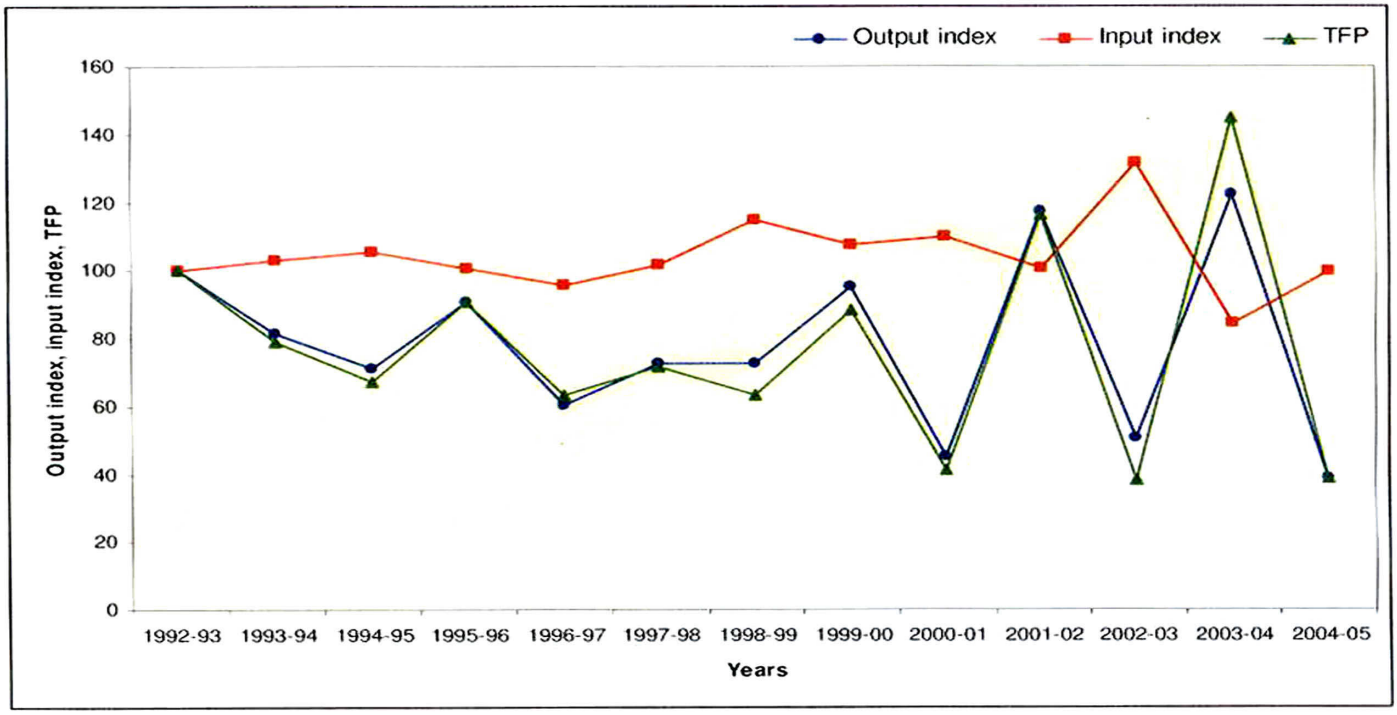

Fig. 18 : Tornqvist – Theil Divisia Index of output, input and TFP of paddy.

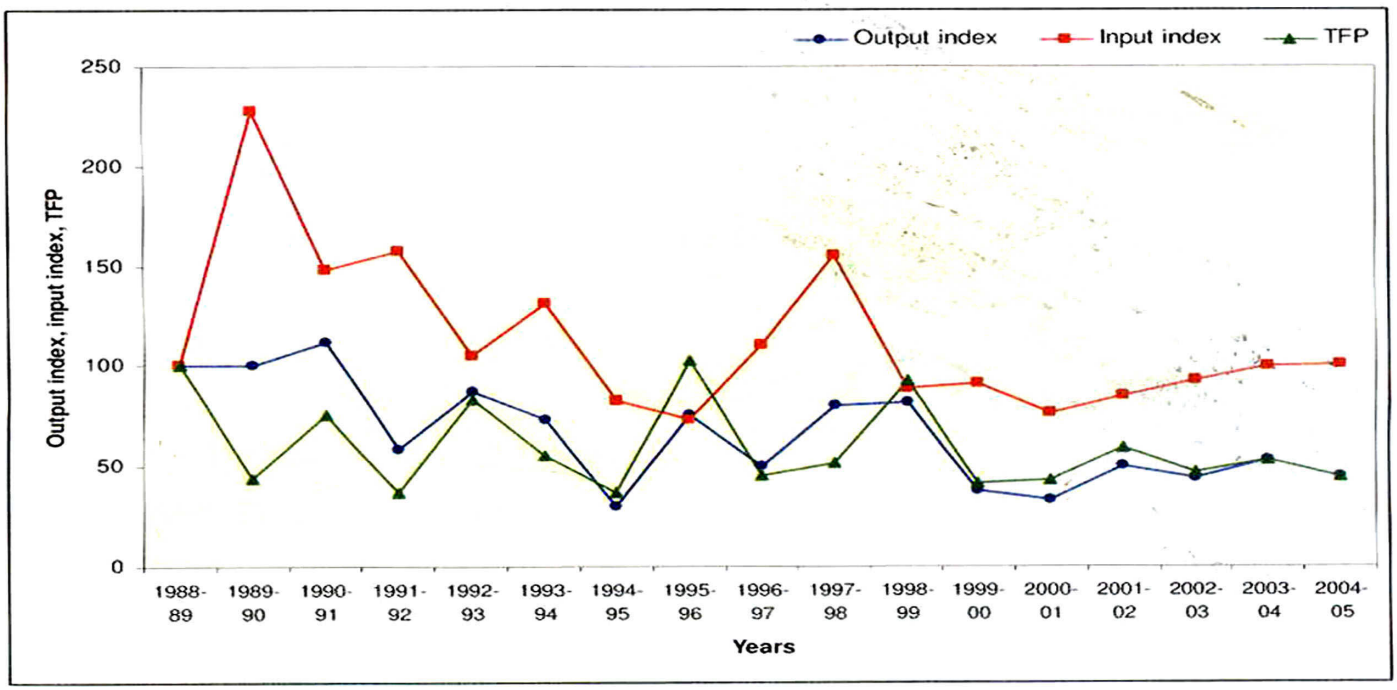

Fig. 19 : Tornqvist – Theil Divisia Index of output, input and TFP of Soybean

annual growth rate of output, input and total factor productivity index in Table 5.38a.

Table 5.38 : Tornqvist – Theil Divisia Index of output, input and TFP of soybean

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	100.31	227.29	44.13
1990-91	111.85	148.19	75.48
1991-92	58.43	157.50	37.10
1992-93	87.57	105.04	83.27
1993-94	73.39	131.27	55.91
1994-95	30.39	82.85	36.68
1995-96	75.53	73.50	102.76
1996-97	50.33	110.37	45.60
1997-98	80.62	154.86	52.06
1998-99	81.81	88.70	92.23
1999-2000	37.72	90.85	41.51
2000-01	33.05	76.74	43.06
2001-02	50.44	84.54	59.67
2002-03	43.68	92.95	46.99
2003-04	52.95	99.68	53.11
2004-05	44.78	100.61	44.51

As observed from Table 5.38 and Table 5.38a that, at overall level, the input index was higher that the output index, therefore total factor productivity was found to be declining. The growth in the input index was positive (0.04%) while, it was negative (-3.45%) in output index. The growth in input index was higher than growth in output index, therefore total factor productivity was found to be negative (-3.49%) over a period.

The total output index was found to be highest in the year 1989-90 (100.31) and 1990-91 (111.85) however it was lowest, in the year 1994-95 (30.39),

2000-01 (33.05), 1999-2000 (37.72) and 2004-05 (44.78) etc. As far as, the total input index is concerned, it was highest in 1989-90 (227.29), 1991-92 (157.50), 1990-91 (148.19) and 1997-98 (154.86) while lowest in 1995-96 (73.50) and 2000-01 (76.74) years.

Table 5.38a : Average annual growth rates of output, inputs and TFP soybean

Period	Output index	Input index	TFP
Overall period	-3.45	0.04	-3.49
Period I	-3.50	-3.79	0.29
Period II	-3.42	3.01	-6.43

Further, the total factor productivity was found to be more than 100 in the years 1995-96 (102.76) where output index was more than input index. While it was lowest in the year 1994-95 (36.68) and 1991-92 (37.10), due to very less growth in output index than input index.

The average annual growth rates of output index was found negative while the growth rates of input index was positive over the entire period of study. The growth in input index was more than the output index therefore total factor productivity found to be negative over the period of study. During period I, the growth of output index was -3.50 per cent per annum, input index (-3.79%) and total factor productivity (0.29%) were found to be positive. While in period II, the growth of output index was negative (-3.42%) and input index was positive (3.01%). During this period growth in output index was less than input index therefore total factor productivity was found to be negative (-6.43%).

The analysis shows that, out of eighteen years, only one year (1995-96) was best and favourable for production of soybean while other years were not favourable for soybean production and in general the total factor productivity growth of soybean was negative at overall level.

Jowar

Total output index (TOI), total input index (TIT) and Total factor productivity (TFP) were worked out and presented in Table 5.39 and average annual

growth rates of TOI, TIT and TFP are presented in Table 5.39a.

Table 5.39 : Tornqvist – Theil Divisia Index of output, input and TFP of jowar

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	158.53	161.45	98.19
1990-91	88.92	135.12	65.81
1991-92	104.68	130.38	80.29
1992-93	167.88	154.20	108.87
1993-94	148.97	136.96	108.77
1994-95	103.65	156.49	66.23
1995-96	110.47	143.06	77.22
1996-97	143.91	140.31	102.57
1997-98	74.71	156.84	47.63
1998-99	131.59	98.47	133.63
1999-2000	173.18	126.85	136.52
2000-01	87.99	74.38	118.29
2001-02	131.01	122.21	107.20
2002-03	76.54	103.03	74.29
2003-04	143.83	183.13	78.54
2004-05	72.33	135.03	53.57

Table 5.39 revealed that, the total output index was highest in the years 1999-2000 (173.18), 1992-93 (167.88), 1989-90 (158.53) and 1993-94 (148.97) and lowest in the year 2004-05 (72.33) 2002-03 (76.54) and 1997-98 (74.71). The total input index was highest in the 2003-04 (183.13) and 1989-90 (161.45). These index were more than 100 in all the years except in 2000-01 where it was found to be 74.38. At overall level, the total input index was more than the total output index.

The total factor productivity index was highest in the year 1999-2000 (136.52), 1998-99 (133.63) and 2000-01 (118.29) and lowest in the years 2004-05

(53.57), 1990-91 (65.81) and 1994-95 (66.23). The total factor productivity was highest when output index were more than input index and lowest when input index was more than output index.

Table 5.39a : Average annual growth rates of output, inputs and TFP indices of jowar

Period	Output index	Input index	TFP
Overall period	-1.73	2.19	-3.92
Period I	1.50	6.15	-4.65
Period II	-4.24	-0.89	-3.35

At overall level, the growth in input index was positive (2.19%) while, growth in output index was negative (-1.73%) and as such total factor productivity for the period was negative (-3.92%). The negative total factor productivity might be due to increasing input index with decreasing output index. In first period, the growth in input index (6.15%) and output index (1.50%) were increasing, however the growth rate of input index was more than that of output index and therefore the total factor productivity found to be negative (-4.65%) for this period. During second period, the growth in input index and output index were negative and the magnitude of total factor productivity index was -3.35 per cent per annum.

Thus, the study indicated that, out of eighteen years, five years were favourable for production of Jowar and rest of the years were bad for Jowar. The reason for declining total factor productivity might be due to drought spell in the year 1995-96 and 1996-97 and 2004-05 where as actual rainfall was very less than normal rainfall and less number of rainy days during these period.

Tur :

Total output, input and total factor productivity (TFP) indices and average annual growth in output, input and total factor productivity were estimated and presented in Table 5.40 and Table 5.40 a.

It could be seen from Table that, the output index was more than 100 in the years 1989-90, 1992-93, 1996-97, 1998-99, 1999-2000, 2001-02 and 2003-04, while in remaining years it was less than 100. Highest output index was observed in the

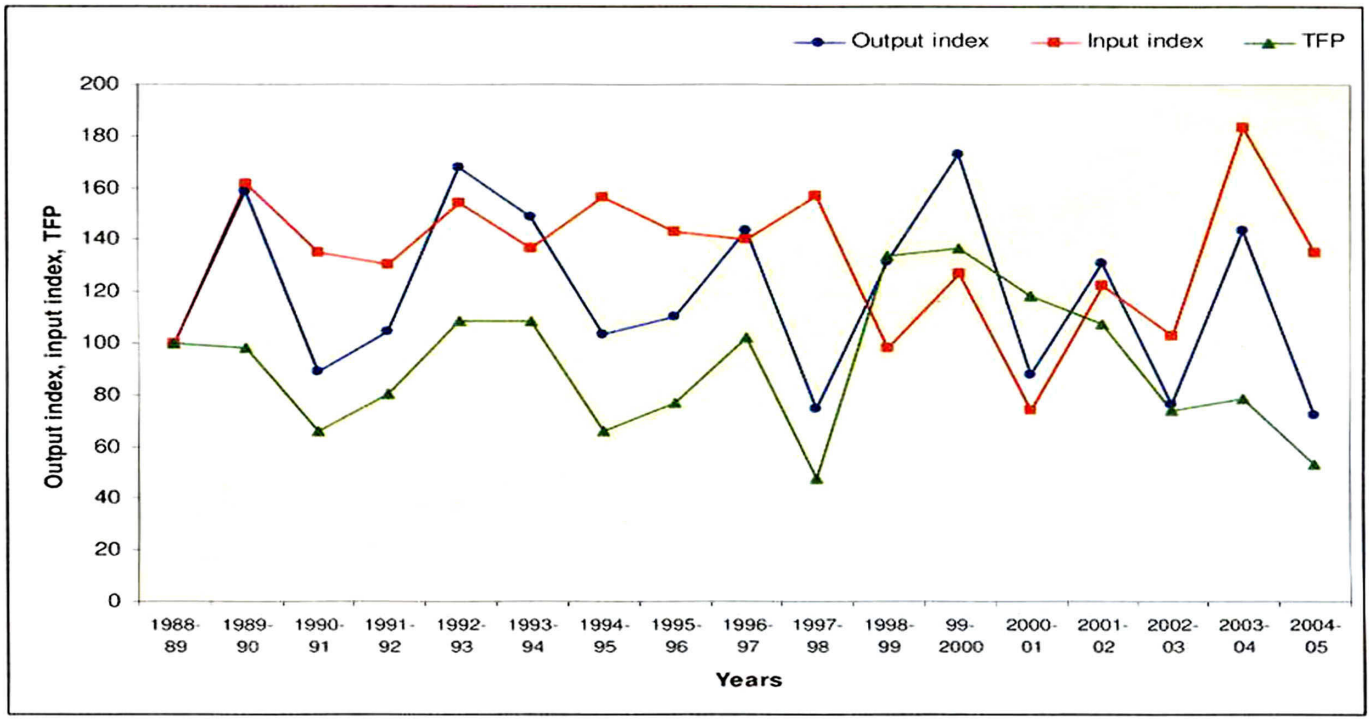

Fig.20 : Tornqvist – Theil Divisia Index of output, input and TFP of jowar.

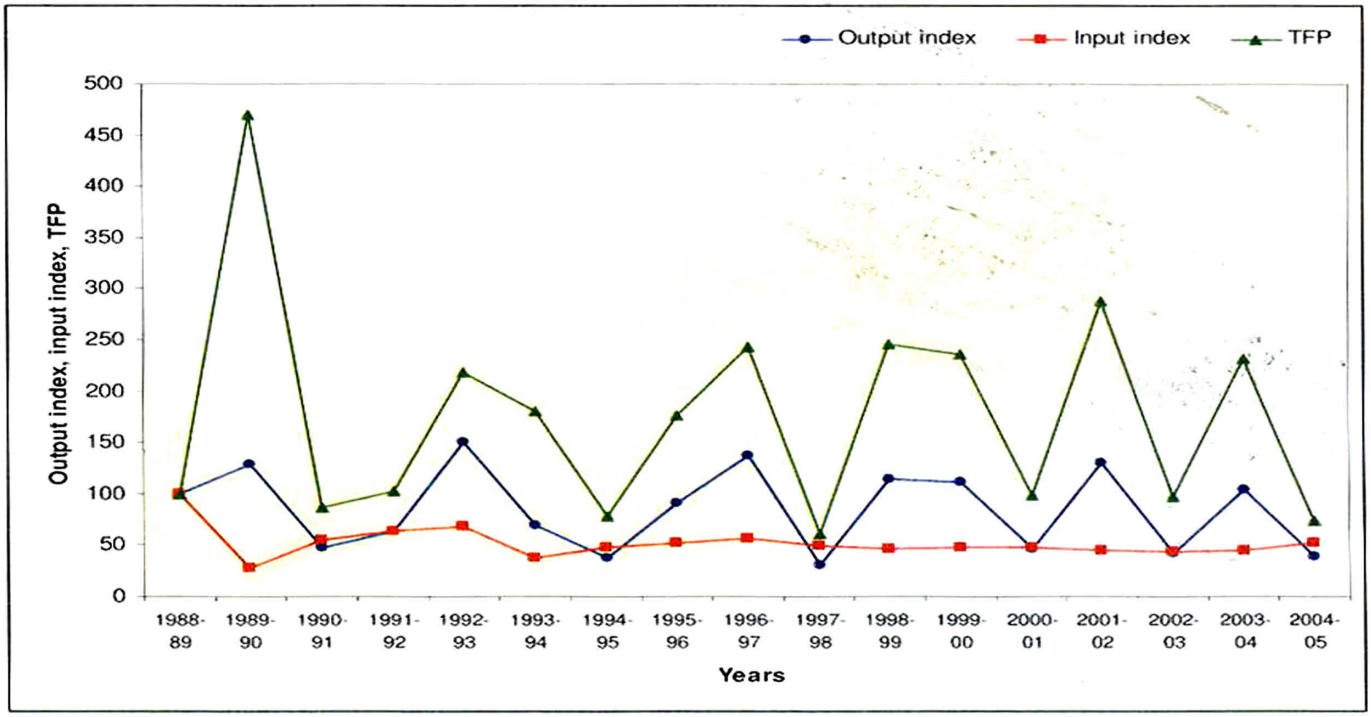

Fig.21 : Tornqvist – Theil Divisia Index of output, input and TFP of tur.

year 1992-93 (149.81) while, lowest output index was observed in the year 1997-98 (29.81). As far as, input index are concerned, it was less than 100 in all the years.

Table 5.40 : Tornqvist – Theil Divisia Index of output, input and TFP of tur

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	129.17	27.50	469.64
1990-91	47.30	54.95	86.09
1991-92	64.28	63.03	101.98
1992-93	149.81	68.64	217.56
1993-94	68.81	38.05	180.84
1994-95	37.39	48.07	77.78
1995-96	91.66	52.06	176.08
1996-97	136.77	56.21	243.32
1997-98	29.81	49.48	60.24
1998-99	114.60	46.55	246.18
1999-2000	111.02	46.99	236.24
2000-01	46.41	47.39	97.95
2001-02	129.53	45.11	287.14
2002-03	42.37	43.43	97.54
2003-04	103.65	44.82	231.28
2004-05	38.40	51.96	73.90

Total factor productivity growth as a measure of rate of growth of output minus the rate of growth of input was highest in the year 1989-90 (469.64). While during the same year input index and output index were 27.50 and 129.17 respectively. This clearly shows that the year in which output index was more than input index. The total factor productivity was positive and increasing. The total factor productivity was lowest in the year 1997-98 (60.24%) where in output index was found to be lower than input index.

Table 5.40a : Average annual growth rates of output, inputs and TFP indices of tur

Period	Output index	Input index	TFP
Overall period	-3.85	-3.00	-0.85
Period I	-1.19	-6.85	5.66
Period II	-5.92	-0.01	-5.91

Table 5.40 a revealed that, over the entire period of study, the output recorded a growth rate of -3.85 per cent per annum. During the same period, input index was -3.00 per cent per annum and total factor productivity was decline to -0.85 per cent per annum. Growth in output index and input index declining over a period while during the same period, output index declining more than input index. In first period, the growth in output was -1.19 per cent per annum and growth in input index was -6.85 per cent per annum which resulted inclining of total factor productivity to 5.66 per cent per annum. In the second period, the growth of output index was lower than input index and as such, total factor productivity recorded a negative growth rate i.e. -5.91 per cent per annum. In the first period, output growth was negative but higher with proportionately input index therefore the growth of total factor productivity at 5.66 per cent per annum. On the contrary, in the second period, use of inputs was more or less same but growth of output index was decline therefore the growth of total factor productivity decline at -5.91 per cent per annum.

Among eighteen years, seven to eight years were good for production of tur, the best year being 1989-90; However the year 1990-91, 1997-98 and 2004-05 were not favourable for production of tur, the reason might be due to occurance of drought condition during crop season.

Gram

The results of total input index (TII), total output index (TOI) and total factor productivity (TFP) are presented in Table 5.41 and average annual growth rates in Table 5.41 a.

Table 5.41 : Tornqvist – Theil Divisia Index of output, input and TFP of gram

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	37.27	108.95	34.20
1990-91	37.17	108.63	34.21
1991-92	34.65	77.06	44.97
1992-93	73.76	146.91	50.21
1993-94	44.94	100.19	44.86
1994-95	53.18	117.13	45.40
1995-96	46.79	116.33	40.22
1996-97	44.12	89.52	49.28
1997-98	24.17	106.74	22.65
1998-99	96.57	98.53	98.01
1999-2000	42.43	113.42	37.40
2000-01	35.17	105.93	33.77
2001-02	43.97	85.34	51.52
2002-03	35.19	109.69	32.08
2003-04	88.61	184.03	48.15
2004-05	28.89	92.74	31.15

It could be seen from Table 5.40 and 5.40 a that, during period of study total input index was higher than total output index, therefore results total factor productivity was observed to be declining. At overall level, growth in input index was negative (-0.45%) while, growth in output index was also negative (-4.44%) and therefore growth in total factor productivity was negative (-3.99%).

The highest output index was observed in the year 1998-99 (96.57%) and lowest in the year 1997-98 (24.17). On the other hand, the input index was highest in the year 2003-04 (184.03) followed by in 1992-93 (146.91). In all, the input index was higher than output index. At overall level, total factor productivity index was found to be lower than 100. Highest total factor productivity observed in the year 1998-

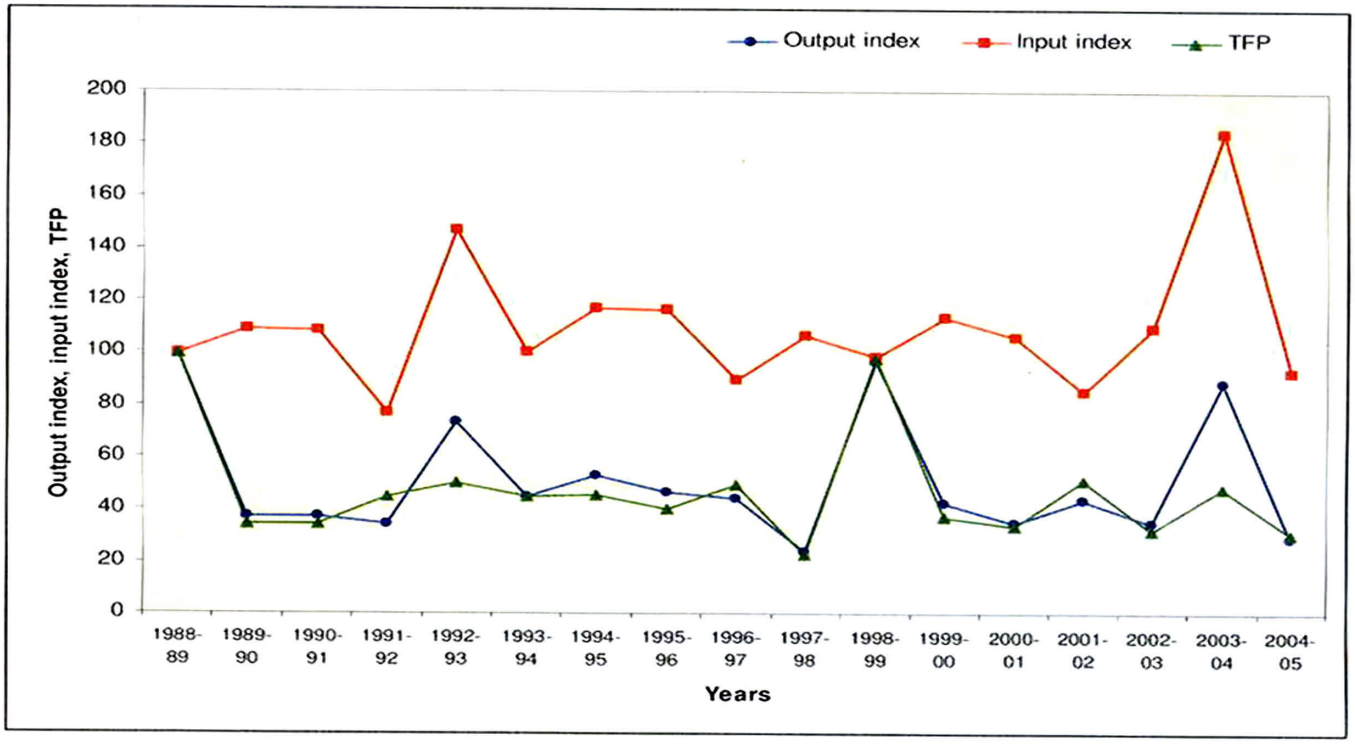

Fig. 22: Tornqvist – Theil Divisia Index of output, input and TFP of gram.

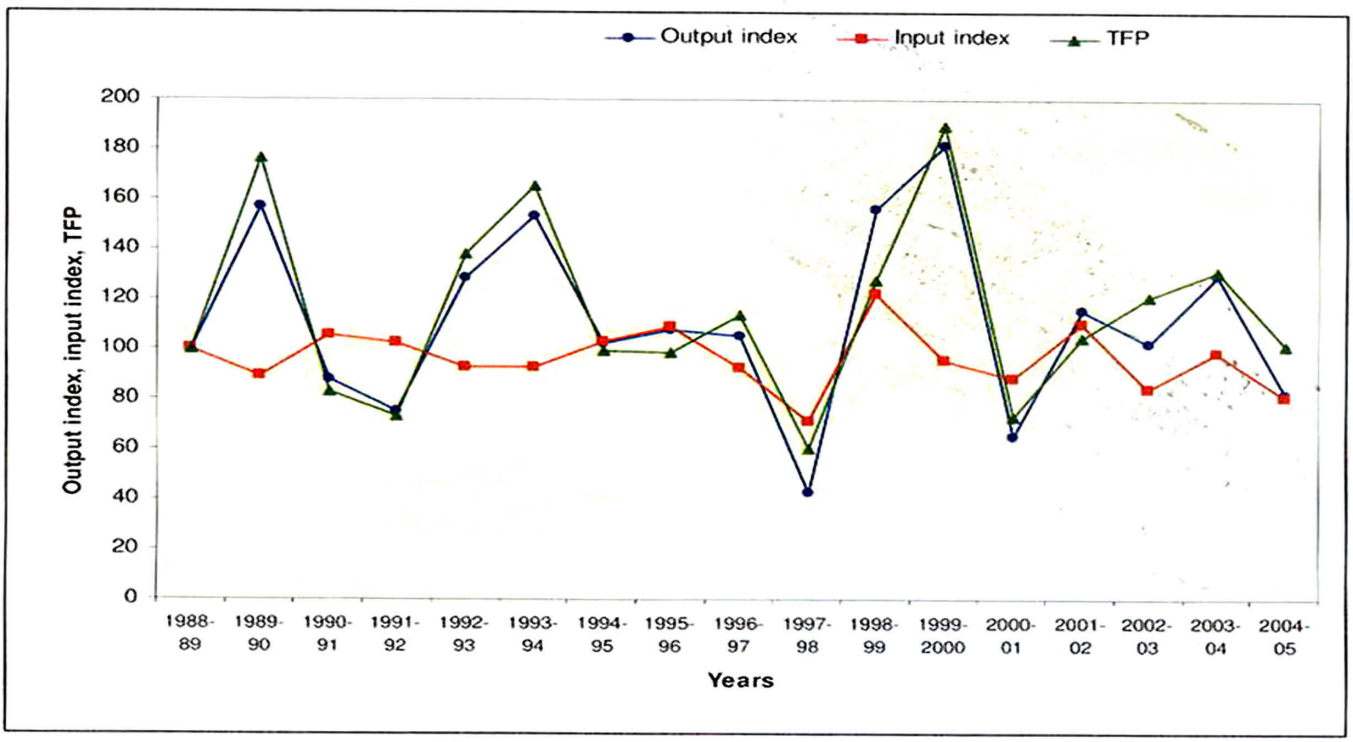

Fig.23 : Tornqvist – Theil Divisia Index of output, input and TFP of cotton.

99 (98.01) where output index was more than input index, while lowest in the year 1997-98 (22.65).

Table 5.41a : Average annual growth rates of output, inputs and TF indices of gram

Period	Output index	Input index	TFP
Overall period	-4.44	-0.45	-3.99
Period I	-7.60	2.33	-9.93
Period II	-1.99	-2.62	0.63

Table 5.41a showed that, over the entire period of study, the output recorded a growth rate of -4.44 per cent per annum. During the same period, input index was negative (-0.45%). Therefore growth of total factor productivity at -3.99 per cent per annum is a resultant of output growth minus the input growth. In the first period, the growth in output was (-7.60%) lower than growth in input (-2.33%). Which resulted a decine of total factor productivity by -9.93 per cent per annum. In the second period, the growth in output index was more than growth in input index. Hence, total factor productivity recorded a growth rate of 0.63 per cent per annum. The decline in total factor productivity during first period, was not only due to low output growth but also due to proportionally high increase in the use of inputs. While, in the second period, output growth was higher with proportionately low input use resulting in the growth of total factor productivity at 0.63 per cent per annum.

Thus, it is implied from the analysis that, the total factor productivity (total factor productivity) in the Eastern Vidarbha Zone for gram declined (-3.99%) during period of study. The growth in output and total factor productivity were affected by the drought that occurred during 1995-96, 1996-97 and 2004-05 resulted in a decline in the productivity. Though gram is a rabi crop, its productivity depend on rainfall received during kharif season.

5.2.4 Central Vidarbha Zone

The cropwise analysis of output, input and total factor productivity index are given below.

Cotton :

The total output index (TOI), total input index (TII) and total factor productivity index (TFP) and its average annual growth rate are presented in Table 5.42 and 5.42a.

Table 5.42 : Tornqvist – Theil Divisia Index of output, input and TFP of cotton

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	156.922	88.95	176.43
1990-91	87.73	105.62	83.06
1991-92	75.11	102.36	73.38
1992-93	128.43	92.77	138.45
1993-94	153.22	92.52	165.60
1994-95	102.25	103.05	99.22
1995-96	108.07	109.22	98.95
1996-97	105.70	92.69	114.04
1997-98	43.162	71.36	60.49
1998-99	156.44	122.27	127.95
1999-2000	181.65	95.61	189.80
2000-01	65.30	88.69	73.62
2001-02	115.96	110.34	105.09
2002-03	102.16	84.24	121.26
2003-04	129.78	98.59	131.64
2004-05	82.63	81.11	101.88

It could be seen from Table 5.42 that, the output index was highest (181.65) in the year 1999-2000 followed in 1989 (156.92), 1998 (156.44) and 153.22 in 1993. While the lowest output index was found (43.16) in the year 1997-98. As regards input index it was highest in the year 1998-99 (122.27) and lowest in the year 1997-98 (71.36) and during the same year output index was also found to be lowest.

The total factor productivity was found to be more than 100 in many years input 1990, 1991, 1993, 1994, 1997 and 2000 years. Amongst eighteen years, total factor

productivity was observed highest in 1999-2000 (189.80) where output index also found to be highest while lowest total factor productivity was observed in the year 1997-98 (60.49) where output index was observed to be lowest and also lower than input index.

Table 5.42a : Average annual growth rates of output, inputs and TFP indices of Cotton

Period	Output index	Input index	TFP
Overall period	-1.09	-1.18	0.10
Period I	1.15	1.32	-0.17
Period II	-2.83	-3.12	0.29

Over the entire period of study the output index recorded a growth rate of -1.09 per cent per annum. During the same period, input was -1.18 per cent per annum which was slightly lower than output index resulted in a incline in total factor productivity by 0.10 per cent per annum. During the first period the growth in output index was 1.15 per cent per annum and growth in input index was 1.32 per cent per annum and total factor productivity recorded a growth rate of -0.17 per cent per annum . In the second period, the growth in output index and input index was decline by -2.83 and -3.12 per cent per annum respectively which resulted in a increase of total factor productivity by 0.29 per cent per annum . The incline in total factor productivity was not only due to output growth but also due to proportionally low increase in the use of inputs.

Thus, study reveals that amongst eighteen years, three years were said to be best i.e. 1989-90, 1993-94 and 1999-2000, where in output index was higher than input index. The reason might be that, in these years actual rainfall received was higher than normal rainfall and timely onset of monsoon while remain five to six years were said to be bad years for production of cotton. This might be because of late onset of monsoon particularly during 1996-97 and 1997-98 and occurance of drought in the year 1997-98.

Soybean

The total output index, total input index and total factor productivity were worked out and presented in Table 5.43 and average annual growth rates of TII, TOI and TFP are presented Table 5.43a.

Table 5.43 : Tornqvist – Theil Divisia Index of output, input and TFP of soybean

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	45.71	111.12	41.13
1990-91	62.57	126.63	49.41
1991-92	30.36	108.55	27.97
1992-93	62.07	117.17	52.97
1993-94	81.52	113.03	72.12
1994-95	24.26	88.04	27.55
1995-96	50.91	99.46	51.19
1996-97	47.30	113.17	41.80
1997-98	33.60	108.15	31.07
1998-99	55.75	92.49	60.28
1999-2000	35.37	89.78	39.40
2000-01	30.03	93.81	32.10
2001-02	37.57	80.13	46.86
2002-03	40.98	104.08	39.38
2003-04	48.17	95.25	50.57
2004-05	24.93	121.39	20.54

Table 5.43 revealed that the output index was lower than input index during all the years. Thereafter total factor productivity was observed to be declining during the period of study. The output index was found to be less than 100 in all the years. However highest output index was observed in the year 1993-94 (81.52) and lowest in the year 1994-95 (24.26) and 2004-05 (24.93). As far as input index are concerned was found highest in the years 1990-91 (126.63) followed by 2004-05 (121.39).

Total factor productivity index was less than 100 in all the years of the study period.

Table 5.43a : Average annual growth rates of output, inputs and TFP indices of soybean

Period	Output index	Input index	TFP
Overall period	-4.69	1.34	-6.03
Period I	-7.01	-0.08	-6.93
Period II	-2.89	2.44	-5.33

Table 5.43 a revealed that, over the entire period of study, the output revealed a decline growth rate of 4.69 per cent per annum . During the same period, input index was increased by 1.34 per cent per annum . Hence total factor productivity recorded a decline growth rate to 6.03 per cent per annum. During first period, the growth in output index was negative (-7.01%) while, the growth in input index was also negative (-0.08%). Hence the total factor productivity recorded a growth rate of -6.93 per cent per annum . While during second period the growth in output index was negative (2.89%) with positive input index (2.44%). Therefore, the total factor productivity recorded a negative growth rate of -5.33 per cent per annum.

The decline in total factor productivity might be due to the occurrence of heavy drought during 1991-92, 1997-98 and 2004-05 as well as late onset of monsoon and dry spell during grain formation caused heavy yield losses in soybean.

Jowar :

Total output index, total input index and total factor productivity and average annual growth rate of output, input and total factor productivity were estimated and presented in Table 5.44 and Table 5.44a.

Table 5.44 revealed that, the output index was found to be highest in the year 1998-99 (198.90), 1996-97 (169.99), 1989-99 (185.00) and it was more than 100 in the years 1992, 1995, 2000, 2001, 2002, 2003 etc. However, it was lowest in the year 1997-98 (57.13). As far as the input index are concerned it was observed highest during the year 1999-2000 (121.78) while it was found to be lowest during the year 2000-01 (81.86). At overall level, input index was higher output input index.

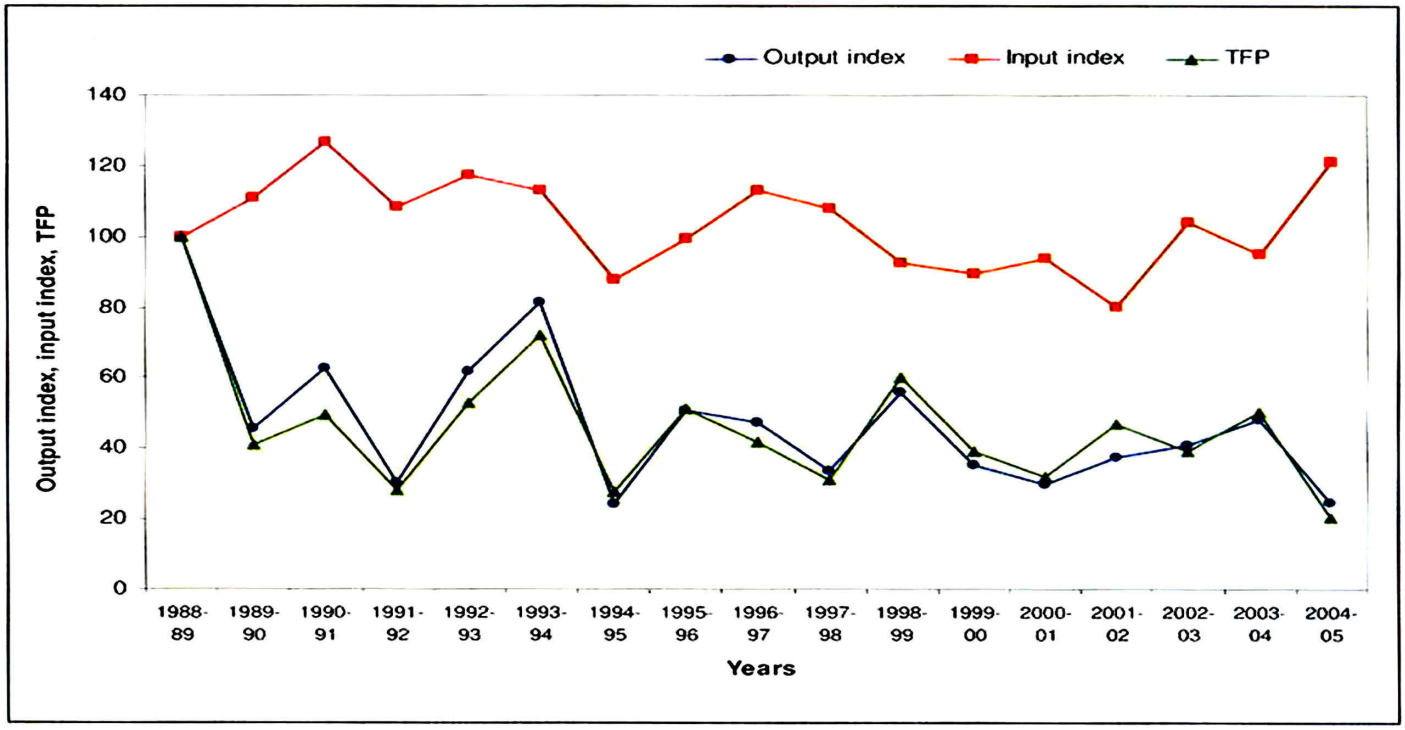

Fig.24 : Tornqvist – Theil Divisia Index of output, input and TFP of soybean.

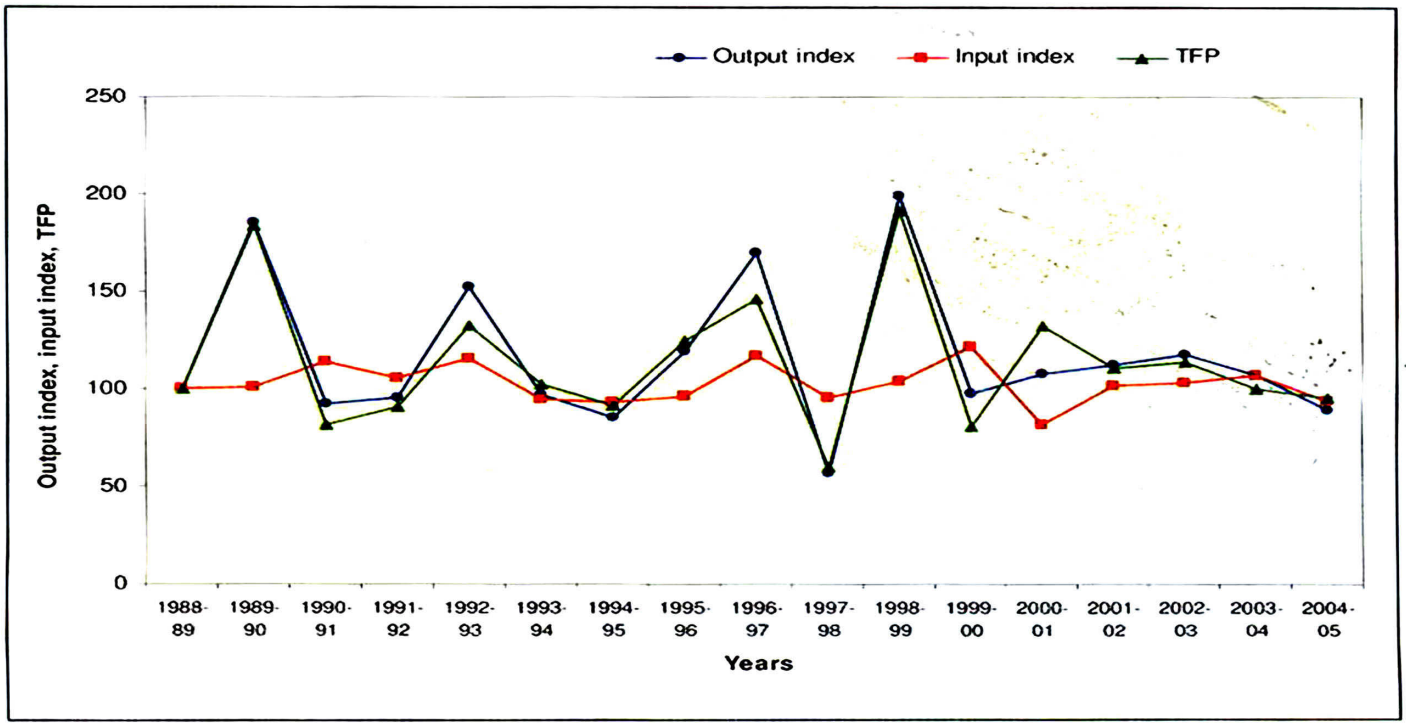

Fig.25 : Tornqvist – Theil Divisia Index of output, input and TFP of jowar

Table 5.44 : Tornqvist – Theil Divisia Index of output, input and TFP of jowar

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	185.004	100.77	183.60
1990-91	92.68	113.60	81.58
1991-92	95.72	105.65	90.60
1992-93	152.47	115.31	132.23
1993-94	96.80	94.58	102.34
1994-95	85.35	93.23	91.55
1995-96	119.60	96.24	124.28
1996-97	169.99	116.58	145.82
1997-98	57.13	95.44	59.86
1998-99	198.90	103.68	191.83
1999-2000	98.05	121.78	80.52
2000-01	108.03	81.86	131.94
2001-02	112.43	101.84	110.39
2002-03	117.61	103.01	114.17
2003-04	107.02	107.17	99.87
2004-05	89.02	93.64	95.07

Total factor productivity index was highest (191.83) during the year 1998-99 where output index was also observed highest in the same year. Whereas, it was found to be lowest (59.86) during the year 1997-98. Where, output index was also lowest during period of study. All the year total factor productivity was found to be more than 100, except during 1990, 1991, 1994, 1997, 1999, 2003 and 2004.

Over the entire period (1987-88 to 2004-05) of study the output index recorded a decline growth rate to 0.69 per cent per annum. During the same period, the growth rate in input index was declining by 0.40 per cent per annum. The growth of total factor productivity found to be declining at 0.29 per cent which is a resultant of output growth at -0.69 per cent per annum minus the input growth at the rate of -0.40 per cent per annum .

The growth in output and input indices explain the behaviour in total factor

productivity growth. The growth in output index was marginally lower than the growth in input index which resulted in a decline of total factor productivity by 0.29 per cent per annum over a period of study.

Table 5.44a : Average annual growth rates of output, inputs and TFP indices of jowar

Period	Output index	Input index	TFP
Overall period	-0.69	-0.40	-0.29
Period I	2.80	-0.54	3.34
Period II	-3.40	-0.29	-3.11

In the first period, the growth in output index was (2.80%) higher than the growth in input index (-0.54%). Hence, total factor productivity recorded a growth rate of 3.34 per cent per annum. In the second period, the growth of output was (-3.40%) lower than the growth in input index (-0.29%) with resulted in a decline of total factor productivity by 3.11 per cent per annum. The decline in total factor productivity was not only due to low output growth but also due to proportionally high increase in the use of inputs.

During second period and overall period of study. On the contrary, in the first period output growth was higher with proportionately low input use resulting in the growth of total factor productivity at 3.34 per cent per annum.

In the Central Vidarbha zone, the production of Jowar was found to decline over the period and second period of study. While it increase during first period. Thus it is concluded from analysis that, for production of Jowar in CVZ, four to five years were said to be best year while six to seven year were bad years and remaining years were average years. The decline in total factor productivity might be due to the occurance of drought during 1990-91, 1997-98 and 2004-05.

Tur :

The total output index (TOI), Total input index (TII) and Total factor productivity (TFP) and their average annual growth rate are presented in Table 5.45 and

Table 5.45a.

Table 5.45 : Tornqvist – Theil Divisia Index of Output, Input and TFP of tur

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	98.39	71.69	137.24
1990-91	62.16	91.42	67.99
1991-92	70.89	71.64	98.96
1992-93	124.15	80.32	154.57
1993-94	104.161	76.78	135.66
1994-95	61.35	71.04	86.36
1995-96	102.42	77.63	131.91
1996-97	80.45	70.70	116.79
1997-98	49.98	71.84	69.57
1998-99	155.37	83.23	186.69
1999-2000	98.94	73.29	134.99
2000-01	83.72	66.05	126.75
2001-02	100.73	88.56	113.75
2002-03	89.78	74.05	94.25
2003-04	75.35	72.78	103.53
2004-05	61.100	90.06	67.85

As observed from Table 5.45 that, the output index was highest (155.37) in the year 1998-99 and lowest in the year 1997-98 (49.98). Likewise, the input index was highest in the year 1991-92 (91.42) and 2004-05 (90.06), while it was lowest in the year 2000-01 (66.05). The input index was found to be less than 100 in all the years of study. While output index was more than 100 in the years 1992, 1993, 1995, 1998 and 2001.

Total factor productivity index was observed more than 100 in many years of study period.

It was highest in the year 1998-99 (186.69) where output index was also found to highest. Total factor productivity was lowest during the year 1990-91 (67.99).

Over the entire period of study the output index recorded a growth rate of -

2.43 per cent per annum. During the same period input index decreased to -0.62 per cent per annum. The total factor productivity decreased to -2.21 per cent per annum. In the first period, the growth in output index was (0.35%) higher than growth in the input index (-3.20%). Hence, total factor productivity recorded a growth rate of 3.55 per cent per annum. This indicates that, in this period output growth was higher with proportionately low input use resulting in the growth of total factor productivity at 3.55 per cent per annum. However, in the second period, the growth in output index lower than the growth in input index which resulted in decline of total factor productivity to 5.98 per cent per annum. During second period, the decline in total factor productivity was not only due to low output growth but also due to proportionately high increase in the use of inputs.

Table 5.45a : Average annual growth rates of output, inputs and TFP indices of tur

Period	Output index	Input index	TFP
Overall period	-2.43	-0.62	-2.21
Period I	0.35	-3.20	3.55
Period II	-4.60	1.38	-5.98

At overall level, decline in total factor productivity might be due to long dry spell during 1996-97 and actual rainfall received was less than normal rainfall during the years 1991-92, 1995-96, 1996-97 and 2004-05 while late onset of monsoon during the year 1997-98 etc.

Thus the study reveals that, production of tur in Central Vidarbha Zone was found highest in the year 1998-99 and these years are said to be best years for tur followed by year 1992, 1989, 1993 while remaining years were unfavourable for production of tur.

Gram :

Total output index, total input index and total factor productivity were estimated and presented in Table 5.46 and average annual growth rates of TOI. TII and total factor productivity presented in Table 5.46a.

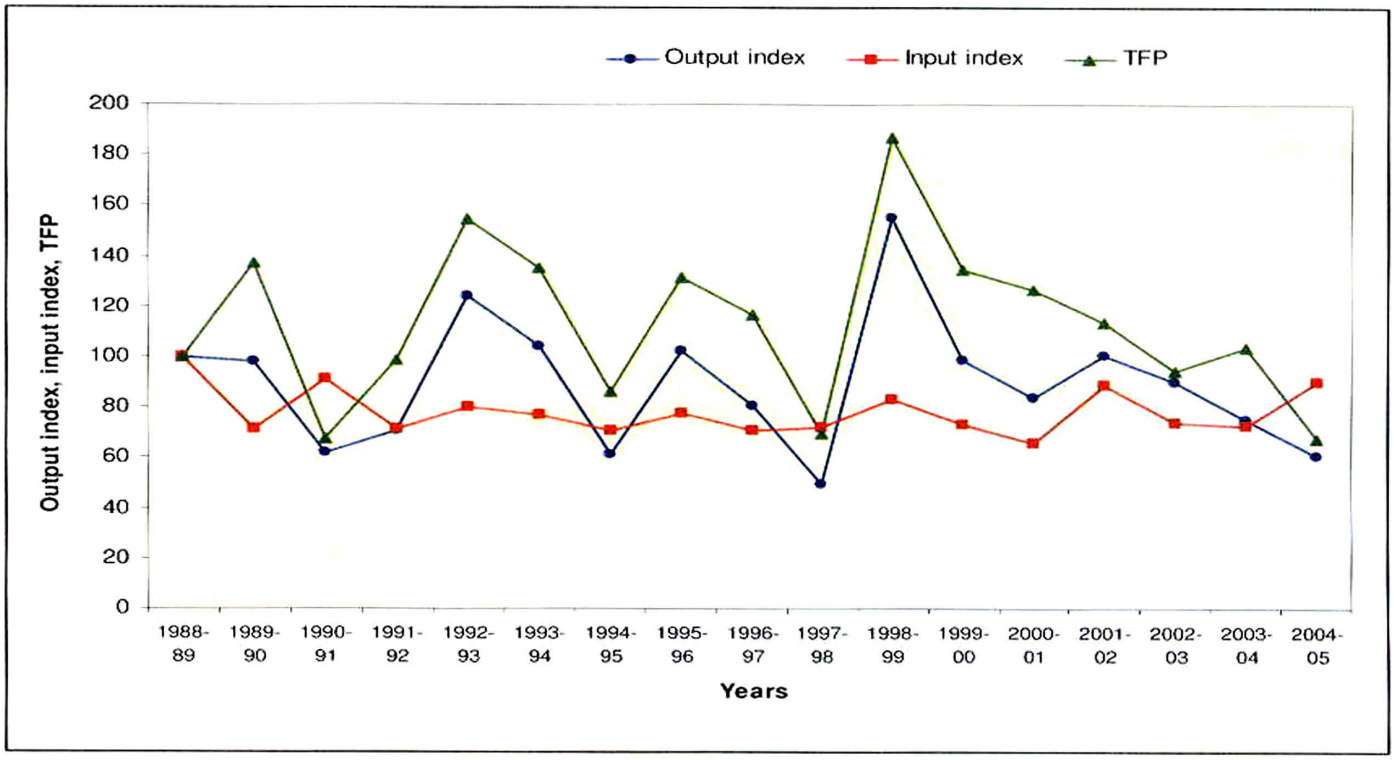

Fig.26 : Tornqvist – Theil Divisia Index of output, input and TFP of tur

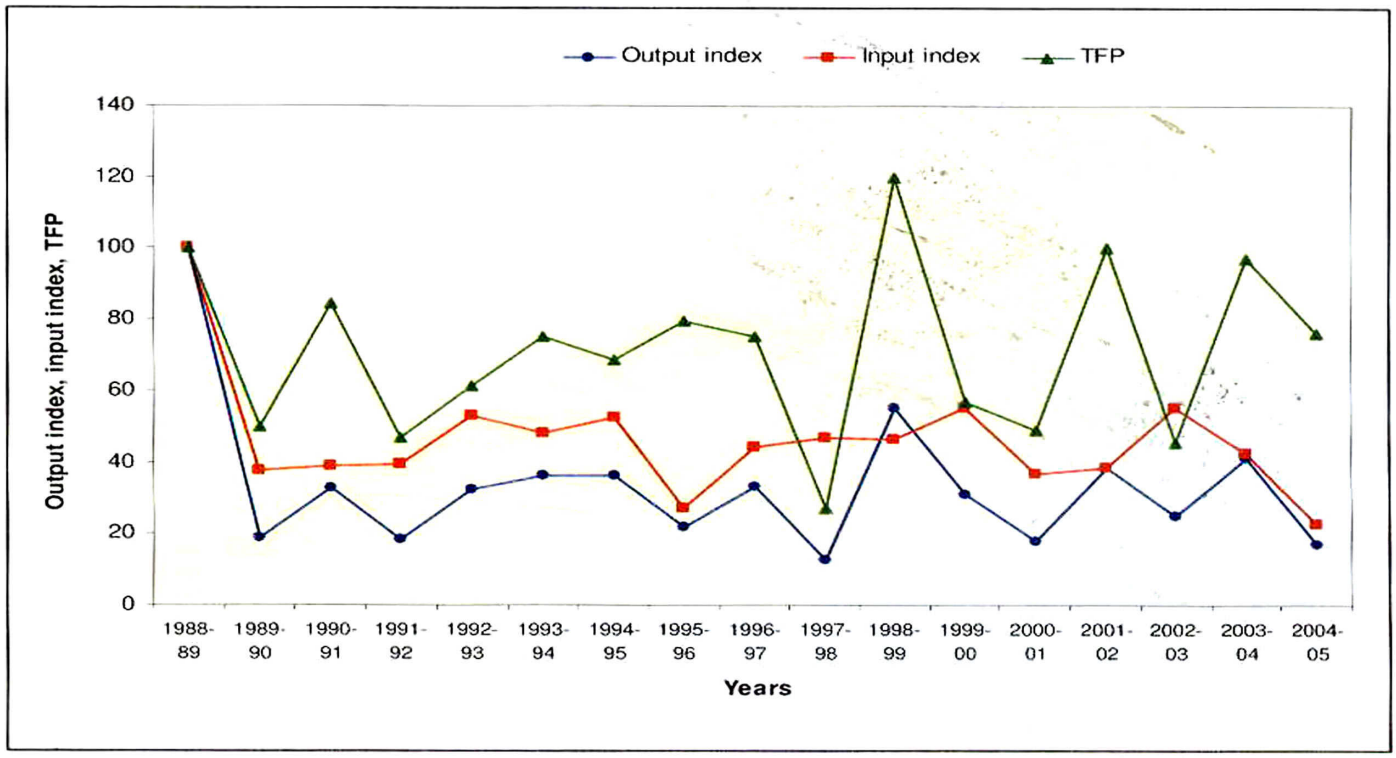

Fig.27 : Tornqvist – Theil Divisia Index of output, input and TFP of gram

Table 5.46 : Tornqvist – Theil Divisia Index of output, input and TFP of gram

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	18.82	37.65	49.98
1990-91	32.89	38.96	84.44
1991-92	18.48	39.46	46.83
1992-93	32.42	52.78	61.42
1993-94	36.18	48.01	75.35
1994-95	36.15	52.49	68.87
1995-96	21.73	27.23	79.81
1996-97	33.18	44.17	75.11
1997-98	12.61	46.77	26.95
1998-99	55.33	46.24	119.67
1999-2000	31.28	55.20	56.66
2000-01	17.98	36.71	48.99
2001-02	38.38	38.37	100.06
2002-03	25.14	55.26	45.49
2003-04	41.23	42.52	96.96
2004-05	16.95	22.67	76.12

It could be seen from Table 5.46 that, the output index was found to be less than 100 during period of study. However it was found to be highest (55.33) during the year 1998-99 and lowest (12.61) during the year 1997-98.

Similarly input index was also found to less than 100 during period of study. However, it was highest during 2002-03 and 1999-2000 and lowest during 2004-05.

As regards to total factor productivity it was more than 100 during the year 1998-99 (119.67) and the year 2001-02 (100.06). While it was lowest (26.95) in the year 1997-98. Where output index was found to be lowest during period of study.

Further Table 5.46a shows that at overall level, the growth in output under was negative (-5.19%) and growth in input index was also decline by 4.86 per cent per annum. Hence total factor productivity recorded declining growth rate at 0.33 per cent

per annum.

During first period, the growth in output index was marginally lower than the growth in input index with resulted in a decline of total factor productivity by 0.78 per cent per annum. In the second period, the growth in output index was negative (-0.53) but slightly higher than growth in input index (-0.65). Hence, total factor productivity recorded a growth rate of 0.12 per cent per annum.

Table 5.46a : Average annual growth rates of output, inputs and TFP indices of gram

Period	Output index	Input index	TFP
Overall period	-5.19	-4.86	-0.33
Period I	-11.18	-10.40	-0.78
Period II	-0.53	-0.65	0.12

Thus the analysis concluded that amongst eighteen years, only two years were said to be best years i.e. 1998-99 and 2001-02 for production of gram in Central Vidarbha Zone. While, the year 1997-98 considered bad year for gram. The reason behind decline in total factor productivity during study period was due to occurance of drought during 1991-92 and 1997-98 and failure of rain in time and less normal rainfall during year 2004-05. Further, hail storm damage the gram crop during 1997-98. In general the total factor productivity of gram were never more than 1988-89.

5.4.3 Western Vidarbha Zone :

Cotton :

The total output index, total input index and total factor productivity were worked out and presented in Table 5.47 and average annual growth rates of output, input and total factor productivity presented in Table 5.47 a.

Table 5.47 : Tornqvist – Theil Divisia Index of output, input and TFP of cotton

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	172.49	125.25	137.71
1990-91	96.56	162.14	63.63
1991-92	56.35	81.19	69.41
1992-93	192.50	88.19	206.95
1993-94	162.67	105.65	153.97
1994-95	107.70	105.94	101.67
1995-96	107.23	114.27	93.84
1996-97	110.30	114.18	96.60
1997-98	43.98	82.70	53.18
1998-99	148.07	93.74	157.96
1999-2000	152.84	99.76	153.20
2000-01	55.57	91.02	61.06
2001-02	167.64	65.14	257.20
2002-03	110.03	127.95	85.99
2003-04	83.38	74.05	112.59
2004-05	100.66	176.78	56.94

It could be seen from Table 5.47 that, the output index was found to be more than 100 in all the years except 1990 (96.56), 1991 (56.35), 1997 (47.98), 2000 (55.57) and 2003 (83.83). It was found to highest (192.50) during the year 1992-93 followed by 1989-90 (172.49) and 2001-02 (167.64) etc. However, it was found to be lowest in the year 1997-98. Regarding input index, it was highest in the year 2004-05 (176.78) and lowest in the year 2003-04 (74.05).

The total factor productivity index was highest in the year 2001-02 (257.20) and lowest (53.18) during the year 1997-98.

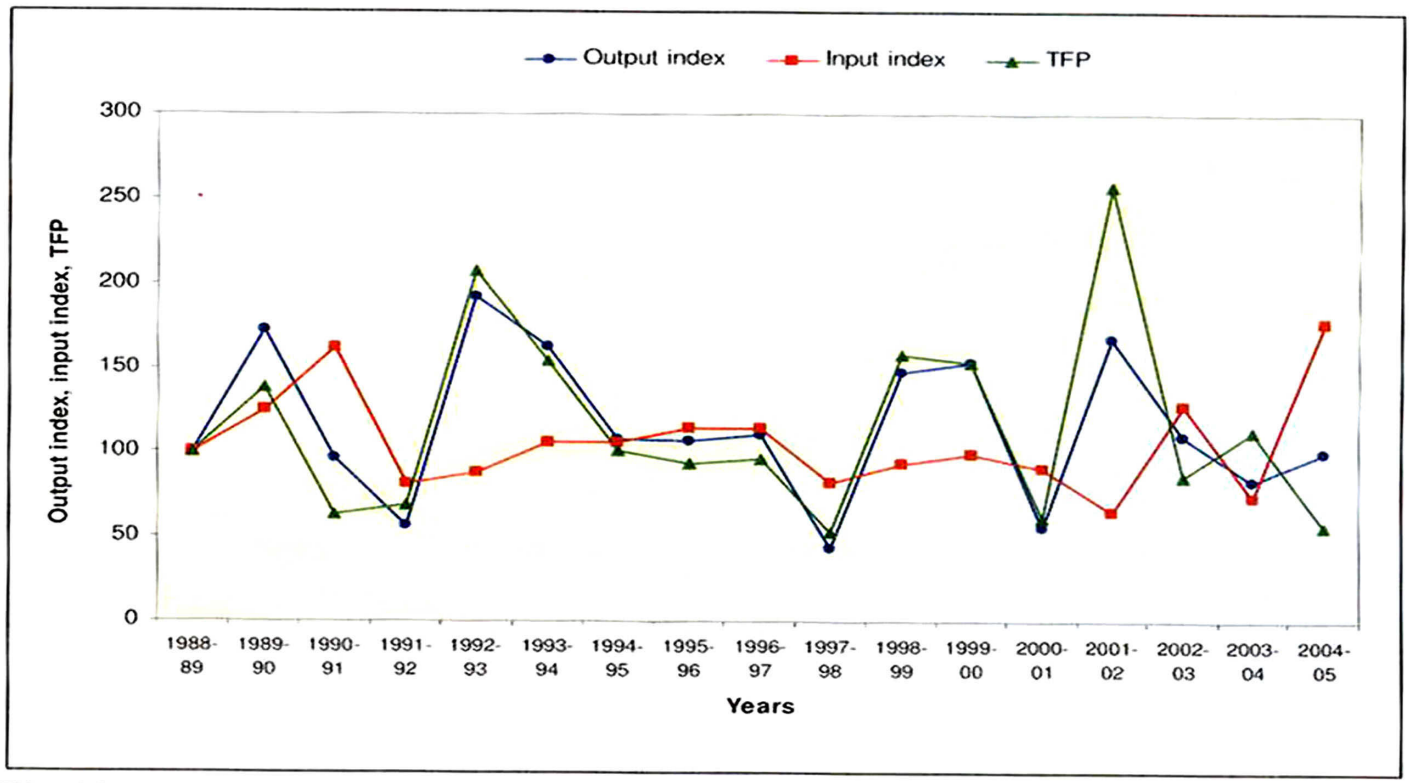

Fig.28 : Tornqvist – Theil Divisia Index of output, input and TFP of cotton

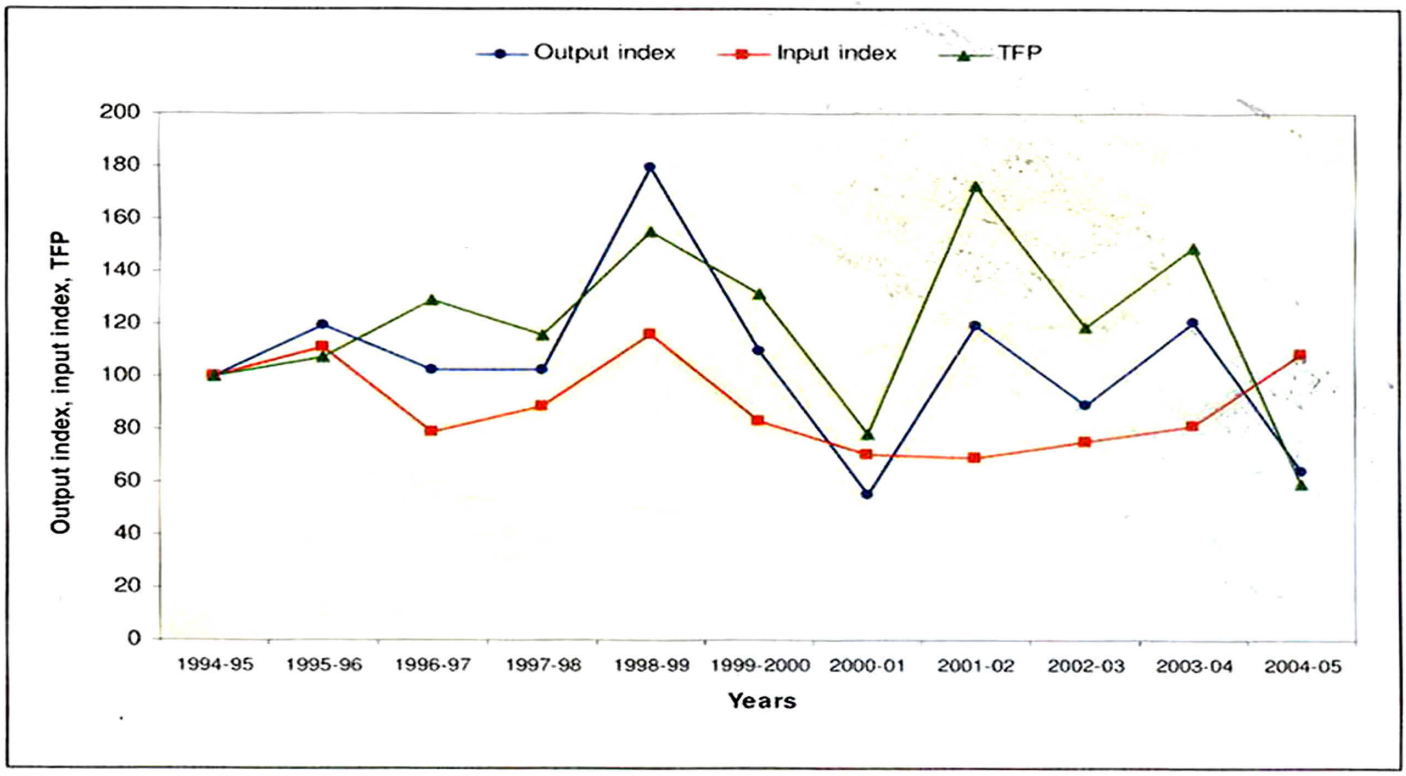

Fig.29 : Tornqvist – Theil Divisia Index of output, input and TFP of soybean

Table 5.47a : Average annual growth rates of output, inputs and TFP indices of Cotton

Period	Output index	Input index	TFP
Overall period	0.04	4.79	-4.75
Period I	1.03	2.04	-1.01
Period II	-0.73	6.95	-7.68

Table 5.47a revealed that, over the entire period of study the output index recorded a growth rate of 0.04 per cent per annum. During the same period, input index was increased to 4.79 per cent per annum. Hence, total factor productivity recorded a declining growth rate of 4.75 per cent per annum. In the first period, the growth in output index was (1.03%) which was lower than the growth in input index (2.04%) which resulted in a decline of total factor productivity by 1.01 per cent per annum. Same trend was found in second period where growth in output index decline by 0.73 per cent per annum and growth in input index increased by 6.95 per cent per annum. Hence, total factor productivity recorded a decline growth rate to 7.68 per cent per annum.

Thus, it is concluded that, the total factor productivity (TFP) of cotton decreased during the period of study. At overall level, growth in output was lower than the growth in input. The growth in output and total factor productivity were interrupted by the drought that occurred during 1991-92, 1997-98 and 2004-05 resulting in decline in the productivity.

Soybean :

The total output, total input and total factor productivity indices were computed for the year 1993-94 to 2004-05 and results are presented in Table 5.48 and Table 5.48a.

Table 5.48 : Tornqvist – Theil Divisia Index of output, input and TFP of soybean

Year	Output index	Input index	TFP
1994-95	100.00	100.00	100.00
1995-96	119.25	110.90	107.53
1996-97	102.17	79.01	129.31
1997-98	102.13	88.44	115.48
1998-99	179.48	115.67	155.17
1999-2000	109.57	83.26	131.60
2000-01	54.89	70.27	78.11
2001-02	119.34	68.97	173.03
2002-03	89.28	75.12	118.86
2003-04	120.88	81.08	149.08
2004-05	64.20	108.62	59.16

Table 5.49 revealed that, total output index was found to be highest during the year 1998-99 (179.48), while it was lowest in the year 2000-01 (54.89). The output index was more than 100 during most of the year of study. However, the input index was found to be more than 100 during 1995-96, 1998-99 and 2004-05 and it was observed highest in the year 1998-99 (115.67).

Table 5.48a : Average annual growth rates of output, inputs and TFP indices of Soybean

Period	Output	Input	TFP
Overall period	-3.58	0.85	-4.43
Period I	1.91	-3.35	5.26
Period II	-9.06	5.05	-14.11

The total factor productivity index in soybean was found to be more than 100 in all the years except during 2000-01 (78.11) and 2004-05 (59.16). The highest total factor productivity was found in the year 2001-02 (173.03) where input index was half to output index.

Over the entire period of study the output recorded a declined growth rate of -3.58 per cent per annum. During the same period, input index increased by 0.85 per cent per annum. Therefore total factor productivity decline by 4.43 per cent per annum. During the first period of growth in output index increased by 1.91 per cent per annum and the growth in input index was declined to 3.35 per cent per annum which resulted in a growth in total factor productivity at 5.26 per cent per annum. However, in the second period, the growth in output index was lower (-9.06%) than growth in input index (5.05%), which resulted in a decline of total factor productivity by 14.11 per cent per annum. The decline in total factor productivity was not only due to low output growth but also due to the proportionally high increase in the use of inputs.

Thus it is revealed from the analysis that, for the production of soybean in Western Vidarbha Zone, two to three years were said to be best years among twelve years. While three years were said to be bad years and remaining years were average years for soybean production. The decline in total factor productivity might be due to less rainfall received during the year 2004-05 and heavy infestation of aphids observed during 2000-01.

Jowar

The Tornquist Theil Divisa chained indices were computed to assess the growth and results are presented in Table 5.49 and Table 5.49a.

It could be seen from Table 5.49 that, output index was found to be more than 100 in all the years except 1991-92 (92.68) and 1997-98 (98.74). The output index was observed highest during the year 1992-93 (406.24) followed by 1989-90 (360.27) etc. However, it was found lowest (92.68) in the year 1991-92. The input index found to be highest in the year 1996-97 (129.60) while, it was lowest in the year 1993-94 (93.26). At overall level, it was observed that, output index was higher than input index.

Table 5.49 : Tornqvist – Theil Divisia Index of output, input and TFP of jowar

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	360.27	121.48	288.32
1990-91	139.23	107.84	129.34
1991-92	92.68	99.33	93.31
1992-93	406.24	121.16	336.29
1993-94	111.62	93.26	119.91
1994-95	160.79	97.28	166.28
1995-96	143.07	96.46	148.33
1996-97	255.63	129.60	197.24
1997-98	98.74	100.07	98.67
1998-99	177.60	97.55	182.06
1999-2000	166.62	110.14	143.93
2000-01	161.68	96.01	168.39
2001-02	160.60	116.66	137.84
2002-03	180.59	100.91	178.96
2003-04	163.54	119.44	137.01
2004-05	111.26	96.60	112.84

Table 5.49a : Average annual growth rates of output, inputs and TFP indices of Jowar

Period	Output index	Input index	TFP
Overall period	0.70	-0.09	0.79
Period I	6.15	-0.51	6.66
Period II	-3.53	0.24	-3.77

The total factor productivity index was found to be more than 100 for all the years except for years 1991-92 (93.31) and 1997-98 (98.67). The highest total factor productivity was observed during 1992-93 (336.29) whereas it was found lowest in year

1991-92.

The growth in output and input indices explain the behaviour in total factor productivity growth. At overall level of study the output recorded a growth rate of 0.70 per cent per annum and input recorded a growth rate of negative (-0.09%) which resulted in a incline of total factor productivity by 0.79 per cent per annum. In the first period, the growth in output was higher (6.15 %) than growth in input (-0.51%) which resulted in a increase in total factor productivity to 6.66 per cent per annum. During the second period, the growth in output index was (-3.53%) lower than growth in input index. Hence, total factor productivity recorded a decline growth rate of 3.77 per cent per annum. During the first period growth in total factor productivity was 6.66 per cent per annum which decline during second period.

Thus it can be concluded from the study that, at overall level, the production of Jowar in Wester Vidarbha Zone was satisfactory. Among eighteen years of study two years were said to bad whereas five to six years best and remaining years were average year for production of Jowar in WVZ. The decline in total factor productivity in second period might be due to heavy dry spell during 1997-98.

Tur :

The Tornqvist – Theil Divisia Chained indices were computed to assess the growth and the results are presented in Table 5.50 and Table 5.50a.

Table 5.50 revealed that, the output index was observed more than 100 in the year 1991 (148.11), 1992 (111.21), 1995 (111.52) and 1998 (118.08). Among the year, the output index was found to be highest in the year 1992-93 (148.11) whereas it was lowest during 1990 (48.64). The input index was recorded highest in the year 1993-94 (102.92) and for remaining year it is less than 100.

It could be seen from Table 5.50 that, the total factor productivity index was found to be more than 100 during 1992-93, 1993-94, 1995-96, 1998-99 and 2002-03. It was found to be highest in the year 1992-93 (183.68) and lowest during the year 1990-91 (56.01) where output index also found lowest.

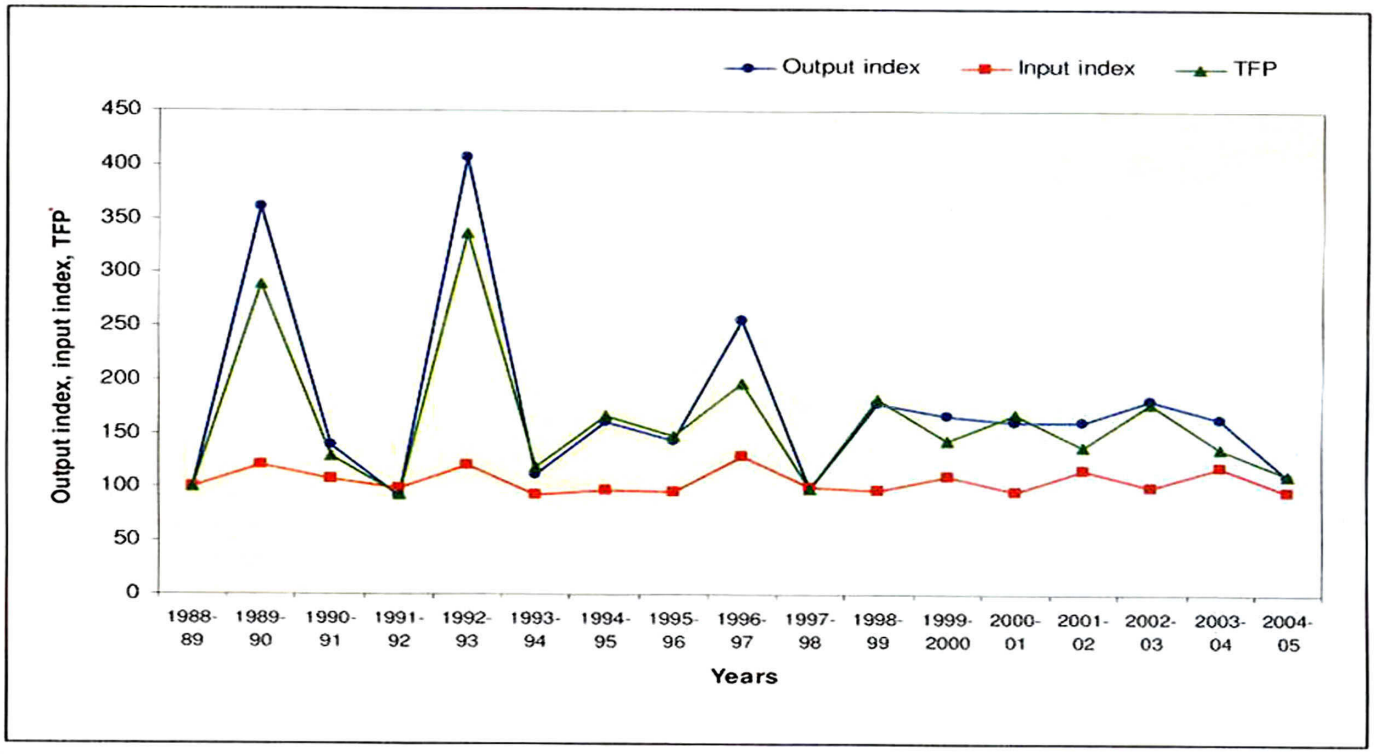

Fig. 30: Tornqvist – Theil Divisia Index of output, input and TFP of jowar

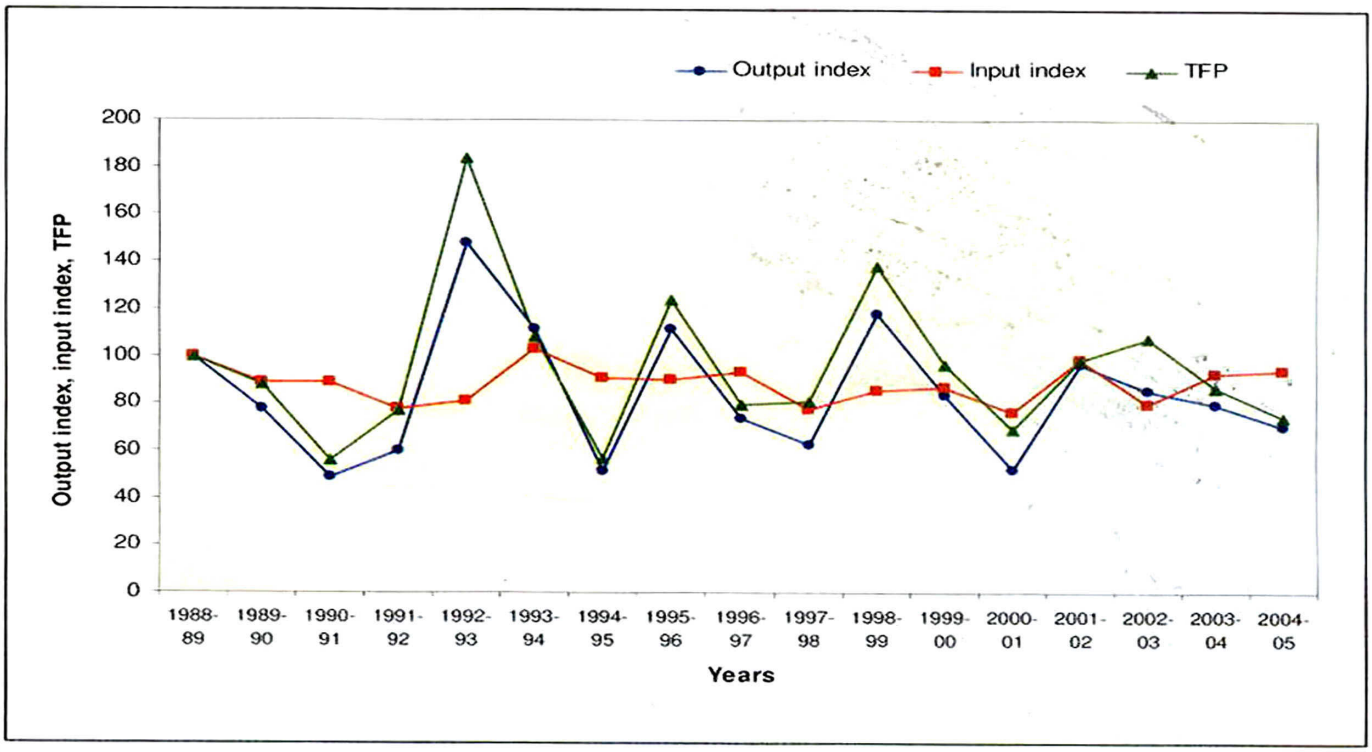

Fig.31: Tornqvist – Theil Divisia Index of output, input and TFP of tur

Table 5.50 : Tornqvist – Theil Divisia Index of output, input and TFP of tur

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	77.64	88.35	87.92
1990-91	48.64	88.34	56.01
1991-92	59.61	77.39	77.02
1992-93	148.11	80.63	183.68
1993-94	111.21	102.92	108.06
1994-95	51.23	90.31	56.73
1995-96	111.52	89.97	124.08
1996-97	73.88	93.06	79.40
1997-98	62.77	77.39	81.10
1998-99	118.08	85.35	138.34
1999-2000	83.45	86.64	96.43
2000-01	52.35	75.96	68.89
2001-02	96.59	98.06	98.50
2002-03	85.21	79.40	107.31
2003-04	79.79	92.36	86.93
2004-05	*70.39*	*94.07*	*74.33*

It could be observed from Table 5.50 a that, at overall period the growth of output index decline at 1.85 per cent per annum. In the same period input index also decline to 0.37 per cent per annum. Therefore resultant total factor productivity also decline to 1.48 per cent per annum. In the first period, the growth of output was higher (1.66%) than the growth in the input (-1.44%). Hence, total factor productivity recorded a growth rate of 3.10 per cent per annum. In the second period, the growth of output was lower (-4.56%) than the growth in input (0.46%) which resulted in a decline of total factor productivity by 5.02 per cent per annum. The decline in total factor productivity during overall and second period not only due to low output growth but also due to proportionally high increase in the use of inputs.

Table 5.50a : Average annual growth rates of output, inputs and TFP indices of tur

Period	Output index	Input index	TFP
Overall period	-1.85	-0.37	-1.48
Period I	1.66	-1.44	3.10
Period II	-4.56	0.46	-5.02

The analysis shows that amongs eighteen years, five years were said to be best years for the production of tur in Western Vidarbha Zone. Decline in total factor productivity in tur was found during overall period. Thus might be due to the actual rainfall received were less than normal rainfall during some of years and long dry spell during crop season.

Gram :

The Tornqvist – Theil Divisia chained indices of output, input and total factor productivity were computed to assess the growth and the results are presented in Table 5.51 and Table 5.51a.

It could be seen from Table that, the output index was found to be highest in the year 1992-93 (103.01) whereas for all the years it was less than 100. While, it was found to be lowest during 1997-98 (19.68). similarly input index was observed to be highest in the year 1992-93 (103.61) and lowest during the year 2001-02 (40.63). As far as, the total factor productivity concerned, it was found to be more than 100 during the years 1993-94 (118.92) and 2001-02 (170.14).

From Table 5.51a it is revealed that, over the entire period of study the output recorded a growth rate of -4.70 per cent per annum. During the same period, input index decline 2.29 per cent per annum. The growth of total factor productivity at -2.4 per cent per annum is a results of output growth minus the input growth. During first period, the growth in output index decline to 10.13 per cent per annum which was lower than the growth in input index which resulted in a decline of total factor productivity by 5.16 per cent per annum. During second period, the growth of output was -0.47 per cent while growth in input was -0.21 per cent per annum. Hence total factor productivity recorded a growth rate of -0.26 per cent per annum. The decline in total factor productivity was not

only due to low output growth but also due to proportionally high increase in the use of inputs.

Table 5.51 : Tornqvist – Theil Divisia Index of output, input and TFP of gram

Year	Output index	Input index	TFP
1988-89	100.00	100.00	100.00
1989-90	24.72	72.65	33.34
1990-91	54.13	86.33	62.71
1991-92	43.43	60.61	71.65
1992-93	103.01	103.61	99.43
1993-94	90.01	76.69	118.92
1994-95	33.39	86.99	38.92
1995-96	29.09	65.19	44.62
1996-97	54.45	80.66	67.50
1997-98	19.68	56.52	34.81
1998-99	97.91	100.65	97.28
1999-2000	38.86	77.17	51.65
2000-01	22.88	50.17	26.98
2001-02	69.12	40.63	170.14
2002-03	41.00	69.62	58.89
2003-04	37.25	66.86	55.71
2004-05	24.84	63.30	39.25

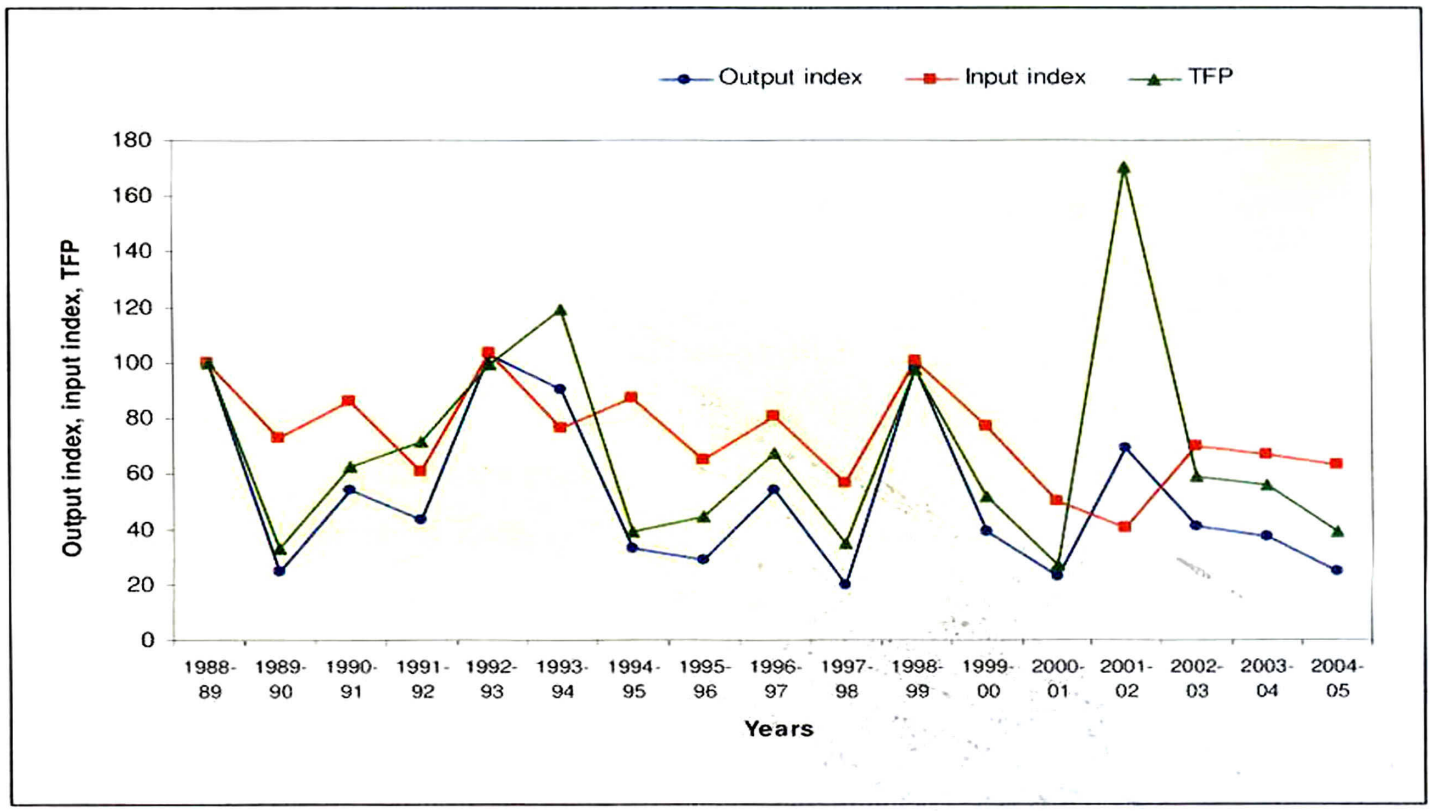

Fig.32 : Tornqvist – Theil Divisia Index of output, input and TFP of gram

Table 5.51a : Average annual growth rates of output, inputs and TFP indices of gram

Period	Output index	Input index	TFP
Overall period	-4.70	-2.29	-2.4
Period I	-10.13	-4.17	-5.16
Period II	-0.47	-0.21	-0.26

Thus could be concluded from the analysis that, for the production of gram in Wester Vidarbha Zone only two years were said to best year i.e. 1993-94 and 2001-02. Decline in total factor productivity might be due to occurance of drought condition during the year 1991-92, 1997-98 and 2004-05. Heavy rainfall during crop season reduce yield of gram in the year 2000-01 etc.

5.5 Factors influencing total factor productivity growth

In order to examine the effect of different factors on total factor productivity growth, log linear regression equation were fitted as given in methodology. The zonewise results obtained are presented below.

5.51 Eastern Vidarbha Zone :

The factors influencing total factor productivity growth in Eastern Vidarbha Zone are presented in Table 5.52.

It may be observed from Table 5.52 that, percentage of net cultivated area under irrigation had positive and significant influence on total factor productivity. Thus, for one per cent increase in net irrigated area, the total factor productivity would increased by 1.81 per cent, as increased irrigation facility enhances productivity. Similarly, factors like road density, annual rainfall and net cultivated area under high yielding varieties (HYV) were positive and significant i.e. by increasing one per cent of these factors, would increase total factor productivity to the extent of 2.98, 5.42 and 0.78 per cent respectively.

Table 5.52 : Factors influencing total factor productivity growth in Easter Vidarbha Zone

Variables	Parameter estimate (bi)
Intercept	0.79 (3.22)
Amount of loan (Rs. in lakh)	-0.90** (0.38)
Irrigation pump sets (No.)	-1.27 (1.15)
Tractor (No.)	-0.21 (0.69)
Net Cultivated Area under irrigation ('000' ha)	1.81* (1.03)
Road density (km/ha)	2.98* (1.55)
Annual rainfall (mm)	5.42*** (1.61)
Net Cultivated Area under HYV('000' ha)	0.78** (0.38)
$R^2 = 0.64$	

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

(Note : Figures in the parenthesis indicate the value of standard error.)

Amount of loan had negative association with total factor productivity thereby indicating that it would decrease by 0.90 per cent with a increase in loan by one per cent.

From the analysis it is concluded that, the net cultivated area under irrigation, road density, annual rainfall and net cultivated area under high yielding varieties were the important factors influcing the TFP growth.

5.5.2 Central Vidarbha Zone

The results of log linear function fitted for the Central Vidarbha Zone as below are presented in Table 5.53.

Table 5.53 revealed that, among different factors under study the factors like net irrigated area, road density and rainfall were positive and significant. Thereby indicated that these factors are responsible in causing variation in total factor productivity. The regression coefficient of these factors were 0.23, 3.52 and 0.58 per cent

respectively.

While, the factors like, net cultivated area under high yielding varieties had a negative and significant influence on total factor productivity, which implied that a one per cent increase in net cultivated area under high yielding variety, total factor productivity would decline by 3.02 per cent. Similar results was also observed by Siddalingappa *et al.* (2002) where in total factor productivity and net cultivated area under high yielding varieties were associated negatively.

Table 5.53 : Factors influencing total factor productivity growth in Central Vidarbha Zone

Variables	Parameter estimate (bi)
Intercept	-5.45 (3.16)
Amount of loan (Rs. in lakh)	0.05 (0.36)
Irrigation pump sets (No.)	0.58 (1.35)
Tractor (No.)	-0.86 (0.50)
Net Cultivated Area under irrigation ('000' ha)	0.23* (0.12)
Road density (km/ha)	3.52* (2.02)
Annual rainfall (mm)	0.58* (0.32)
Net Cultivated Area under HYV('000' ha)	-3.02*** (1.23)
R^2 = 0.59	

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

(Note : figures in the parenthesis are the value of standard error.)

Thus from the analysis it is concluded that, among different factors, net cultivated area under irrigation, road density and annual rainfall were found to be positive influence on total factor productivity. While, net cultivated area under high yielding varieties would reduce the total factor productivity growth in the zone.

5.5.3 Western Vidarbha Zone

The factors influencing total factor productivity growth in Western Vidarbha Zone are presented in Table 5.54.

Table 5.54 : Factors influencing total factor productivity growth in Western Vidarbha Zone

Variables	Parameter estimate (bi)
Intercept	6.58 (4.10)
Amount of loan (Rs. in lakh)	0.27* (0.13)
Irrigation pump sets (No.)	-4.52** (1.82)
Tractor (No.)	1.49* (0.78)
Net Cultivated Area under irrigation ('000' ha)	-1.68** (0.78)
Road density (km/ha)	1.47* (0.77)
Annual rainfall (mm)	0.08 (0.78)
Net Cultivated Area under HYV('000' ha)	0.92** (0.42)
$R^2 = 0.55$	

*** Indicate significance at 1% level

** Indicate significance at 5% level

* Indicate significance at 10% level

(Note : figures in the parenthesis are the value of standard error.)

It could be seen from Table 5.54 that the factors like total amount of loan, number of tractors, road density and net cultivated area were positive and significant, impliying that, these factors would be responsible for causing variation in total factor productivity. The effect of these factors were 0.27, 1.49, 1.47 and 0.92 per cent respectively.

The factors like, number of irrigation pump sets and net cultivated area under irrigation were found to be having negative and significant influence on total factor productivity i.e. for a one per cent increase in number of irrigation pump sets and NCA under irrigation, the total factor would decline by 4.52 and 1.68 per cent respectively.

Thus the results revealed that, among different factors under study, the factors like, number of tractors, road density, net cultivated area, under high yielding varieties were influencing the total factor productivity growth while irrigation pump sets and net irrigated area had a negative influence on total factor productivity growth Western Vidarbha Zone.

From above discussion, it is concluded that, in Eastern Vidarbha Zone the factors like, net cultivated area under irrigation, road density, annual rainfall and net cultivated area under high yielding varieties were important factors influencing total factor productivity growth. As far as, Central Vidarbha Zone is concerned, the factors namely, net cultivated area under irrigation, road density and annual rainfall were found to be having positive influence on total factor productivity growth on the other hand for Western Vidarbha Zone, road density, net cultivated area under high yielding varieties were influencing the total factor productivity growth.

CHAPTER – VI

Summary and Conclusions

CHAPTER – VI

SUMMARY AND CONCLUSION

Agricultural productivity and technological changes are important for enhancing growth in agriculture. Measurement of these factors would help to determine the direction of investments in agriculture. The measure that compares output with the levels of inputs used would be the most ideal one. Keeping this in view, the total factor productivity (TFP) was used to measure productivity growth of agriculture in Vidarbha region.

Total factor productivity (TFP) is sometimes referred to as multifactor productivity and is a true measure of economic efficiency. It can be interpreted as a measure of change in output relative to a weighted combination of inputs, where the weights are corresponding factors shares. The present study was carried out using Tornquist Theil Chained Divisia Index Numbers approach. Further, inputs share in total cost, annual growth rates of inputs and output and the factors influcing total factor productivity, growth were also estimated.

The study was planned to analyse the performance of agriculture in Vidarbha region by measuring total factor productivity (TFP) indices. For the analysis, Vidarbha is broadly divided into three agroclimatic zones namely, Eastern Vidarbha Zone, Central Vidarbha Zone and Western Vidarbha Zone.

Data pertaining to inputs used and its value were collected from "Agriculture Prices and Costs Scheme", Department of Agricultural Economics and Statistics, Dr. PDKV, Akola while secondary data were obtained from various government publications. The crops considered were Cotton, Soybean, Jowar, Tur and Gram for Central and Western Vidarbha zone while paddy was selected for Eastern Vidarbha zone. The input considered in the study were human labour (male and female), bullock labour (hired + owned), machine labour (hired + owned), seed, manures, fertilizers (N,P,K), insecticides and rental value of land. The study pertained for the period from 1987-8s8 to 2004-05. The period of study was divided into two sub periods. The first period was from 1987-88 to 1995-96 and second period was from 1996-97 to 2004-05, while the data on inputs for soybean and paddy were taken after 1990.

The results of the study are summarised below.

In Eastern Vidarbha Zone, paddy is the most dominating crop, occupied area of 57.03 per cent of gross cropped area. Next crop is soybean with 21.57 per cent. In Central Vidarbha Zone, soybean occupied 30.77 per cent of the gross cropped area followed by cotton 25.76 per cent. In Western Vidarbha Zone cotton was dominating which occupied an area of 29.45 per cent of the gross cropped area followed by soybean on 21.57 per cent.

In Eastern Vidarbha Zone, the growth rate of area under paddy, cotton, soybean, Jowar and tur were increased significantly while the area under gram was more or less same over the years. The growth rate of production of paddy, soybean and Jowar were increasing significantly while the growth rate of production of cotton, tur and gram was found to be more or less same during period of study. The growth rate of yield was found increasing only in soybean over the years.

In Central Vidarbha Zone, the growth rate of area under soyban, Jowar, tur, gram and paddy were increased significantly. However, area under cotton was more or less same during the period under study. As far as, the growth rate of production concerned, it was found to be increasing for soybean, jowar, tur and gram while production of cotton and paddy were more or less same. The growth rate of yield of soybean crop increased significantly while yield of all other crops were found to be more or less same, over the period of study.

In Western Vidarbha Zone, at overall level, the growth rate of area under all the crops considered in the study were increased significantly. The growth rate of production of soybean, Jowar, gram and paddy increased over the years, while, cotton and tur showed more or less same growth in production. The growth rate of yield of cotton, soybean, Jowar and gram increased significantly while it was found to be more or less same in tur and paddy.

In Eastern Vidarbha Zone, the growth rate of output of paddy was 0.23 per cent which was non significant during period of study. At overall level, among different input used in production of paddy, the growth rate if input like bullock labour, machine labour, manures and rental value of land were significantly increased at 1.96, 30.73, 1.81 and 5.14 per cent respectively. The growth of input like human labour, bullock labour, machine labour and nitrogenous fertilizers were increased significantly during the first

period of study. While, in the second period only rental value of land showed increasing growth rate.

The growth rate of output of soybean was 0.93 per cent which was non significant over the years. Among different input used in production of soybean, the growth rate of inputs like female labour and machine labour were more or less same over the years while all other inputs increased significantly during period of study. During first period, the growth rate of inputs like, seed, human labour, machine labour, N, P and rental value of land were significantly increased while in second period, the input like male labour and rental value of land were increased.

The growth rates of output of jowar was more or less same over the period of study. The growth rate of bullock labour, manures, fertilizers and rental value of land increased during period of study. While in first period, the growth rate of machine labour, manures and insecticides were found to be increasing.

The growth rate of output of tur was significantly increased at 4.66 per cent over the period of study. At overall level, among different inputs used in production of tur, the inputs like male labour, P and rental value of land were increased at 11.11, 5.24 and 11.49 per cent respectively. In first period, the inputs like human labour, fertilizers and rental value of land were increased while in second period, the growth rate of machine labour, manures and insecticides were found to be increased.

The growth rate of output of gram was increased significantly at 3.79 per cent while during both the periods, it was more or less the same. At overall level, the growth of inputs like female labour, machine labour and rental value of land were found to be increased. During first period, use in machine labour and rental value of land increased while in second period, use of machine labour was significantly increased.

In Central Vidarbha Zone, the growth rate of output of cotton was 0.82 per cent which was non significant during period of study. The inputs used in production of cotton like seed, machine labour, manures, fertilizers and rental value of land were significantly increased over the years. While, the inputs like human labour, manures, fertilizers and rental value of land were significantly increased during first period of study and the inputs like male labour and were increased during second period of study.

The growth rate of output of soybean was increased at 2.20 per cent over the years. In first period, the growth in output was increased significantly while it was more

or less same during second period. At overall level, among different inputs used in the production of soybean. The growth of all inputs were increased significantly over the years except in manures and potash, it was found non significant. During first period, the growth rate of machine labour, K and insecticides were more or less same while all other inputs increased significantly. In the second period, the growth rate of human labour, bullock labour, machine labour, insecticides and rental value of land were increased significantly.

The growth rate of output of jowar was 0.65 per cent which was non significant over a period of study. This indicates that output was more or less same during periods of study. As regards to growth rate of manures, nitrogenous fertilizers and rental value of land were significant while, the growth rates of all other inputs were non significant over the years. The growth of inputs like bullock labour manures, fertilizers and rental value of land were increased significantly during the first period while its use were more orders same during second period which was indicated by non significant growth in inputs except in nitrogenous fertilizers which was increased to the extent of 4.19 per cent.

The growth rate of output of tur was 3.17 per cent which was significant over the years. However, during first period, it was 2.70 per cent and the same speed of growth was observed during second period and for both the periods it was non significant. At overall level, among the different inputs use in production of tur, the growth rate of inputs like N. P. insecticides and rental value of land were significantly increased over the years while, use of other inputs were more or less same.

The growth rate of output of gram was 0.34 per cent which was non significant over a period of study. However during period I and period II, it was 3.87 and 10.06 per cent respectively and for both the periods it was non significant. As regards to growth of inputs like seed, bullock labour, fertilizers and rental value of land were increased significantly over the years while all use of other inputs were more or less same.

In western vidarbha zone, the growth rate of output of cotton was 1.36 per cent and non significant i. e. growth in the output of cotton was more or less same over the years. At over all level, among different inputs used in production of cotton, the growth rate of inputs like human labour, bullock labour, machine labour and rental value

of land were significantly increased over the years. As far as to growth of inputs like N and rental value of land were increased significantly during the first period of study while, growth of male labour, bullock labour, machine labour manures and fertilizers were significant during second period of study.

The growth rate of output of soybean was 3.31 per cent and significant over the years. At overall level, among the different inputs use in production of soybean, the growth in inputs like seed, male labour, bullock labour, phosphorus and rental value of land were increased over the period of study. The growth of inputs like seed, machine labour and P were increased significantly during first period while in second period growth of insecticide was found significant.

The growth rate of output of jowar was 0.38 per cent and non significant and same were 2.25 and 1.23 per cent respectively in period I and period II which were also non significant i.e. growth in output of jowar was more or less same in periods of study. The growth of inputs like, male labour, machine labour, bullock labour, manures, P and rental value of land were significantly increased over the years. During first period use of inputs like male labour, nitrogenous fertilizers, K and rental value of land increased however, the growth rate of N, K and insecticides were more or less same.

The growth rate of output of tur was 4.00 per cent and significant while it was 0.90 per cent in first period and 5.25 per cent in second period and for both the periods it was non significant. As regards to the growth of inputs like machine labour, nitrogenous fertilizer, phosphorus and rental value of land were increased significantly over the years. during first period, the growth of inputs like male labour, machine labour, manures, N, K, insecticides and rental value of land were found to be increased while its use were more or less same during second period except nitrogenous fertilizers which was increased significantly to the extent of 5.08 per cent.

The growth of output of gram was found to be significant i.e. 3.06 per cent over the years. However, during both the period it was found to be more or less same and non significant. At overall level, the growth of inputs like human labour, bullock labour, machine labour, N, P , insecticides and rental value of land were increased over the years. The growth of inputs like machine labour and phosphorus were increased significantly in the first period, while the growth of bullock labour found significant during second period.

In Eastern Vidarbha Zone, among different inputs use in production of paddy, the share of rental value of land worked out to 25.29 per cent which was higher among all inputs followed by female labour (18.23%), bullock labour (12.47%) and male labour (12.47%) However, the share of female labour was more than male labour in production of paddy.

The share of inputs in total cost of soybean, rental value of land constitutes 26.55 per cent followed by bullock labour (16.73%) seed (15.21%) and female labour (14.04%) The contribution of male labour was found to be half of to share of female labour.

The average share of individual inputs in the total cost of jowar showed that, bullock labour contributes higher share i.e. 25.49 per cent than other inputs followed by rental value of land (22.23%).

The inputs share in the production of tur showed that, the rental value of land registered highest share i.e. 29.83 per cent in total cost followed by bullock labour (19.51%) and female labour (15.31%). The shares of female labour was found to be more than the share of male labour (6.46%).

Inputs share in production of gram seen that, rental value of land accounts 28.45 per cent share in total cost of gram followed by bullock labour (28.02%) and Seed (26.08%). However, the share of female labour in total cost was very less (0.67%).

In Central Vidarbha Zone, inputs share in total cost of cotton showed that, the share of rental value of land worked out 24.31 per cent which was higher among different inputs followed by female labour (19.80%) and bullock labour (17.11%) and seed (10.40%) However, the share of female labour was found more than male labour.

The shares of different inputs in total cost of Soybean revealed that, the rental value of land contributes major share i.e. 26.75 per cent in total cost followed by bullock labour (16.24%), Seed (15.41%) and female labour (13.31%). The contribution of male labour was found to be 7.45 per cent which was nearly half to the share of female labour. shares of insecticide was found negligible during period of study.

Among different inputs used in production of jowar, the higher share in total cost was observed in rental value of land (24.87%) fallowed by bullock labour (18.71%) female labour (13.76%) and male labour (12.75%). As for us the shares of other inputs were less than 10 per cent.

Average share of individual inputs in total cost for cultivation of tur showed that, rental value of land registered highest share i.e. 29.91 per cent followed by bullock labour (18.18%), female labour (16.59%) and male labour (11.61%). The contribution of female labour was more than male labour in total cost of tur.

The share of different inputs in total cost of gram revealed that, the rental value of land contributes 27.62 per cent in total cost followed by bullock labour (20.43%) and seed (15.98%). The contribution of male labour (6.82%) which was near about half to the share of female labour.

In Western Vidarbha Zone, the share of inputs in total cost of cotton showed that, the share of rental value of land was 24.18 per cent which was higher among different inputs followed by female labour (19.65%) and bullock labour (16.77%). However, the share of female labour was found more than male labour (7.59%) in production of cotton.

The inputs share in production of soybean showed that, the higher share in total cost was observed in rental value of land (24.41%) followed by seed (16.20%), bullock labour (15.81%) and feamle labour (11.02%). The share of fertilizers was 10.85 per cent while the share of other inputs were less than 10 per cent in total cost .

The average share of inputs in total cost of jowar showed that, rental value of land registered highest share (25.29%) followed by bullock labour (17.69%), male labour (13.96%) and female labour (12.68%) . The share of machine labour was 8.02 per cent which was near about half to the share of bullock labour in total cost of jowar.

The shares of different inputs to total cost of two showed that, rental value of land contributes 30.88 per cent in total cost followed by bullock labour (16.72%), female labour (15.33%) and male labour (14.22%). The contribution of machine labour (3.44%) was found to be very less as compared to bullock labour.

Among different inputs use in production of gram, the share of rental value of land worked out to 28.64 per cent which was higher among different inputs followed by bullock labour (17.23%) and seed (17.03%). The share of machine labour accounts less share (11.63%) as compared to bullock labour. The share of fertilizers was found 9.27 per cent in total cost.

In Eastern Vidarbha Zone, total factor productivity growth in paddy declined at 5.07 per cent per annum is a resultant of output growth at -5.11 per cent per annum

minus the input growth at the rate of -0.04 per cent per annum during entire period of study. in the first period, growth in output index declined at 4.56 per cent while growth in input index increased at the rate of 2.44 per cent, because of growth in input index was higher than growth in output index, resultant total factor productivity declined at rate of 7.00 per cent per annum. While, during second period, growth in output index was 5.66 per cent per annum whereas growth in input index was -2.53 per cent per annum therefore growth in TFP also declined at 3.13 per cent per annum.

The total factor productivity growth in soybean declined at 3.49 per cent per annum over the years. In the same period, the output index was -3.45 per cent per annum and input index was 0.04 per cent per annum i.e. the growth in input index was more than the output index therefore total factor productivity found to be negative over a period of study. During period I, the growth of output index was -3.50 per cent per annum and growth in input index was 3.79 , the resultant total factor productivity were found to be negative i.e. 0.29 per cent per annum. While in period II, the growth of output index was -3.42 per cent per annum and input index was 3.01 per cent per annum, during this period growth in output index was less than input index therefore total factor productivity found to be negative (-6.43%).

At overall level, the growth in input index of jowar wa positive (2.19%) while growth in output index was declined at 1.73 per cent and as such total factor productivity for the period declined at 3.92 per cent per annum. The negative total factor productivity might be due to increasing input index with decreasing output index. In first period, the growth in input index (6.15%) and output index (1.50%), however the growth rate of input index was more than that of output index and therefore the total factor productivity found to be negative (-4.65%) for this period. During second period, the growth in input index and output index were negative (-4.24 and -0.89% respectively) and the magnitude of total factor productivity index was -3.35 per cent per annum.

In tur crop, over the entire period of study, the output recorded a growth rate of -3.85 per cent per annum and input index was -3.00 per cent per annum the resultant total factor productivity was declined to 0.85 per cent per annum. Growth in output index was -1.19 per cent per annum and growth in input index was -6.85 per cent per annum which resulted inclining total factor productivity to 5.66 per cent per annum during first period. in the second period, the growth of output index (-5.92%) was lower than input

index (-0.01%) and as such, total factor productivity recorded a negative growth rate (-5.91%).

In gram, over the entire period of study, the growth rate of output index declined at 4.44 per cent per annum and growth in input index also declined at 0.45 per cent per annum. The rate of declining of output index was more than that of input index therefore growth in total factor productivity declined at 3.99 per cent per annum. In the first period, the growth in output was (-7.60%) lower than growth in input (-2.33%) which resulted a declined of total factor productivity by 9.93 per cent per annum. In the second period, the growth in output index (-1.99%) was more than growth in input index (-2.62%). Hence, total factor productivity recorded a growth rate of 0.63 per cent per annum.

In Central Vidarbha Zone, at overall level, the output index of cotton recorded a growth rate of -1.09 per cent. while, growth in input index was -1.18 per cent per annum which was slightly lower than output index resulted in a incline in total factor productivity to 0.10 per cent. During the first period the growth in output index was 1.15 per cent and growth in input index was 1.32 per cent per annum and total factor productivity recorded a growth rate of -0.17 per cent per annum. In the second period, the growth in output index -2.83 and -3.12 per cent per annum respectively which resulted in a increase of total factor productivity by 0.29 per cent per annum. The incline in total factor productivity was not only due to output growth but also due to proportionally low increase in the use of inputs.

In soybean, over the entire period of study, the output revealed a decline growth rate of 4.69 per cent per annum. During the same period, input index was increased by 1.34 per cent per annum. Hence total factor productivity recorded a decline growth rate to 6.03 per cent per annum. During first period, the growth in output index ws negative (-7.01%) while, the growth in input index was also negative (-0.08%). Hence the total factor productivity recorded a growth rate of -6.93 per cent per annum. During second period the growth in output index was negative (2.89%) with positive input index (2.44%). However, the total factor productivity recorded a negative growth rate of -5.33 per cent per annum.

In jowar, at overall level, the output index recorded a decline growth rate to

0.69 per cent. During the same period, the growth rate in input index was declining by 0.40 per cent. the growth of total factor productivity forund to be declining at 0.29 per cent per annum. In the first period, the growth in output index was (2.80%) higher than the growth in input index (-0.54%). Hence, the total factor productivity recorded a growth rate of 3.34 per cent per annum. In the second period, the growth of output was (-3.40%) lower than the growth in input index (-0.29%) with resulted in a decline of total factor productivity by 3.11 per cent per annum.

In tur, over the entire period of study the output index recorded a growth rate of -2.43 per cent per annum. During the same period input index decreased to -0.62 per cent per annum. therefore the total factor productivity decreased to 2.21 per cent per annum. In the first period, the growth in output index was (0.35%) higher than growth in the input index (-3.20%). Hence, total factor productivity recorded a growth rate of 3.55 per cent per annum. In the second period, the growth in output index (-4.60%) lower than the growth in input index (1.38%) which resulted in decline of total factor productivity to 5.98 per cent per annum.

In gram, at overall level, the growth in output index was negative (-5.19%) and growth, in input index was also declined (-4.86%). Hence total factor productivity recorded declining growth rate at 0.33 per cent. During first period, the growth in output index was marginally lower than the growth in input index with resulted in a decline of total factor productivity by 0.78 per cent per annum. In the second period, the growth in output index (-0.53%) was slightly higher than growth in input index (-0.65%). Hence total factor productivity recorded a growth rate of 0.12 per cent per annum.

In Western Vidarbha Zone, the output index of cotton recorded a growth rate of 0.04 per cent per annum and growth rate of input index was increased to 4.79 per cent per annum which was higher than growth in output index Hence, total factor productivity recorded a declining growth rate of 4.75 per cent per annum over the year of study. In the first period, the growth in output index was (1.03%) lower than the growth in input index (2.04%) which resulted in a decline of total factor productivity by 1.01 per cent. Same trend was found in second period where growth in output index decline by 0.73 per cent and growth in input index increased by 6.95 per cent. Hence, total factor productivity recorded a decline growth rate to 7.68 per cent per annum.

In soybean, over the entire period of study the output recorded a declined

growth rate of 3.58 per cent per annum. During the same period, input index increased by 0.85 per cent per annum. therefore total factor productivity decline by 4.43 per cent per annum. During the first period of growth in output index increaed by 1.91 per cent per annum and the growth in input index was declined to 3.35 per cent per annum which resulted in a growth in total factor productivity at 5.36 per cent per annum. However, in second period, the growth in output index was lower (-9.06%) than growth in input index (5.05%) which resulted in a decline of total factor by 14.11 per cent per annum. The decline in total factor productivity was not only due to low output growth but also due to the proportionally high increase in the use of inputs.

In jowar, the growth in output and input indices explain the behaviour in total factore productivity growth. At over all level of study, the output recorded a growth rate of 0.70 per cent per annum and input recorded a growth rate of negative (-0.09%) which resulted in a incline of total factor productivity by 0.79 per cent per annum. In the first period, the growth in output was higher (6.15%) than growth in input (-0.51%) which resulted in a increase in total factor productivity at 6.66 per cent. During the second period the growth in output index was (-3.53%) lower than growth in input index Hence, total factor productivity recorded a decline growth rate of 3.77 per cent per annum.

In tur, at overall period of study, the growth of output index decline at 1.85 per cent per annum and input index also decline (0.37%). Therefore resultant total factor productivity also dedline to 1.48 per cent per annum. In the first period, the growth of output was higher (1.66%) than the growth in the input (-1.44%). Hence total factor productivity recorded a growth rate of 3.10 per cent per annum. In the second period, the growth of output was lower (-4.56%) than the growth in input index (0.46%) which resulted in a decline of total factor productivity by 5.02 per cent per annum.

In gram, over the entire period of study the output recorded a growth rate of -4.70 per cent per annum. During the same period, input index decline at 2.29 per cent per annum. Therefore the total factor productivity was decline at 2.4 per cent per annum. During first period, the growth in output index decline to 10.13 per cent per annum. which was lower than the growth in input index (-4.17%) which resulted in a decline of total factor productivity by 5.16 per cent per annum. During second period, the growth of output was -0.47 per cent per annum while growth in input was -0.21 per cent per annum. Hence total factor productivity recorded a growth rate of -0.26 per cent per annum.

In Eastern Vidarbha Zone, among different factors influencing total factor productivity growth, percentage of net cultivated area under irrigation, road density, annual rainfall and net cultivated area under high yielding varieties had positive and significance influence on total factor productivity. Thus for a one per cent increase in these factors, the total factor productivity would increased by 1.81, 2.98, 5.42 and 0.78 per cent respectively. While amount of loan had negative association with total factor productivity thereby indicating that it would decrease by 0.90 per cent with a increase in lone one per cent.

In central Vidarbha Zone, among different factors under study the factors like net irrigated area, road density and rainfall were positive and significant influence on total factor productivity growth. The regression coefficient of these factors were 0.23, 3.52 and 0.58 per cent respectively. While, the factors like, net cultivated area under high yielding varieties had a negative and significant influence on total factors productivity growth.

In Wastern Vidarbha Zone,factors like total amount of loan, number of tractors , road density and net cultivated area were positive and significant. The effect of these factors were 0.27, 1.49, 1.47 and 0.92 per cent respectively on total factor productivity growth. The factors like number of irrigation pump sets and net cultivated area under irrigation were found to be negative and significant influence on total factor productivity.

Conslusions

The conclusions of the study are given below :

- Paddy was the main crop of Eastern Vidarbha Zone while soybean and cotton were the main crops of Central and Western Vidarbha Zone.
- In general, the growth rate of area under different crops in all the zones showed increasing trends except gram and cotton. The reason might be due to occurance of drought during crop season.
- The growth rates of production and productivity of Soybean were found to be increasing for all zones of Vidarbha.
- The growth in output was found increasing in gram and tur in Eastern Vidarbha Zone while Soybean and tur in Central Vidarbha Zone and tur and gram in

Western Vidarbha Zone. However, the growth in output of all crops were found to be more or less same during the study period.

- Among the inputs used in production of crops, the growth rate of rental value of land and machine labour were found increasing over the period of study.
- The share of rental value of land in total cost was higher than all other inputs.
- The total factor productivity analysis revealed that the growth in input was higher than growth in output therefore resultant total factor productivity showed decelin over the period of study.
- In Eastern Vidarbha Zone, at overall level the growth in total factor productivity was declined in all the crops. while the growth of total factor productivity in tur and gram were increased during first and second period respectively.
- In central Vidarbha Zone, the growth in total factor productivity was found increasing in cotton over the period of study. In period I, it was found increasing in tur and jowar while in second period, gram showed positive total factor productivity growth.
- In Western Vidarbha Zone, the growth in the total factor productivity were declined in all crops except in jowar. During first period, it was found positive in Soybean, jowar and tur while in second period, it was found negative for all crops.
- In Eastern Vidarbha Zone, factors like, net cultivated area under irrigaiton, road density, annual rainfall and net cultivated area under high yielding varieties were important factors influencing total factor productivity growth.
- In Central Vidarbha Zone, net cultivated area under irrigation, road density and annual rainfall were found positive influence on total factor productivity growth.
- In Western Vidarbha Zone, factors like, road density and net cultivated area under high yielding varieties were important factors influencing the total factor productivity.

Policy Implications

- For increasing the productivity of crops having negative growth in total factor productivity, attention will have to be paid to strengthen the sources which have positive impact on total factor productivity and to check the effect of sources which are experiencing negative relationship with total factor productivity.
- Suitable new innovations be introduced in the state to increase the productivity of crop sector. Thus all the efforts in future will have to be concentrated on accelerating the pace of total factor for productivity growth by conserving natural resources and promoting institutional intrastructure.
- The institutional infrastructure, plays an important role not only in providing physical inputs but also in inducing technical change. For this, increasing investment in research and infrastructural facilities, and increasing input use efficiency are necessary.

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Vita

VITA

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Thesis Abstract

THESIS ABASTRACT

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ABSTRACT

Total factor productivity (TFP) is sometimes referred to as multifactor productivity and is a true measure of economic efficiency. It can be interpreted as a measure of change in output relative to a weighted combination of inputs, where the weights are factor shares. More over total factor productivity compares output with

the level of inputs. The change in total factor productivity index can be used as one measure of technical change.

For the analysis, Vidarbha region is broadly divided into three agroclimatic zone i.e. Eastern Vidarbha Zone (EVZ) , Central Vidarbha Zone (CVZ) and Western Vidarbha Zone (WVZ) . The crops considered were cotton, soybean, Jowar, tur and gram for Central and Western Vidarbha Zone while paddy was selected for Eastern Vidarbha Zone. The study pertained for the year 1987-88 to 2004-05. Data pertaining to inputs used and its value were collected from Agricultural Price Scheme, Department of Agril. Economics and Statistics, Dr. PDKV, Akola while secondary data were obtained from various Government publications. The present study was carried out using Tornqvist-Theil Chained Divisia Index Number approach. Further, inputs share in total cost, annual growth rates of input and output and factor influencing total factor productivity growth were also estimated.

Paddy was a main crop of the Eastern Vidarbha Zone while soybean and cotton were the major crops of Central and Western Vidarbha Zone. The growth rate of area under different crops in all the zones shows increasing trend except in gram and cotton. The growth rate of production and productivity of soybean was found increasing in all zone of Vidarbha.

In Eastern Vidarbha Zone, the growth rate of output of paddy, soybean and jowar were, 0.23, 0.93 and 1.38 per cent respectively and which was more or less same over the years of study while, the growth in output was found increasing in tur (4.66%) and gram (3.79%). In Central Vidarbha Zone the growth rates of output was found increasing in soybean (2.20%) and tur (3.17%) and in Western Vidarbha Zone, the growth in output of soybean (3.33%), tur (4.00%) and gram (3.06%) were found increasing trend over the period of study. Among different inputs used in production of crops, the growth rate of rental value of land and machine labour were found increasing over the period of study while use of all other inputs were more or less same over the years. The shares of different inputs in total cost of production of crops in all zones were found that, the share of rental value of land in total cost was higher than all other inputs.

In Eastern Vidarbha Zone, the annual growth rates of total factor productivity were decline at 5.07, 3.49, 3.29, 0.85 and 3.99 per cent per annum in respect of paddy, soybean, jowar, tur and gram while, the growth of total factor productivity were

increasing in soybean (0.29%) and tur (5.66%) during first period and gram (0.63%) during second period

In Central Vidarbha Zone, the growth in total factor productivity found increasing in cotton at 0.10 per cent per annum while soybean, Jowar, tur and gram declined at 6.03, 0.29, 2.21 and 0.33 per cent per annum respectively. While in first period, it was found increasing in tur (3.55%) gram (0.12%) in second period.

In Western Vidarbha Zone, the growth rate of total factor productivity were declined in cotton, soybean, tur and gram at 4.75, 4.43, 1.48 and 2.41 per cent per annum respectively while, It was found positive in jowar at 0.79 per cent per annum. During first period, the growth in total factor productivity were found to be increasing in soybean (5.26%) jowar (0.79%) and tur (3.10%) while in second period, it was found declining for all crops.

In Eastern Vidarbha Zone, among different factors influencing total factor productivity growth, percentage of net cultivated area under irrigation, road density, annual rainfall and net cultivated area under high yielding varieties had positive influence on total factor productivity. Thus for one per cent increase in these factor, total factor productivity would increased by 1.81, 2.98, 5.42 and 0.78 per cent respectively. While, the amount of loan had negative association with total factor productivity, indicating that it would decrease by 0.90 per cent with a increase in amount of loan by one per cent.

In Central Vidarbha Zone, the factors like net cultivated area under irrigation, road density and annual rainfall were found positive influence on total factor productivity growth. The influences of these factors were 0.23, 3.52 and 0.58 per cent respectively. While, net cultivated area under high yielding varieties had a negative influence on total factor productivity.

In Western Vidarbha Zone, the factors like, total amount of loan, number of tractors, road density and net cultivated area were positive and significant influence on total factor productivity. The effects of these factors were 0.27, 1.49, 1.47 and 0.92 per cent respectively. While, the factors like, number of irrigation pump sets and net cultivated area under irrigation were negative influence on total factor productivity.

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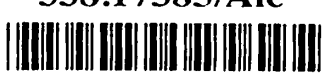
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