IMPACT ASSESSMENT OF TECHNOLOGY MISSION ON OILSEEDS AND PULSES IN KARNATAKA

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INTRODUCTION

Agriculture is a critical sector of the Indian economy. Though its contribution to the overall Gross Domestic Product (GDP) of the country has fallen from about 30 per cent in 1990-91 to less than 15 per cent in 2011-12, a trend that is expected in the development of any economy, agriculture yet forms the backbone of the economy. An average Indian spends almost half of his/her total expenditure on food while little more than half (nearly 60 per cent) of India's work force is still dependent on agriculture for their livelihood. Being both a source of livelihood and food security for a vast majority of low income, poor and vulnerable sections of society, its performance assumes greater significance in view of the proposed National Food Security Bill and the ongoing Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). The experience from BRICS countries indicates that one percentage growth in agriculture is at least two to three times more effective in reducing poverty than the same growth emanating from non-agriculture sectors. India being a home to the largest number of poor and malnourished people in the world, a higher priority to agriculture will achieve the goals of reducing poverty and malnutrition as well as of inclusive growth. Since agriculture forms the resource base for many agro-based industries and agro-services, it would be meaningful to view agriculture not as farming alone but as a holistic value chain, which includes farming, wholesaling, warehousing, processing and retailing. Further, the last two Five Year Plans reported that for the economy to grow at nine per cent per annum, it was important that agriculture should grow by at least four per cent (Final report on state of Indian agriculture – press 2011-12).

India has achieved a significant progress in agricultural production, particularly in cereals. As per the second advance estimates, production of food grains during 2011-12 was estimated at an all time record of 250.42 million tonnes which is a significant achievement mainly due to increase in the production of two major cereals- rice (192.93 mt) and wheat (88.1 mt). However, of late, necessity for changes in the composition of agricultural production is being highlighted. The production of oilseeds and pulses has been identified as one of the major thrust areas keeping in view dietary, economic and other considerations.

1.1 Importance of oilseeds and pulses

Oilseeds produce edible as well as non-edible oils which have various uses. Edible oil is one of the five nutrient elements essential for our body. Non-edible oils are used in various products like paints, varnishes, lubricants, textile auxiliaries and for illumination in households. Apart from these, oilseed cakes are highly proteinaceous and are extensively used as a livestock feed. Some oilseeds are leguminous crops which fix atmospheric nitrogen into the soil. The oil content of small grains (*e.g,* wheat) is only 1-2 per cent whereas for oilseeds it ranges from about 20 per cent for soya bean to over 40 per cent for sunflower and rapeseed. The major sources of edible oil are soya bean, sunflower, rapeseed, cotton and peanuts. India is fortunate to have a wide range of oilseed crops grown in its different agro climatic zones. Groundnut, rapeseed-mustard, sesame, safflower, linseed, niger and castor are the major traditionally cultivated oilseeds. Soya bean and sunflower have also assumed importance in recent years. Coconut is the most important amongst plantation crops. Among the non-conventional oils, rice bran oil and cottonseed oil are the most important. In addition, oilseeds of tree and forest origin, grown mostly in tribal areas, are also a significant source of oils.

Pulses are one of the important segments of food grain production after cereals and oilseeds. These pulses constitute chickpea, pigeon pea, lentil, mungbean, urdbean and field pea. The split grains of these pulses called *dal* are excellent source of high quality protein, essential amino and fatty acids, fibers, minerals and vitamins have a vast multiplicity of uses as food and industrial products. These crops improve soil health by enriching nitrogen status, long-term fertility and sustainability of the cropping systems by fixing large amounts of atmospheric nitrogen through the root nodules and also through leaf fall on the ground at maturity. It meets up to 80 per cent of its nitrogen requirement from symbiotic nitrogen fixation from air and leaves behind substantial amount of residual nitrogen and organic matter for subsequent crops. The water requirement of pulses is about one-fifth that of cereals thereby saving precious irrigation water. It can be used as fodder, forage can be made into hay, silage, *etc.* Its forage and cake are excellent nutritive foods for livestock and poultry.

1.2 Oilseeds and pulses scenario

1.2.1 Global scenario of oilseeds and pulses

World oilseeds production has been growing constantly year-after-year on higher acreage and improving yield level. However, there were certain hiccups in between due to bad weather conditions as witnessed in 2009. Global oilseeds production grew at a Compound Annual Growth Rate of 16.65 per cent since 2004-05. For 2010-11, the production was 439.74 million tonnes, down 0.3 per cent. Marginal fall was due to decline in production of rapeseed. Soybean is the world's largest produced oilseeds, having a contribution of around 58per cent. Other major oilseeds are rapeseed – mustard (13%), cotton seed (10%), peanut (8%) and sunflower (7%). Soybean is being grown on a larger extent because of its various kinds of uses for food, feed and fuel (*FAOSTAT 2010*).

Pulses are the second most important crops after cereals. In 2009, the global pulses production was 61.5 million tonnes from an area of 70.6 million ha with an average yield of 871 kg/ha. Dry beans contributed about 32 per cent to global pulses production followed by dry peas (17%), chickpea (15.9%), broad bean (7.5%), lentil (5.7%), cowpea (6%) and pigeon pea (4.0%). The triennium (2007-09) average of 61.2 million tonnes production shows a positive annual growth of 0.7per cent per annum over 55.03 million tonnes recorded in 1997. Comparative data for the eighties reveal phenomenal annual growth of 2.85 per cent mainly attributed to positive growth of 0.87 per cent in area and 1.83 per cent in productivity. Developing countries contribute about 74 per cent to the global pulses production and the remaining comes from developed countries. India, China, Brazil, Canada, Myanmar and Australia are the major pulse producing countries with relative share of 25 per cent, 10 per cent, 5 per cent, 5 per cent and 4 per cent, respectively. Countries recording annual production growth of more than four per cent are Myanmar (11.48%), Canada (10.80%), Germany (8.27%), Sudan (8.08%), Spain (7.37%), Ethiopia (4.92%), China (4.67%) and Syria (4.12%).

1.2.2 National scenario of oilseeds and pulses

Oilseeds are one of the commercially grown crops in India along with cereals, pulses and spices. Majority of the oilseeds grown in India are planted and harvested in *Kharif* season except a few like mustard and linseed. Major oilseeds grown in India are soybean, mustard, groundnut, sesame, sunflower, linseed and niger seed.

India is one of the largest producers of oilseeds in the world and this sector occupies an important position in the agricultural economy. It accounts for the estimated production of 24.88 million tonnes of nine cultivated oilseeds during the year 2009-10. India contributes about 6-7 per cent of the world oilseeds production. Export of oil meals, oilseeds and minor oils has increased from 5.06 million tonnes in 2005-06 to 6.2 million tonnes in 2010-11. In terms of value, realization has gone up from Rs. 5514 crores to Rs.14116 crores from 2005-06 to 2010-11. India accounted for about 6.3 per cent of the world's oil meal export during 2009-10. Indian vegetable oil economy is the fourth largest in the world next only to US, China and Brazil accounting for about 14 per cent of world's oilseeds area and 8.5 per cent of world's oilseeds production. India ranks first in castor and safflower production in the world, second in groundnut and sesame, third in linseed and rapeseed, fifth and sixth in soya bean and sunflower, respectively. In terms of area, out of eight oilseed crops, India ranks first in five crops (groundnut, sesame, safflower, linseed and castor) second in rapeseed next only to China and fourth in sunflower and soya bean. Among the nine oilseeds grown in India, soya bean is the single largest crop produced in India with a share of 43 per cent followed by mustard seed with 29 per cent contribution to total oilseeds production. The top-four oilseed producing states are Madhya Pradesh, Rajasthan, Gujarat and Maharashtra. Madhya Pradesh alone accounts for 31 per cent of the total oilseed production in India, with the other three states contributing 10 to 15 per cent each. Andhra Pradesh, Karnataka, Tamil Nadu, Haryana, Uttar Pradesh, West Bengal, Orissa and Assam are the other important oilseed producers in India. Groundnut holds the third position accounting for 20 per cent of total oilseeds production. It is mainly grown in the states of Gujarat, Andhra Pradesh, Tamil Nadu and Karnataka. The three largest states producing mustard are Tamil Nadu, Rajasthan and UP. Sunflower is mainly grown in Karnataka, AP and Maharashtra (Directorate of oilseeds Research (ICAR), Hyderabad).

India consumes around 12.5-13.0 million tonnes of vegetable oil annually. India's per capita consumption of edible oil was 12.78 kg/annum in the 2008-09, up 1.38 kg as compared to 11.40 kg/annum in 2007-08 due to cheaper availability of edible oil and increasing per capita income, but it is still significantly lower as compared to developed countries. A large gap in consumption among sections of the population exists in India. The top 10 per cent of the population consumes over 20 kg per capita and the bottom 30 per cent consumes less than 5 kg per capita. Palm oil and soy oil accounts for 37 per cent and 18 per cent of India's total edible oil consumption respectively.

Pulses remain a major ingredient in the Indian diet. Over 20 per cent of the population is strictly vegetarian, with pulses providing the main source of protein for these consumers. However, in India, even non-vegetarians consume pulses in significant quantities.About 90 per cent of the global pigeon pea, 75 per cent of chickpea and 37 per cent of lentil area falls in India *(FAOSTAT 2009)*. India is the largest producer and consumer of pulses in the world contributing around 25-28 per cent of the total global production. The country grows a variety of pulse crops such as chickpea, pigeon pea, green gram (mung beans), black gram (urdbean), dry peas and lentils under a wide range of agro-climate conditions.

The production of total pulses in India is presently about 15 million tonnes covering an area of about 22-23 million hectares majority of which is produced under rainfed, resource poor and harsh environment frequently prone to drought and other abiotic stress condition. Irrigated area under pulses was almost stagnant from 1980's to 2010 accounting for 4 per cent of the total irrigated area in the country. Among food grains, less attention has been given to pulses in terms of irrigation as irrigated area under pulses constituted only 5 per cent of the total irrigated area under food grains. Chickpea is the main pulse grown under irrigation.

The estimates for 2010-11 indicate that the total pulse production was 17.29 million tonnes from 25.51 million ha area, which was an all time high and was the only exception year. Pulses are least preferred by farmers because of high risk and less remunerative than cereals and consequently, the production of the pulses is sufficiently low. To meet the demand of pulses, India is at present importing about 3 million tonnes. Chickpea continues to be the largest consumed pulses in this complex comprising of 45-50 per cent of the total pulses production of India followed by pigeon pea (15-16%), black gram and lentil *.*

The major producers of pulses in the country are Madhya Pradesh (24%), Uttar Pradesh (16%), Maharashtra (14%), Andhra Pradesh (10%), Karnataka (7%) and Rajasthan (6%). These six states accounted for 77 per cent of total pulse production remaining 23 per cent is contributed by Gujarat, Chhattisgarh, Bihar, Orissa and Jharkhand.

With stagnant area under cultivation and production, India has permitted unrestricted imports of pulses with low duties for about 20 years. India has been the world's largest pulses importer. For many pulses, large shares of import, including *desi* chickpea, pigeon pea, mung bean and kidney bean, come from Myanmar. Canada and Australia are major suppliers of dry peas and *kabuli* chickpeas to the Indian market, each supplying about one-third of India's peas imports. Most *kabuli* chickpeas come from Mexico, Australia, Canada, Turkey and Iran. Nepal and Syria account for the largest share of Indian lentil imports. During the recent four decades (1971-2010), a marginal increase of approximately 10 per cent in the area under pulse cultivation with a nominal gain of total production, however the yield of pulses has remained virtually stagnant for the last 20 years (580 kg/ha in 1990's to nearly 607 kg/ha during 2010).In terms of area, production and yield, chickpea contributed maximum among all major pulse crops.

Karnataka's scenario

Karnataka is one of the major oilseed producing state in the country. During 1980-81 the area under oilseeds in the state was 12.51 lakh hectare with a production of 6.5 lakh tonnes and productivity of 520 kg/ha. The area covered under cultivation of oilseeds in 2009-10 was 20.01 lakh hectare, production of 89.91 lakh hectare and with productivity of 473 kg/ha. Among the districts in Karnataka where oilseeds are cultivated in 2009-10, Bijapur ranked first in area covering 2,10,784 ha. In terms of production, Belgaum topped with 99,651 tonnes. Shimoga ranked first with respect to productivity of 1506 kg/ha. The least area under oilseeds cultivation was under Kodagu with 33 ha and least production of 26 tonnes and in productivity wise Gadag was least of about 359 kg/ha (Economic Survey of Karnataka, 2010-11).

Karnataka is the largest sunflower growing state in India, sharing nearly 64 and 55 per cent of India's area and production, respectively. It also has 15 per cent of the groundnut area of India and is one of the major growers of groundnut. Area under sunflower and groundnut together accounts for 84 per cent of Karnataka's oilseed area. Similarly, in the production, groundnut and sunflower together contributed 84 per cent of Karnataka's total oilseeds.

In 1981, the area under pulses cultivation in Karnataka was 15.31 lakh hectare with production of 4.88 lakh tonnes and productivity of 319 kg/ha. The area covered under cultivation of pulses in 2009-10 was 24.79 lakh hectare, production of 11.72 lakh hectare and with productivity of 468 kg/ha. Among the districts in Karnataka where pulses are cultivated in 2009-10, Gulbarga stands first in area and production accounting for 6,67,879 ha and 3,37,109 tonnes, respectively.In productivity Bangalore Urban ranks first with 906 kg/ha. The least area under pulses cultivation was under Kodagu with 532 ha, least production of 193 tonnes and productivity in Gadag was found to be least at 244 Kg/ha. (Economic Survey of Karnataka ,2010-11).

1.3 Demand supply gap

Oils, fats and proteins constitute an essential part of human diet and the calorie requirement cannot be resolved without their adequate supply. The price of edible oils and pulses has increased much more than that of cereals making it difficult especially for low income groups to eat a balanced mix of edible oils, pulses and cereals. On the other hand, the income elasticity of demand for pulses for lower and middle income groups are greater than unity. This suggests a rising pressure on the demand for pulses with the rise in income. Therefore, absence of any response from supply side will ultimately force the consumers to substitute other crops like vegetables in place of pulses on consumption side. Consequently, farmers have to adjust cropping pattern accordingly.

The annual consumption of edible oils was about 11 million tonnes, the per capita consumption is at 11.50 kgs, which is very low compared to world average of 20 kgs. The consumption level of edible oils of India is not only below the world average of 66 gm/day/capita but also below Indian Council of Medical Research (ICMR) recommendation which is 20 gm/day/capita. Even at this low level of edible oil intake, the fluctuating levels of production of various oilseeds have forced the country to import a large quantity of edible oil which has increased from 49.03 lakh tonnes to 101.00 lakh tonnes respectively from 2007-08 to 2009-10 to meet the demand *i.e.* India has to import 40% of its oil consumption requirements. The production growth has not been able to keep pace with the population growth.The size of consumption of pulses in India is around 16 million MT. In order to meet such demand, India is dependent upon import of pulses to the extent of 2-3 million MT. India's net capita availability of pulses has come down from 60 gm/day/person in 1951 to 31 gm/day/ in 2009. According to ICMR, the minimum per capita requirement of pulses is 30 kg/annum or 43 gm per day. Thus, the edible oil and pulses economy of the country is characterised by an overall shortage in supply in relation to its demand.

1.4 Research efforts

Recognising the importance of oilseeds and pulses in the Indian economy as well as the demand and supply gap, several initiatives have been taken by the government from time to time.

Technology Mission on Oilseeds and Pulses

Technology Mission on Oilseeds (TMO) was **launched by the Central Government** through Department of Agriculture Research and Education (DARE) in May 1986, under the chairmanship of secretary, Agriculture and Cooperation and with DG, ICAR and secretary, DARE being its co-chairmen, to increase the production of oilseeds, reduce the import of oilseeds and achieve self sufficiency in edible oils. The TMO was transferred from DARE to Department of Agriculture and Cooperation (DAC) in March, 1990. Keeping in view the success on oilseeds production, pulses were brought under the Technology Mission in 1990. Subsequently, oil palm and maize were also brought within the purview of the Mission in 1992 and 1995-96 respectively. The scheme **is being** implemented **by 14** major growing **states** for oilseeds and pulses and **15 States** for maize **and in 10 States for** oil palm.

Objectives of the mission

The main objectives of the mission as envisaged in the note for the cabinet was to make the country self-reliant as early as possible in edible and non-edible oils and reduce imports through integrated approach involving different developmental, scientific, input, banking and marketing agencies. It was also envisaged in the note for the cabinet that the Mission would

1. Aim at increasing production and productivity of the different oilseed crops in 180 districts through assured input supply and technology packages
2. Develop location-specific technologies for each of the crops for maximizing production.

3. Produce adequate quantities of breeder, foundation and certified seeds of different oilseed crops
4. Take up mass multiplication of tissue-cultured plants of oil palm and coconut
5. Modernize cyro-preservation of important germplasms of oilseed crops and also develop facilities for importing superior oil-yielding plants from outside
6. Organize seed gardens to produce superior quality varietal and hybrid materials of oil palm and coconut
7. Create awareness about the improved and emerging technologies in selected blocks through National Demonstrations, Operational Research Projects, Krishi Vigyan Kendras and Lab-to-Land Programmes
8. Assist the developmental workers in training and imparting latest technologies of science
9. Help modernize the processing technology to increase the output and improve the safety and quality of oil.

It was further envisaged that the Mission would concentrate first on the major crops which contributed the maximum to the edible oils economy of India. The crops that would receive priority are groundnut, rapeseed-mustard, soybean, sunflower, safflower, linseed, sesamum and niger in that order. It was further provided that the Mission would also give priority to non-edible oilseed crops to meet the requirement of industry.

The other schemes implemented under Technology Mission are Oilseeds Production Programme (OPP), National Pulses Development Project (NPDP), Accelerated Maize Development Programme (AMDP) and Oil Palm Development Programme (OPDP). In order to provide flexibility to the States in implementation based on regionally differentiated approach, to promote crop diversification and to provide focused approach to the programmes, the four erstwhile schemes of OPP, NPDP, OPDP and AMDP have been merged into one Centrally Sponsored Integrated Scheme of Oilseeds, Pulses, Oil palm and Maize (ISOPOM) being implemented since 2004.

The salient features of ISOPOM are as under:

1. Flexibility to the states to utilize the funds for the scheme/crop of their choice.
2. Annual action plan to be formulated by the State Governments for consideration and approval of the Government of India.
3. Flexibility to the states for introducing innovative measures or any special component to the extent of 10 per cent of financial allocation.
4. Involvement of private sector by the State Governments in the implementation of the programme with a financial cap of 15 per cent.
5. Flexibility for inter component diversion of funds up to 20 per cent for non-seed components only.
6. Diversion of funds from seed components to non-seed components with the prior approval of the Department of Agriculture and Cooperation.
7. Increase under staff and contingency not permitted except by revision of pay scale and increase in rate of Dearness Allowance with the prior approval of the Department of Agriculture and Cooperation.

Under ISOPOM the programmes for development of oilseeds and pulses are implemented in 14 potential states *viz.* Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. Under this Scheme, financial assistance is provided for purchase of breeder seeds, production of foundation seeds, production and distribution of certified seeds, distribution of seed minikits, distribution of plant protection chemicals and equipments, weedicides, *etc.* to encourage farmers to grow oilseeds and pulses. In order to disseminate information on improved production technologies amongst the farmers, block demonstrations and Integrated Pest Management (IPM) demonstrations are organized through State Department of Agriculture and Front Line Demonstrations through the ICAR.

Keeping in view the role of women farmers and their participation in oilseeds cultivation, ICAR has developed gender friendly equipment and efforts are being made to make these equipments/implements available to women farmers' beneficiaries. Under ISOPOM for Oilseeds and Pulses Developments Programmes, a higher rate of subsidy/assistance is being provided to the women Farmers under the components of sprinkler sets and pipes for carrying water from source to the field. Assistance at 50 per cent cost of the sprinkler set or ₹.15000 per set whichever is less is being provided to the women farmers where as 33 per cent cost of the set or ₹ 10000 per set whichever is less is being provided to other categories of farmers. Under the component pipes for carrying water from source to the field, assistance of ₹ 15000 is being provided to women farmers for length of 210 meters of pipes whereas the assistance is restricted to ₹ 10000 to other categories of farmers. For OPDP, under ISOPOM, assistance is being provided to women farmers under the component of drip irrigation to the tune of 50 per cent of the cost.

National Food Security Mission (NFSM): NFSM on Pulses was launched during 2007-08 being implemented in 171 identified districts of 14 major pulses growing states

Pulses and Oilseeds villages: Another initiative with allocation of ₹. 300 crore under RKVY has been announced for increasing production of oilseeds and pulses in 60000 'Pulses and Oilseeds villages' in rainfed areas to provide an integrated intervention of water harvesting, watershed management and soil health, to enhance the productivity of the dry land farming areas.

From *Kharif* 2010, pulses components of Integrated Scheme of Oilseeds Pulses Oilpalm and Maize (ISOPOM) have been merged under NFSM Pulses to intensify efforts for production of pulses.

Accelerated Pulses Production Programme: A new initiative 'Accelerated Pulses Production Programme (A3P)' has been launched as part of NFSM Pulses from 2010-11. One million hectares of potential areas for the major pulses crops - tur, urad, moong, gram and lentil have been taken up for large scale demonstration of production technologies in compact blocks. Nearly 4.0 lakh hectare area was covered during *Kharif* 2010 under the programme.

1.5 Present study

India is the fourth among largest producer of oilseeds in the world next to the USA, China and Brazil, but its productivity is quite low. The low and fluctuating yields are primarily due to a large part of the cultivation being on marginal lands lacking irrigation. Growing population, good supply conditions and rising income levels of Indian consumers are likely to raise edible oil consumption levels to 17.1 million tonnes. The vegetable oil deficit in 2011-12 is expected to be around 10.8 million tonnes, of which 87 per cent is likely to be met through imports. The edible oil import for 2011 marketing year is estimated at 9 million tonnes. However, even as per capita edible oil consumption in India is increasing (estimated at 13.8 kg for 2011-12) it is still far below the estimated world average per capita consumption of 21.7 kg.

Pulses are an essential source of protein in the diet of the vegetarian Indian population. With an annual production of 12 to 14 million tonnes, India is among the major pulse producing countries even today, but its productivity is low compared to other countries. Indian per capita consumption of pulses has fallen from 27 kg in 1960's to 11 kg by the end of 2010 as rising prices curb consumption across the country and shortfall of around 3 million tonnes every year is met with imports. Therefore, our target should be to achieve production levels equivalent to say 25 kg per capita consumption instead of the present 10 to 20 kg per capita if we are to make a meaningful impact on health and nutrition requirements of the vast majority of our population.

One of the approach to increase domestic production of oilseeds and pulses and to reduce imports is Technology Mission on Oilseeds and Pulses and other such schemes implemented by Government to increase production of oilseeds and pulses and to make country self sufficient. After the introduction of Technology Mission on Oilseeds and Pulses in the state, the total area under oilseeds and pulses has increased, but the level of instability also increased over the period. Therefore, the efforts to induce stability in oilseeds and pulses sector of the state require proper understanding and analysis of factors responsible for output instability. It is, therefore, of great importance to study the performance of major oilseeds and pulses in major producing districts of the state and assess the impact of TMOP on cropping pattern, input usage and crop yield.

Hence, the present study attempts to analyse the performance of the major oilseeds and pulses of Karnataka namely groundnut, sunflower, pigeon pea, chickpea and also total oilseeds and total pulses both at disaggregate and aggregate levels. The results and policies of the present study helps Technology Mission to carry out its programme still in a better way and reach its goal of making Karnataka in particular and India in general self sufficient in oilseeds and pulses production.

1.6 Objectives of the study

The specific objectives of study are:

1. To study the growth in area, production and yield of oilseeds and pulses in Karnataka during pre and post Technology Mission on Oilseeds and Pulses;
2. To analyze the impact of Technology Mission on Oilseeds and Pulses economy of the state;
3. To analyse factors influencing production of oilseeds and pulses in the state; and
4. To study the returns to investment on Technology Mission on Oilseeds and Pulses in the state.

1.7 Hypotheses

The hypotheses framed for the respective specific objectives are as follows:

1. There exists positive growth in area, production and productivity of oilseeds and pulses during Post Technology Mission period in the state.
2. There is a positive impact of TMOP on oilseeds and pulses economy
3. The main sources of instability in production of oilseeds and pulses are the fluctuations in area and yield.
4. Investment on Technology Mission on Oilseeds and Pulses is profitable.

1.8 Presentation of thesis

The thesis is presented under six chapters.

Chapter-I Introduction: In this chapter, the nature, importance of the present study and the specific objectives of the study have been indicated.

Chapter-II Review of literature: It presents a comprehensive review of the relevant research work done on related topics by different economists.

Chapter-III Methodology: It outlines the features of the study area, sampling design followed, relevant data and analytical tools used in the study.

Chapter-IV Results: It is devoted to present the main findings of the study through tables and graphs

Chapter-V Discussion: It presents meaningful interpretation and discussion of the results of the study.

Chapter- VI Summary and policy implications: This chapter provides summary of the entire research work and suggests the policy implications emerged from the findings.

1.9 Limitations of the study

Due to the limitations of time and other resources, the study was confined to four districts of Karnataka which are considered as major oilseeds and pulses growing areas of Karnataka. The primary data was collected for the year 2011-12. Further, the expressed opinions of respondents with regard to the various issues of the study may not be totally free from personal bias and prejudice. Hence, the results of the study cannot be generalized beyond the limits of the study area.

REVIEW OF LITERATURE

In this chapter findings of some of the earlier research studies relevant to the present study have been reviewed. This would enable the researcher to collect information and subject them to sound reasoning and meaningful interpretation. It was expected that such a review of literature would provide a basis for either conforming the earlier results or contradicting them and there by suggesting the points for further improvement.

Keeping in view the objectives of the study, the literature reviewed are presented under the following headings:

2.1 Growth in area, production and productivity of oilseeds and pulses.

2. 2 Impact of Technology Mission on oilseeds and pulses economy.

2.3 Sources of instability in production of oilseeds and pulses

2.4 Returns to investment on Technology Mission on Oilseeds and Pulses.

2.1 Growth in area, production and productivity of oilseeds and pulses

Waliya *et al.* (1986) carried out the growth rate and trend analysis in area, production and yield of potato in major potato growing states of India using 30 years secondary data from 1950-51 to 1979-80. The results revealed that increase in area in all states were significant except in 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 showed positive growth in production and declined yields were observed in Bihar and Madhya Pradesh during 1950-51 to 1969-70.

Sale (1987) studied the performance of principal crops in Maharashtra during the period 1956-57 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 were satisfactory, while *Rabi* jowar and groundnut wereunsatisfactory during the period. The higher growth rates in production of *Kharif* jowar and sugarcane were due to area expansion and improvement in productivity. He observed that inter-district disparities in performance of the most of the crops were mainly due to variations in the extent of adoption of technological change in agriculture.

Singh and Swarup (1988) analysed the growth rates in area, yield and output of important pulses in Himachal Pradesh during the period 1972-73 to1981-82. The study concluded that the relative acreage under pulses had decreased at the compound growth rate of 0.92 per cent per 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 bengal gram, blackgram and horsegram showed positive trend to the tune of 0.04 to 0.60 per cent per annum, respectively.

Lal *et al.* (1989) analysed the growth performance of rapeseed-mustard at the state level in India for the period from 1954-55 to 1984-85. Over the period, compound growth rates of area, production and yield had varied between states and indicated a low growth rate during the Post green revolution period as compared to the Pre-green revolution period.

Sharma and Gandhi (1990) examined the annual compound growth rates of food grain production in India during the period 1950 to 1984. It was found that growth in production had declined between 1949-50 to 1975-76, while it modestly accelerated during 1975-76 to 1983-84. However, the overall growth rate per annum was 2.6 per cent which indicated a sustained recovery. Area led growth rate had shown declining potential, while yield based growth rate had shown increasing potential during 1975-76 to 1983-84. This necessitated for sustaining yield and technology based growth for the future.

Jain and Singh (1991) estimated the growth rates for different pulses in Punjab during Pre and Post-Green Revolution phase to examine whether the new cereal technology had got diffused to Pulses. During the Pre-Green Revolution period area, yield and production of total pulses registered a positive but non-significant growth rates indicating stagnation. Whereas, in the second period, all the three variables showed negative growth rates which were significant in the case of area and production, denoting deceleration.

Continuous substitution of area under pulses with HYV cereal crops was the main reason for the desperate performance of pulses in the Post-Green Revolution period.

Mitra and Jena (1991) conducted a study on growth of groundnut production in Orissa. The entire period of 36 years was divided into two sub periods *viz.,* Period-I (1950-53 to 1962-65), Period-II (1967-70 to 1983-86). Growth rates of the entire period *i.e.* from 1950-51 to 1985-86 were also studied. The study concluded that the compound growth rates of area were increased by 3.70 per cent per annum, whereas the magnitude for productivity was 2.12 per cent per annum for Period - I (1950-53 to 1962-65) in Orissa. During Period - II, significant growth was observed in area by 9.83 per cent per annum and productivity by 0.16 per cent per annum. During Period III, productivity increased by 2.11 per cent per annum.

Tripathy and Gowda (1993) used exponential functions to estimate and compare the district-wise compound growth rates of area; yield and production of groundnut in Orissa during seventies (1970-71 to 1979-80) and eighties (1980-81 to 1989-90). The structural change in the growth pattern between two decades was examined employing Chow's test. Despite negative growth in yield in both decades, the growth in production was impressive, which increased from 4.56 per cent per annum in the seventies to 7.87 per cent in the eighties which was mainly due to high growth in area under groundnut. The structural change in the growth function, especially that of yield and production in almost all the districts covered in the study was apparent from the significant 'F' values obtained in the Chow's test.

Goswami *et al.* (1995) made an attempt to analyze the compound growth rates in area, yield and production of total pulses, bengal gram and pigeon pea. The compound growth rate in area of total pulses and bengal gram (1.77 and 1.82 per cent, respectively) was higher in Phase-I (1950-51 to 1964-95) as compared to Phase-II (1967-68 to 1980-81) and Phase-III (1981-82 to 1990-91). However, the highest growth rate in pigeon pea area (2.28 per cent) was noticed in Phase-III. The growth in yield of total pulses and bengal gram was found to be 1.04 and 1.03 per cent in Phase-III. While growth in yield of pigeon pea was negative both in Phase-I and Phase-III. Higher growth rate was noticed in production of total pulses and pigeon pea to the extent of 2.19 and 2.66 per cent respectively in Phase-III. Increase in area contributed for higher growth rate in production of total pulses and bengal gram in Phase-I, while in Phase-III higher growth in production was due to increase in yield.

Hiremath *et al.* (1996) studied the growth rates in area, production and productivity of important pulse crops in Karnataka for the period from 1984-85 to 1993-94. The compound annual growth rate in area under red gram decreased steadily (0.06%) over the period from 1984 to 1994 where as in other pulse crops it increased. The area under black gram showed the highest growth rate of 6.51 per cent followed by green gram (5.40%) and bengal gram (1.12%). With respect to production, black gram registered a higher growth rate (12.15%) followed by green gram (2.23%). Production of bengal gram and red gram decreased over a period of time by 1.31 per cent and 1.57 per cent respectively. With respect to productivity, black gram showed the highest growth rate (5.50%) followed by green gram (4.90%) and both were statistically significant. The growth rate of bengal gram was 0.38 per cent and that of red gram was 3.25 per cent.

Kumar Priya Ranjan (1996) studied compound growth rates in area, production and productivity of pulses in North Bihar region covering two zones, Zone-I and Zone-II. The changes in area, production and productivity have been examined for 24 years in two periods *i.e.,* early period of green revolution (1974-84) and later period of green revolution (1984-94). The annual growth rates of area under arhar was negative (-3.0%) during study period which remained negative during 1970s and 1980s but turned out to be positive during early nineties. Area under bengal gram also witnessed negative growth rate (-3.3%), but the rate of decline slowed down during early 1990s. It was finally concluded that inspite of negative growth in area under major pulses, the area under total pulses showed positive growth in both the zones, indicating an increase in area under minor pulse like greengram and blackgram which were grown during *Kharif* and summer seasons in the project area.

Patel *et al.* (1996) studied the compound growth rate of pulses in selected districts of Gujarat for the period 1949-1991. For Gujarat state as a whole, the production growth rate for the study period worked out to be 3.05 per cent, the growth rate in area and yield was 0.70 per cent and 2.19 per cent, respectively. Surendranagar district registered highest growth in area (4.78%) and production (6.82%). The coefficient of variation was found to be 43.63 per cent for production, 22.65 per cent for area and 29.22 per cent for yield.

Ram Singh (1996) studied the growth trend for four major pulse crops in four regions of Uttar Pradesh. The Bundhelkhand region showed consistently positive growth, while the rest of the three regions showed negative growth in acreage under all the major pulse crops. The annual growth rate of bengal gram varies from 0.9 per cent in the Budenlkhand region to -2.1 per cent in the Western region. The Western region has suffered the most in terms of displacement of acreage under all the pulse crops under study, the decline being the highest (7.5%/annum) for green gram (moong).

Kandarapa Kumar Barman (1997) studied the compound growth rates of area, production and productivity of pulses in Assam for the period 1967-68 to 1989-90. It was found that the compound growth rates of production of bengal gram, pigeon pea, other pulses and total pulses were 3.75 per cent, 5.03 per cent 2.64 per cent and 2.85 per cent, respectively. The growth rate of the production of pigeon pea was found to be the highest but its yield growth was negative (-0.51 per cent per annum). The growth rates of area under different pulses turn out to be positive in case of Assam and these are much higher than the corresponding growth rates as compared to India.

Sawant (1997) studied the growth performance of India's agriculture sector during different periods. Compound Annual Growth Rates (CAGRs) (Abbreviations could be given when CAGR was used ealier) were estimated by fitting a log linear trend function, to the time periods specified *viz.,* period I (1968-69 to 1980-81) and period II (1981-82 to 1994-95). The growth scenario for pulses indicated that from acute stagnation in output in the early part of the green revolution period, the situation improved to a positive, significant but low growth in output (CAGR=1%) after 1981. The former was the outcome of slow expansion in area accompanied by decline in the yield of pulses while in the post 1981 period, expansion in pulses output was totally induced by growth in their yield (CAGR=1%). The dismal performance of the two major pulses, *viz* bengal gram and pigeon pea, was largely responsible for low level of output growth of all pulses after 1981. By and large, pulses represented a group of slow growing crops throughout the green revolution period.

Singh *et al.* (1997) while assessing the regional variations in agricultural performance in India, estimated the compound growth rates of area, production and yield of pulses by fitting log-linear functions of the form log y=a+bt. The data were analyzed for three time periods *viz.,* Period I (1960-61 to 1967-68), Period II (1968-69 to 1980-81) and Period III (1981-82 to 1992-93). In almost all the states selected for analysis, the growth rates of pulses were highest during period II. In Karnataka during the same period, significant growth rates were observed with respect to area (1.93%), production (1.72%) and productivity (3.66%).

Kulkarni (1998) reported that Belgaum district registered a positive and significant growth in area (16.53%) and production (21.53%) of cotton. The growth rates of productivity were positive but non-significant.

Anonymous (1999) studied the growth in agricultural production in India. The growth in agricultural production was about 3.9 per cent in 1998-99 as against a drop of 6 per cent in the preceding year. Foodgrains production increased annually by 3.22 per cent during fifties mainly because of expansion in foodgrain area. The sixties recorded a low annual growth of 1.72 per cent necessitating large scale imports of foodgrains. Annual growth of 2.08 per cent was recorded during seventies. This decade was the turning point in the India's foodgrain economy 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. An annual growth of 3.5 per cent in foodgrains in eighties was the hallmark of the green revolution that enabled India to become self sufficient in foodgrains and even a marginal exporter.

Balappa *et al.* (1999) analyzed the growth performance of red gram in Gulbarga district and Karnataka state as a whole over the period 1980 to 1994. The quadratic growth function was fitted for the estimation of growth in area and cubic function for production and productivity, respectively. The study showed that area under red gram declined significantly by 10 per cent and 9 per cent per annum respectively during 1980-81 to 1994-95 in Gulbarga district and Karnataka state as a whole, whereas a significant growth in productivity was (11.00%) observed at the state level.

Legesse (2000) found that during 1980s wheat area showed a declining growth (- 3.94 per cent) but production and productivity showed negative growth rate. During 1990s, the Karnataka state recorded a significant positive growth of 3.47 per cent in area while in production, the state recorded a mild growth but productivity showed a negative growth.

Veeresh Hiremath (2004) studied the growth in area, production and productivity of cotton in Dharwad district of Karnataka state. The results showed that both area (4.90%) and production (10.60%) of cotton showed significant growth whereas the productivity growth (3.00%) was found to be non-significant

Bindukumar (2006) studied the changes in redgram economy of Karnataka and study period was divided in to three sub periods Pre-WTO (1985-86 to 1994-95), Post-WTO (1995-96 to 2004-05) and overall period (1985-86 to 2004-05). The results of the study revealed that, growth in area was almost constant in both Pre-WTO and Post-WTO period *i.e.,* 2.80 per cent per annum. In Pre-WTO period the performance of this crop was poor both in production and productivity which showed negative trend (-3.21% and -5.85% respectively), whereas in Post-WTO period production grew at the rate of 8.33 per cent and productivity at the rate of 5.50 per cent which was impressive. The growth in area, production and productivity for overall period, in Karnataka was not encouraging (0.52, 0.59 and 0.06 per cent respectively).

Sandesh *et al.* (2006) in their study on growth and instability analysis of major oilseeds in selected states of India revealed that, among the selected major oilseeds growing states, the production of total oilseeds showed significant positive growth in Karnataka, Madhya Pradesh and Maharashtra (3.07, 8.57 and 4.74 per cent) during overall period (1971-72 to 2002-03) and all other states showed positive growth during the same period except in Uttar Pradesh India as whole showed a significant positive growth in area, production and productivity (1.65, 3.66 and 1.98 per cent) during overall period and this is due to the implementation of Technology Mission on Oilseeds.

Shinde (2008) studied the diversification of agriculture in Maharashtra. He estimated the compound growth rates in area, production and productivity of major crops for different time period *viz.* Period I (1960-69), Period II (1970-89), Period III (1990-2003) and overall Period (1960-2003) for different regions and state as a whole. The study was based on both the macro and micro level data. For macro-level analysis, the district wise time-series data for 43 years, from 1960-61 to 2002-03 on area, production and productivity of crops, rainfall, GCA, GIA and other economic indicators were obtained from various publications. The study concluded that at the state level, area, production and productivity of bengal gram was observed to be decreased during Period-I. Significant negative growth rates were noticed in the area under ragi, *Kharif* groundnut, wheat and production of pigeon pea and *Rabi* jowar during the same period, whereas area under bajra, pigeon pea, urad, sesamum and cotton increased significantly during this period. During Period-II, area and production of sesamum and sugarcane increased significantly. During the same period, the area, production and productivity of *Kharif* jowar, paddy, ragi, pigeon pea, mung, cotton, sugarcane, *Rabi* jowar, bengal gram and safflower and productivity of wheat and bengal gram increased significantly. During Period-III, significant growth was observed in area, production and productivity of pigeon pea and soybean, whereas significant declining trends were observed in area and production of ragi, *Kharif* groundnut, sesamum, safflower and sunflower. During Period-III, the productivity of all the crops increased significantly with different magnitudes in the state during the entire period, except, pigeon pea, which recorded positive but non-significant growth.

Rama Rao (2010) studied performance of pulses during Pre and Post-WTO periods in Andhra Pradesh and found that during the overall period, state as a whole, pulses had shown high growth rate in area (1.60%), production (3.17%) and productivity (1.54%). During the period I, growth rate was low in productivity (0.38%), whereas, growth in area (1.11%) and production (1.49%) were moderate for state as a whole. So, growth in area contributed more towards growth in production than by growth in productivity. Pulses production in Post-WTO era (1996-97 to 2005-06) showed tremendous growth (6.85%). Reason may be due to effective implementation of Technology mission on pulses since 1990-91 in Andhra Pradesh and more importantly expansion of area of chickpea in *Rabi* season.

Mahal Kaur *et al.* (2011) studied on growth performance, variability and instability of pulses and food grains in Punjab state. The study was based on secondary data collected from statistical abstracts of Punjab for the years 1960-61 to 2009-10. The study showed that growth rate of pulses production decreased significantly during this period. It was -8.09 per cent per annum during sixties and decreased to -9.16 per cent per annum during 2000-01 to 2009-10. This happened due to significant decrease in area *i.e.* -7.17 per cent for whole period under pulses, whereas production of food grains increased at the rate of 4.62 per cent per annum *i.e.* five times because of significant increase in area and yield of food grains. The instability in production of pulses is much higher *i.e.* up to 35.74 per cent. Variability and instability increased in pulses but decreased in food grains.

2.2 The impact of Technology Mission on oilseeds and pulses economy

Patil *et al.* (1991) in their study on oilseeds production – constraints, technology and future research needs in Maharashtra found that due to frontline demonstrations in 1990 in Jalgaon, there was 16 per cent increase in yield compared to farmer's practices in case of *Kharif* groundnut crop and likewise there was 25.11 per cent increase in yield in *Rabi*/ summer groundnut.

Balappa *et al.* (1998) evaluated the economics of IPM for redgram in Gulbarga district of Karnataka. They indicated that the farmers who followed IPM technology used more human and bullock labour, manures, fertilizers and less of chemical fertilizers. Whereas, non-IPM farmers used more of pesticides and imbalanced nutrients. The non-IPM farmers incurred relatively higher cost on plant protection measures through the indiscriminate use of chemical pesticides. The IPM farmers obtained higher yield (12.4 q/ha) and net income (19.45%) despite relatively higher cost of cultivation as per the farm management concept. The B: C ratio in IPM farm was marginally higher than that of non-IPM farm.

Nagaraj *et al.* (2004) conducted a study on impact of application of bio fertilizer on groundnut production, in Koratagere taluk of Tumkur district in Karnataka. The data pertaining to *Kharif* season of 1998 was collected from 30 farms each with and without bio fertilizer application, growing JL 34 and TMV 2 variety of groundnut crop were selected randomly from three villages. The results showed a productivity change of 497.60 kg/ha, of which 36.41 per cent was due to use of bio fertilizer in groundnut production.

Aung Kyaw Moe *et al.* (2007) studied the impact of changes of agricultural marketing and pricing policies in Myanmar. Before market reform, domestic and export markets were monopolized by government and farmers had to sell quota of their marketable surplus at fixed prices. After market reforms, compulsory delivery system of agriculture produce was discontinued and private marketing was well-developed in domestic markets as well as in export of crops such as pulses. This study assessed the impact of market reform by examining acreage response to price with Nerlove partial-adjustment model covering yearly data from 1988-2004. Acreage response to liberalization of prices and marketing was statistically significant in export crops, Black gram, Green gram, Pigeon pea and Chickpea except Soybean with lack of export demand. Although the short-run elasticity of acreage was less than unity, the long-run elasticity was quite greater than unity. Agricultural market reform, with price incentive to farmers, can induce the motivation of production. However, complementary interventions for the improvement of infrastructure, marketing, access to inputs and credits, production technology etc are still pre-requisite.

Grover and Singh (2007) studied potential and constraints in Sesamum cultivation in Punjab and showed that the impact of technology in terms of increase in area was observed in Amritsar, Ferozepur, Jalandhar and Kapurthala districts, which were statistically significant. Increase in yield was recorded in the Ferozepur and Ludhiana districts only. Therefore, no major impact of development programmes was observed in terms of increase in yield in the major sesamum growing districts, though in a few districts, it was observed in terms of increase in area.

Singh *et al.* (2007) evaluated a study which was carried out by the Krishi Vigyan Kendra under IISR, Lucknow during *Rabi* season from 2002-03 to 2006-07 in Lucknow district of Uttar Pradesh. It indicated that the cultivation practices comprised under FLD *viz.*, use of improved variety (*Pusa Jaikisan*), line sowing, balanced application of fertilizer and control of mustard aphid through insecticide at economic threshold level, produced on an average 45.97% more yield of mustard as compared to local check (12.4q/ ha). The results indicated that the frontline demonstration has given a good impact on the farming community of Lucknow district as they were motivated by the new agricultural technologies applied in the FLD plots. It showed that the yield of mustard in these years increased which clearly speaks of the positive impact of FLD over existing practices of mustard cultivation.

Nath and Lingareddy (2008) studied the effect of introduction of futures trading in India on spot prices of pulses. Price data were obtained from the wholesale price index series compiled and published by the Central Statistical Organization for the commodities under study covering the period January 2001-August 2007, while commodity-wise futures volumes were collected from the web sites of the respective exchanges and the Forward Markets Commission. It is shown that futures activity has a significant and direct causal influence on urad prices and volatilities whereas the same has not been statistically significant in the case of gram.

Nevertheless, average price changes and volatilities have increased during the period of futures trading in the case of urad, bengal gram and total pulses.

Chatterjee and Giri(2010) studied on assessment of National Food Security Mission in India with special reference to West Bengal and found that in none of the NFSM districts under pulses, actual production seemed to have surpassed the targeted production level up to 2008-09. It is therefore, observed that the progress achieved in raising additional production through efforts under NFSM is not satisfactory up to second year of operation. But it is expected that the initial hurdle in the implementation of programmes will soon be removed and the programme will gain momentum eventually, provided the weather factor does not disturb the programmes.

Ashok Kumar *et al.* (2011) studied the impact of frontline demonstrations on Indian mustard in Bharatpur district of Rajasthan. The results showed that the level of knowledge and adoption of improved mustard production technology was higher in beneficiary farmers than non-beneficiary farmers. The overall difference in knowledge level of beneficiary and non-beneficiary farmers was only 5.82 Mean Percent Scores (MPS). It was found that difference in adoption level between beneficiary and non-beneficiary farmers ranging from MPS 3.89 to MPS 40.50. The highest and significant difference was observed in adoption of fertilizer management followed by seed treatment, use of high yielding varieties, seed rate and spacing, pest management, harvesting and storage and soil treatment. The overall difference in adoption level of different practices of MPT between beneficiary and non-beneficiary was 14.22 MPS. Further, most of the beneficiary respondents had positive attitude towards FLDs. It can be said that there was positive impact of FLDs conducted by National Research Centre on Rapeseed-Mustard on knowledge and adoption of the mustard production technology.

Deepak (2012) evaluated the impact of NFSM on pulse crops in Maharashtra and reported that the average category of sample farmers belonging to NFSM district of Amravati generated 33.31 per cent higher per hectare net returns in 2007-09 over 2006-07, 43.97 per cent in 2008-09 over 2006-07. The average category of sample farmers belonging to non-NFSM district of Beed 42 per cent rise in per hectare net returns in 2008-09 over 2006-07.The comparative analysis drawn clearly showed positive impact of NFSM programme in raising various pulses since net returns from these crops are not only higher in NFSM district as against non- NFSM district but net returns have grown sharply in 2008-09 over that of 2007-08, especially in NFSM district of Amravati. In fact, the farmers belonging to NFSM district derived 44 per cent higher net returns from pulses crop cultivation in 2008-09 over that of 2007-08 as against only 20 per cent higher net returns being generated from pulses cultivation in non-NFSM district of Beed in 2008-09 over that of 2007-08.

2.3 Sources of instability in production of oilseeds and pulses

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

Pal and Sirohi (1989) identified the sources of instability in crop production and yield in different states in India between two periods, 1960-1965 and 1966-1984. The results revealed that yield variation contributed largely to the variance in production of pulses and oil seeds and the same being increased over time. After adoption of HYV's, the absolute variance increased on account of increased sensitivity of HYV to inputs and weather, especially rainfall. The intensive use of irrigation led to comparatively stable production of food grains.

Gemtessa (1991) compared the variability in export earnings of Ethiopian coffee over pre-green revolution and post- green revolution periods. The price variation contributed for a larger share of variance of export earnings. This accounted for 137.5 per cent increase in the variance of total earning from coffee.

Jain and Singh (1991) studied the growth and instability in pulses production in Punjab. The change in variance of production over two periods (Period-I : 1950-51 to 1983-84 and Period –II :1965-66 to 1983-84) was decomposed using Bohrnstedt and Boldberger (1969) scheme and it was found that decline in mean area was the major primary factor responsible for the decline in production variance. Within the district, the area variability declined for each pulse crop and between the pulses crops over the two periods.

Singh (1993) applied variance decomposition procedure to time series data on food grains to analyze the sources of instability over a period from 1950-51 to 1989-90. The increase in total food grain production and average production for two sub-periods had been accompanied by higher instability and risk in production of certain crops. The coefficient of variation of food grain production increased by 6.97 per cent and 39.65 per cent respectively between the periods.

Jalajakshi (1994) studied the instability in the export of shrimps from India for the period 1966-91. The shrimp exports to Japan and USA were found to be stable but dried and canned shrimp exports to Japan, USA, UK and EEC showed a high variability. This was due to the decreased demand in the importing countries and high cost of production in India.

Singh and Mathur (1994) assessed instability in production of potato in India using coefficient of variation. It was found that area and production were unstable because of the response of potato production to prices of competing crops and the adoption of modern technology respectively. The production of potato increased and decreased with the increase and decrease in the prices of competing crops respectively.

Ananthi (2000) studied the instability in export value and export unit value of basmati and non-basmati rice for the period from 1990-91 to 1997 -98. The coefficient of variation was 90.76 per cent for export quantity, 55.77 per cent for export value and 24.35 per cent for export unit value. She concluded that the instability was relatively high in the case of export quantity value of basmati rice.

Mahadevaiah (2001) studied the export trade performance of Indian Cotton. He found that the stability in export earnings from total cotton exports, exports to major importing countries and others indicated that change in price variance, change in mean price and change in the interaction term were the major sources which contributed to the variability in cotton exports. He found that the change in price variance (19.72%) together with change in mean price (13.72%) increased the instability in total cotton export earnings. About 66 per cent of variance in export earnings was due to interaction between change in mean quantity and mean price. The change in price variance has contributed less than one per cent to the instability of export earnings from most of the major importing countries except in case of Japan, where it has stabilized the export earnings. The study also found that the increase in mean price has mainly contributed to the increase in total cotton export earnings.

Girma (2002) studied the instability and its sources in cotton production in Karnataka. The results showed that the instability increased from 14.8% to 27.8% in the second period, the coefficient of variation was 40.66%. All the study districts except Belgaum and Gulbarga showed maximum instability in cotton production.

Sharma and Kalita (2008) studied the variation and instability in area, production and productivity of major fruit crops in Jammu and Kashmir for the period from 1974-75 to 1999-2000. It revealed that growing of pear, cherry and almond were more risky compared to other fruit crops in the state due to higher coefficient of variation. The coefficient of variation in area production and productivity of these were more than 78 per cent. The raising of apple in the state was less risky, which had a coefficient of variation of less than 35 per cent.

Krishnadas(2010) analysed the instability in production of major spices in India for the period from 1979-80 to 2006-07. The study revealed that sources of instability in chilli production were found to be change in area variance and change in yield variance. The total change in variance of pepper production was found to be zero. The main source of change in average turmeric production was found to be change in mean yield and the main sources of instability in coriander production were found to be change in yield variance and change in area- yield covariance.

Rama Rao (2010) studied on performance of pulses during Pre and Post-WTO period in Andhra Pradesh and found that in thirteen districts, change in mean area has more effect on average production differential than by other components of change. The highest mean area effect was recorded in Khammam district (217.78%), whereas, highest change in mean yield (3214.54%) was noticed in Visakhapatnam. Further, in majority of districts (13 out of 22) mean area effect was higher than other components. Among the regions, from period I to period II change in mean yield was higher than other components of change in Telangana, whereas, change in mean area was higher in Coastal Andhra and Rayalaseema, of which, the highest was in Coastal Andhra (85.12%).

State as a whole, effect of change in mean area (44.87%) was marginally higher than mean yield (43.91), mean area and yield (7.12%) and area and yield covariance (4.10%). Thus, change in mean area and mean yield has equal destabilizing effect on average production differential between the periods I and II.

2.4 Returns to investment on Technology Mission on Oilseeds and Pulses

Patil and Jha (1978) studied changes in output, input and agricultural productivity growth in Maharashtra state and India during 1951-52 to 1971-72. During the sub-period 1951-52 to 1960-61, 18 out of 25 district recorded positive output growth, growth in inputs varied between 0.82 per cent and 2.82 per cent per annum in different districts and the average growth in inputs was nearly 1.84 per cent and a negligible growth in modern inputs was observed. Total factor productivity growth was positive in 14 districts and was between 0.85 to 5.92 per cent per annum. During the sub-period 1960-61 to 1971-72, the growth decreased. Only nine out of 23 districts showed growth rates over 2.5 per cent per annum, 2.09 per cent of this increase was due to growth in the modern inputs, although output growth did not seem to be related to growth in either traditional or modern inputs. Only three districts recorded productivity gains other showed decline in productivity. During the sixties, agricultural output stagnated in spite of rapid growth in modern inputs mainly because the technological assets acquired in the 1950 s had depreciated greatly and this completely nullified the condition of modern inputs. Agricultural research and extension to disseminate new technology must have a most critical role in rapid output growth.

Bramhananda (1982) estimated TFP for agricultural sector (crop production and livestock) in India vis-a-vis other sectors. The chain index of productivity in agriculture sector showed a productivity improvement of 1.5 per cent per annum during 1950 and thereafter it declined to 0.8 per cent per annum between 1960-61 and 1970-71 and further to 0.3 per cent per annum between 1970-71 and 1980-81. After studying other sectors, he also observed that as we move from first to the third decade, the TFP growth rates decline universally. Thus, the contribution of improvement in TFP to sectoral growth shown to have become less and less as we move from the first decade to the third decade. The most important commodity producing sector like agriculture had a negative contribution to TFP growth in the third decade. The productivity growth momentum was thus lost.

Kumar and Mruthyunjaya (1992) estimated Total Factor Productivity (TFP) for wheat in Indian states. During the period 1972-89, the TFP index had risen by around 1.9 per cent in Punjab, 2.7 per cent in Haryana and Rajasthan, 2.6 per cent in Uttar Pradesh and 0.4 per cent in Madhya Pradesh. Thus, the TFP growth rates in wheat sector in the states of Northern India were much above the rate of growth in TFP in other states of India and Pakistan for these crops sector and also during postwar agriculture period in United States of America. The productivity growth was responsible for 37 to 53 per cent of total output growth in the frontline states, around 17 per cent in Madhya Pradesh and nearly all the output growth in Rajasthan.

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 drought years of 1965, 1966 and 1979. Variation in TFP around trend was due to variation in output as total input use increase smoothly over time. With total output growth increasing at three per cent per annum, productive growth has accounted for approximately one- third of the total output in the Indian crop sector.

Singh and Paramjit (1992) in their study on returns to investment on agricultural research and extension in India and Punjab state found that the marginal products were computed at ₹. 10.69 for research and ₹. 3.99 for extension in India and ₹.7.34 for research and ₹. 5.64 for extension in Punjab. Internal Rate of Return worked out to be 87.15 and 60.62 per cent for India and 90.60 per cent and 64 per cent for Punjab under first (returns will accrue into perpetuity) and second (returns will accrue once for all in the peak period of research impact on productivity) assumptions, respectively.

Thirtle and Bottomley (1992) studied indices of Total Factor 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 community. At the aggregate level, this change was explained by increased aggregate output and decreased aggregate input in about equal proportions. Disaggregation showed the intensification effect of the common agricultural policy price regime. They observed that there has been rapid growth in the output of farm crops and in the use of agricultural chemicals.

Tuteja (1992) examined changes in factor proportions in wheat and rice farms in Punjab and Haryana and the role of price and technological change on the factor proportions. An impact of technological change on factor proportions was analysed using capital-labour ratio, capital land ratio and land-labour ratio. The capital land ratio has increased from 2.26 to 4.26 over the period 1970-71 to 1984-85. Generally, the capital labour ratio was lower on rice farms as compared to wheat farms. The capital land ratio has risen with the changing level of technology. On wheat farms in the Indian Punjab, this ratio rose from 1.25 to 1.98 between 1970 to 1984-85. In Haryana, it rose from 2.00 to 2.67 over the period. The land-labour ratio also tends to rise with technology change. The land labour ratio on wheat farm in the Punjab and Haryana had shown increase of 18.78 and 11.25 per cent, respectively over the period. The policy implication is that investment in agricultural research, extension and irrigation could be more effective than manipulating input-output prices.

Dholakia and Dholakia (1993) examined the sources of growth of Total Factor Productivity in Indian agriculture over three periods, Pre-green revolution (1950-51 to1966-67), Initial phase of the green revolution (1966-67 to 1980-81) and Modernization phase (1980-81 onwards). The study shows that total factor productivity growth in agriculture had been the prime driving force behind the acceleration of overall growth in the Indian economy achieved during the 1980s. Technical progress as measured through TFPG had not been directly determined by capital, labour or capital per worker. Modern inputs such as HYV seeds, fertilizer and irrigation were successfully raised TFPG in Indian agriculture, particularly during the 1980s.

Kumar and Rosegrant (1994) estimated TFP for rice in India. The results revealed that though growth in input index has declined from 2.99 per cent in 1970s to 2.13 per cent in 1980s. Similarly, the output index declined from 4.30 per cent during 1970s to 3.10 per cent during 1980s. Closely following the input-output index, the TFP declined from 1.31 per cent during 1970s to 0.97 per cent during 1980s. Thus, the recent studies covering the period up to 1980s in Indian crop sector indicated that growth has declined in 1980s as compared to 1970s as shown in rice.

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 into 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.

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 of 1.3 per cent per annum proceeded along the traditional production function and was driven by growth in output. 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.

Evenson *et al.* (1999) had analysed the trends and sources of TFP growth in India's agriculture and showed that the gains in productivity had contributed about 1.1 per cent per annum since 1956. The TFP and conventional inputs contributed roughly 2.3 per cent growth rate per annum in total crop output.

Fan *et al.* (1999) computed TFP for the agriculture sector of India as a whole and different states of India for the period 1970 to 1995. Five major crops (rice, wheat, sorghum, pearl millet and maize), 14 minor crops (barley, cotton, groundnut, other grains, other pulses, potato, rapeseed, mustard, sesame, sugar, tobacco, soybeans, jute and sunflower) and threemajor livestock products (milk, meat and chicken) were included in the measurement of output index. TFP for India grew at an average annual rate of 1.8 per cent. During the 1970s, TFP growth rate was 1.6, but it grew fast during the 1980s, at 2.5 per cent per annum. Since 1990, TFP in Indian agriculture has continued to grow at a slower rate (2.3% per annum), butstill it is at a high level. Modern inputs such as HYV seeds, fertilizers and irrigation were major contributors to TFP growth in Indian agriculture. Rapid adoption of new technologies and improved rural infrastructure induced productivity growth. The government spending on productivity-enhancing investments (especially agricultural research and extension), rural infrastructure (especially roads and education) and rural development targeted directly at the rural poor, all contribute to the growth in agricultural productivity.

Mittal and Lal (2001) worked out TFP and sources of productivity growth in wheat in major states of India. They found growth in index to be 0.9 per cent per annum. Cost per unit of wheat has declined steadily at an annual rate of 2.2 per cent. The study concluded that the investment in research, tubewells, irrigation and rural electrification are the determinants of TFP growth.

Shhariyanto and Thirtle (2001) measured total factor productivity (TFP) for 18 Asian countries from 1965-96. TFP was measured by calculating the Malmquist index with respect to the sequential frontier, which is appropriate when the cross selection 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.

Brummer *et al.* (2002) studied the total factor productivity growth index. TFP was decomposed into four components (technical change, technical and allocative efficiency and scale component). Stochastic Translog output distance functions were estimated using panel data from dairy farms over the period 1991-94 for three European countries (Germany, Netherlands and Poland). Results indicated that the change in the productivity growth index in Germany (6%) and Poland (-5%) are mainly dictated by the technical change component. In contrast, the productivity growth index in the Netherlands (+3%) is influenced by allocative efficiency components.

Dhillon and Ali (2002) reviewed the performance of agriculture in Punjab. The authors main focus was to estimate changes in Total Factor Productivity and to examine the implication of the recent trends in TFP for further growth of agriculture in the state. The standard Division Tornqvist index was used for computing output inputs and TFP index. The study concluded that indices of output and input have steadily increased throughout the period under study.

Murvi and Shiyani (2002) examined the TFP growth in eight food crops of Gujarat using the data from 1981-82 to 1998-99. A continuous increase in the productivity of all crops was reported during 1960-61 to 1999-2000. Bajra crop registered a very high growth rate of TFP indicating technological change. The crops showing moderate technological change were wheat, maize, green gram. Jowar and pigeonpea registered a negative growth of TFP. The authors focused on increasing investment in research, infrastructure facilities and increasing input use efficiency.

Singh and Pal (2002) studied the 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 result showed that crops yields have become more stable over time and the system was moving towards specialization growth in the output and input. Siddlingappa and Chinnapa (2002) studied on factors influencing total factor productivity in the dry agro climatic zone of Karnataka state. He 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 in three periods.

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 to 1993. They found that the high performing states show a gradual movement towards the trends while the low performing states generally show more volatility.

Kumar *et al.* (2004a) in an analysis of productivity of the crop sector in the Indo-Gangetic Plains (IGP) has revealed that the TFPG of the crop sector in the IGP had risen at the rate of 1.2 per cent per annum during the period 1980-81 to 1996-97. The TFP results for different agro-eco-regions have shown considerable variations. The Low- Gangetic Plain (LGP) region has depicted the highest growth in TFP (3.1%) and MGP, the lowest (0.37%). The TFP growth rates were estimated at 1.4 per cent in the Trans-Gangetic Plain (TGP) and 0.9 per cent in the Upper-Gangetic Plains (UGP). In IGP, one-third of output growth was contributed by TFP. However, the contribution of TFP to output growth varied from as high as 57 per cent in the LGP to a meagre 17.3 per cent in the MGP. The shares of TFP in the output growth of the crop sector in the TGP and the UGP regions were observed to be 34 per cent and 26 per cent, respectively. The output growth in the UGP and the MGP was input-based, while in the LGP, it was technology-based. The output growth in the TGP was input as well as technology-based. The analysis has confirmed that contribution of TFPG to output growth had started declining and was, in fact, showing a tendency of further deterioration in the process. Productivity growth, which picked up during the early-1980s, could not sustain during 1990s and this situation raised an alarm for the policymakers and researchers of the country.

Kumar *et al.* (2004 b) examined the TFP growth in Indian fisheries sector. The results of the study indicated that the annual average growth of TFP was estimated to be 4.74 per cent for agriculture and 2.0 per cent of marine sectors. The study projected 6.5 to 6.7 million tonnes of fish production by the year 2005 and will reach about 7.8 to 9.0 million tonnes by 2015 under different scenarios and technological growth projections for price, supply demand and export. The authors concluded that the technological advancement will make fish available at cheaper rates to consumer while producers would get more income by developing export market.

Bhushan (2005) used Data Envelopment Analysis to estimate Malmquist TFP index for major wheat producing states in India- Punjab, Haryana, Madhya Pradesh, Uttar Pradesh and Rajasthan. He found TFP growth rate to be highest in Punjab and Haryana which is attributed to technical progress in these two states. Rajasthan (with no efficiency change) and Uttar Pradesh (with improvement in efficiency and negative growth in technological progress) have positive TFP growth rate while Madhya Pradesh (no change in efficiency and negative growth of technical progress) is reported to record negative TFP growth rate. As compared to 1980s, mean growth of TFP is found to be higher in 1990s and the primary source of TFP growth is technical progress and not efficiency improvements. Lissitsa and Odening (2005) analysed efficiency and TFP change of large agricultural enterprises using data envelopment approach and productivity change by Malmqvist approach. The results of study indicated that decreased inefficiency was the main reason for declining TFP.

Kumar and Mittal (2006) studied on Agricultural productivity trends in India. The results for 1971-1986 and 1987-2000 revealed that all crops have benefited from the technological change in some parts of the country, but there are some exceptions in pulses and oilseeds where only a few states has performed well. Several states have recorded positive TFP growth. Paddy and wheat, the major staple food crops, have performed well in productivity gains. However, TFP of paddy has started showing deceleration in Haryana and Punjab but TFP of wheat is still growing in these two Green Revolution states. All eastern states have shown improvement in TFP of paddy after the mid-1980s.

Thorat *et al.* (2006) studied on total factor productivity in horticultural crops in Konkan region of Maharashtra found that the internal rate of return to horticultural research investment was computed to the tune of 119 per cent, which was much higher than those of crop, livestock and fisheries in India. The result clearly implied that investment on horticultural research was highly profitable.Elumalai Kannan (2011) estimated TFP of ten major crops grown in the Indian state of Karnataka and analysed its determinants. Growth accounting method of Tornqvist-Theil Index has been used for estimating TFP. It was observed that TFP of paddy has registered positive growth during 1980s, 1990s and 2000s. Higher output growth triggered by technological change has resulted in positive TFP growth. Annual growth in TFP was impressive at 1.48 per cent in the 1990s and 2.68 per cent in the 2000s when compared to 0.42 per cent during the 1980s. For the entire period of analysis, *i.e.* 1980-81 to 2007-08 TFP has risen at 1.49 per cent. Overall, the contribution of TFP to output growth was found to be 60.02 per cent. The contribution of technological change to paddy output growth was positive and respectable across sub-periods. This indicates that the productivity growth rather than the input growth is the main driver of paddy production in Karnataka.

Ramesh *et al.* (2011) studied Total Factor Productivity and Contribution of Research Investment to Agricultural Growth in India showed that the major cereals, namely wheat, paddy and maize have experienced a lower growth in TFP after mid-1990s. Despite lot of claims about hybrid sorghum, its TFP showed a decline during 1995 to 2005. In contrast, the TFP growth in bajra, which is entirely a rainfed crop, was highly impressive. More than half of the total growth in output of wheat and around onefourth in other cereals has been contributed by the increase in TFP. Out of 18 crops selected for the study, two-thirds have exhibited a decline in TFP after mid-1990s. The TFP growths have indicated that technological gains have not been experienced in a number of crops in many states. Some states have even shown a negative, stagnant or poor growth in TFP for some of the crops under the study. Returns to investment on research have been found to be a highly paying proposition. The overall internal rates of return to public investment in agricultural research during the period 1975 to 2005 turned out to be 29% for rice, 38% for wheat, 28% for maize, 39% for jowar, 31% for bajra, 34% for bengal gram, 57% for arhar, 18% for groundnut, 20% for rapeseed and mustard and 39% for cotton. The study has suggested that further investments on research will generate significant returns.

METHODOLOGY

The research methodology and design of the study is an important component of research. To analyze various objectives of the study, an appropriate methodology describing selection of study area, sampling design, nature and sources of data collection and tools of analysis are important. This chapter presents the methodology adopted in the present study. The chapter is presented under the following heads:

3.1 Description of the study area

3.2 Sampling procedure

3.3 Nature and sources of data

3.4 Statistical techniques employed

3.1 Description of the study area

Karnataka state is located within 11.5° and 18.5° North latitudes and 74.0° and 78.5° East longitude. It is situated on a tableland where the Western and Eastern Ghat ranges converge into the Nilgiri hill complex, in the western part of the Deccan Peninsular region of India. The State is bound by Maharashtra and Goa states in the North and Northwest, by the Arabian Sea in the West by Kerala and Tamil Nadu states in the South and by the state of Andhra Pradesh in the East. Karnataka extends to about 750 kms from North to South and about 400 kms from East to West. The highest point in Karnataka is the Mullayanagiri hill in Chikkamagaluru district which has an altitude of 1,929 metres (6,329 ft) above the sea level. Karnataka State has been divided into four revenue divisions, 49 sub-divisions, 30 districts, 176 taluks and 747 hoblies/revenue circles and 5628 gram panchayats for administrative purposes.The state has 281 towns and 7 municipal corporations.

Karnataka is situated in tropical zone and enjoys warm climate throughout the year. The mean temperature ranges from 21.5^0 C to 31.7^0 C, the maximum and minimum temperature being 42^0 C and 14^{0}C respectively. The normal rainfall of the state ranges from as low as 569 mm to as high as 4,029 mm. Average annual rainfall of the state is 1,354 mm. The major part of the rainfall of the state is received from the southwest monsoon, which commences in the first week of June and continues till the end of September. Major part of the state has red soils. Laterite soils are found in the hilly and coastal regions of the western parts. The northern part of the state has black soils with high moisture holding capacity.

Karnataka state presents varied topographical features which may be divided into four regions, *viz.*,

1. The coastal region which is a narrow coastal plain between the Western Ghats edge and the Arabian Sea.
2. The Malnad hilly area lying east of the Western Ghats edge.
3. The Northern trappeanless undulating plateau.
4. The southern broad Archaean undulating plateau.

Karnataka has a total land area of 1,91,791 km^2 and accounts for 5.83 per cent of the total area of the country (measured at 3,288,000 km^2). The state is in eighth place in terms of size. With a population of 5,28,50562, it occupies ninth place in terms of population. The population density which stands at 275 persons per km^2 is considerably lower than the all-India average of 324 persons per km^2.

Eleven groups of soil orders are found in Karnataka *viz.* Entisols, Inceptisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, Aridisols, Vertisols, Andisols and Histosols. Depending on the agricultural capability of the soil, the soil types are divided into six types *viz.*, Red, lateritic, black, alluvio-colluvial, forest and coastal soils. The common types of soil groups found in Karnataka are; red soils: red gravelly loam soils, red loam soils, red gravelly clay soils and red clay soils.

With a surface water potential of about 102 cubic kilometers, Karnataka accounts for about six per cent of the country's surface water resources. Around 60 per cent of this is provided by the west flowing rivers while the remaining comes from the east flowing rivers.

Table 3.1: Profile of the study area (2010-11)

Sl. No.	Particulars	Units	Tumkur District	Bijapur District	Gulbarga District
1	Geographical area	(Sq. kms)	10597	10536.23	10954.97
2	Population				
i	Rural	No	2077509	1410829	1485176
ii	Urban	No	507202	396089	689566
	Total(i+ii)		2584711		
3	Literacy rate	%	67.00	57.00	51.00
4	Net sown area	Ha	563421	871198	924002
5	Net irrigated area	Ha			
i	Canals		3014	87472	34010
ii	Tanks		19019	3279	863
iii	Wells		1484	95341	22830
iv	Bore well		145056	84810	20800
v	Others		NA		680+2073
	Total(I to v)		193547		91913
6	Rainfall				
i	Normal	Mm	584.4	632	575.20
ii	Actual	Mm	837.4	594.60	642.00
7	Gross cropped area	Ha	624381	1041347	1061757
8	Area under crops				
I	Cereals	Ha	228240	408801	261878
ii	Pulses	Ha	54904	333925	684094
iii	Oilseeds	Ha	113093	211101	66191
iv	Commercial crops	Ha	3792	47936	38600

Source: District at a glance 2010-11

Table 3.2: Land utilization pattern of the study area (2010-11)

Sl. No	Particulars	Tumkur District	Bijapur District	Gulbarga District
1	Area under forest	45177	1977	35316
2	Land not available for cultivation			
i	Non-agricultural uses	84442	36027	38420
ii	Barren land	67539	29059	35113
	Total	151981	67063	73533
3	Other cultivated land			
i	Cultivable waste	62642	5502	9417
ii	Permanent pastures	76453	9575	25855
iii	Trees and grooves	21033	1316	1131
	Total	160128	16393	36403
4	Fallow land			
i	Current fallow	112792	93132	22242
ii	Other fallow	31256	5685	2624
	Total	144048	98817	24866
5	Net sown area	563421	871198	9240002
6	Area sown more than once	60960	170149	137755
	Total	624381	1041347	1061757
7	Geographical area (Sq. kms)	1064755	1053471	10954.97

Source: District at a glance 2010-11

Table 3.3: Area under crops in study districts during 2010-11

Sl. No.	Crops	Tumkur District	Bijapur District	Gulbarga District
I	Cereals			
1	Paddy	36033	27	4542
2	Ragi	162613	NA	NA
3	Maize	19886	64558	7941
4	Jowar	6692	200722	212798
5	Wheat		81437	17702
6	Bajra	136	62057	18875
	Total cereals	228240	408801	261878
II	Pulses			
7	Chickpea	746	189384	208465
8	Pigeon pea	12002	104091	377775
9	Green gram	7102	24110	44830
10	Cow pea	3517	1457	1872
11	Horse gram	22973	9105	1204
12	Black gram		154	49090
	Total pulses	54904	333925	684094
III	Oil seeds			
13	Sunflower	8092	119522	32724
14	Ground nut	99357	77615	5767
15	Sesamum	682	1130	15782
	Total oil seeds	113093	211101	66191
IV	Commercial crops			
16	Cotton	852	3669	14129
17	Sugarcane	2935	44113	24471
18	Tobacco	5	154	NA
	Total commercial crops	3792	47936	38600
V	Horticultural crops			
19	Fruit crops	21635	6719	4698
20	Vegetables	2592	19263	3038
	Total cropped area	624381	1041347	1061757

Source: District at a glance 2010-11

Table 3.4: Major state wise area under oilseeds and pulses during 2009-10

States	Area under Oilseeds	% to India	Area under pulses	% to India
Andhra Pradesh	2072.2	7.98	1932	8.30
Gujarat	2793	10.76	733	3.15
Karnataka	2001	7.71	2479	10.65
Madhya Pradesh	6765.1	26.06	4940.5	21.22
Maharashtra	3884	14.96	3376	14.50
Rajasthan	4133.1	15.92	3501	15.04
Uttar Pradesh	1084	4.18	2540.7	10.91
India	25958.9	100.00	23282.3	100.00

Source: www.indiastat.com

The state has the following four seasons in the year:

- The winter season from January to February
- The summer season from March to May
- The monsoon season from June to September
- The post-monsoon season from October to December.

The post-monsoon and winter seasons are generally pleasant over the entire state.The months of April and May are hot, very dry and generally uncomfortable. Weather tends to be oppressive during June due to high humidity and temperature. The next three months (July, August and September) are somewhat comfortable due to reduced day temperature although the humidity continue to be very high. The highest recorded temperature was 45.6 °C (114 °F) at Raichur on May 23, 1928. The lowest recorded temperature was 2.8 °C (37 °F) at Bidar on December 16, 1918. The Southwest monsoon accounts for almost 80 per cent of the rainfall that the state receives. The annual rainfall across the state ranges from low of 50 cm to copious 350 cm. The districts of Bijapur, Raichur, Bellary and southern half of Gulbarga experience the lowest rainfall ranging from 50 cm to 60 cm while the west coastal region and malnadu enjoy the highest rainfall. Agumbe in the Western Ghats experiences the heaviest rainfall in the country next only to Cherrapunji. About 38724 km² area (or 20 per cent of geographic area) is covered by forests. The forests are classified as reserved (28,611 km²), protected (3,932 km²), unclosed (5,748 km²), village (124 km²) and private (309 km²) forests. The percentage of forests area to geographical area in the State is less than the all-India average (23%) and that prescribed in the National Forest Policy (33%). About 70 per cent of the people of the state live in villages and 71 per cent of the total population is agriculture dependent. The major crops grown in the state are, rice, ragi, jowar, maize and pulses besides oilseeds and number of cash crops. Cashew, coconut, areca nut, cardamom, chilies, cotton, sugarcane and tobacco are among the plantation and commercial crops grown in the state.

One of the objectives of the present study were analyzed using primary data obtained through survey in Tumkur district, Bijapur district and Gulbarga district. Therefore, an attempt is made in this section to provide a brief description about the selected districts as they are major oilseeds and pulses growing areas of Karnataka.

Table 3.1 shows the brief profile of the study area.

3.1.1 Tumkur district

The geographical area of Tumkur district is 10, 64,755 hectares consisting of ten taluks, fifty hoblis and 2,537 inhabited villages, as well as 181 uninhabited villages. The total population in the district is around 25,84711 (as per 2001 census), out of which rural population constitutes 20.78 lakhs. The climate of the district is moderate and healthy. Soils of the district comprises of red soils, red sandy soils and sandy soils. The soils are moderately rich in plant nutrients.

The district is ideally suited for cultivation of groundnut in terms of their soil characteristics and agro climatic features. The percentage of net sown area to total area comes to about 90 per cent. The normal rainfall ranged 584.4 mm and actual rainfall with 837 mm. The main food crops of the district are ragi, paddy,maize, horsegram, pigeon pea, avare *etc.*, the important commercial crops in this area are sugarcane. Groundnut covers about 99357 hectares of land constituting 15.91 per cent of total gross cropped area. Irrigation through tubewells is the main source of irrigation accounting for 74.9 per cent for Tumkur district.

3.1.2 Bijapur district

The geographical area of Bijapur district is 10,536 hectares consisting of five taluks. The total population in the district is around 18, 06,918 (as per 2001 census), out of which rural population constitutes 14.10 lakhs. The district experiences semi-arid climate with extreme summers. Soils of the district comprises of black, red sandy soils and mixed soils. The district is ideally suited for cultivation of sunflower in terms of their soil characteristics and agro climatic features. The percentage of net sown area to total area comes to about 83 per cent. The normal rainfall ranged 632 mm and actual rainfall with 594.6 mm. The main food crops of the district are jowar, maize, wheat, pigeon pea, green gram *etc.*, the important commercial crops in this area are sugarcane. sunflower covers about 1,19,522 hectares of land constituting 12.08 per cent of total gross cropped area. Irrigation through wells is the main source of irrigation accounting for 26.8 per cent for Bijapur district.

KARNATAKA STATE

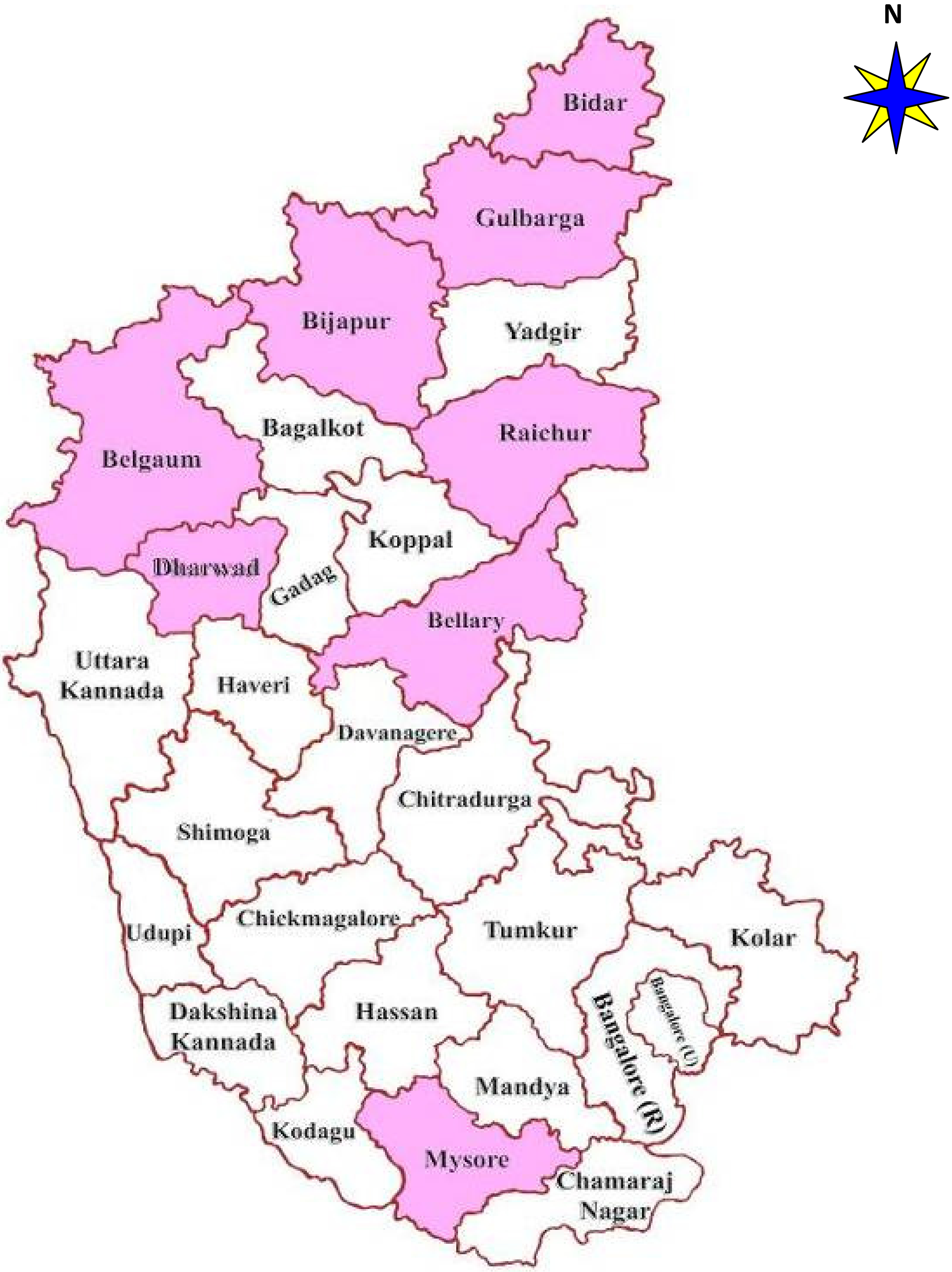

Fig. 1: Map showing oilseeds growing study districts of Karnataka

KARNATAKA STATE

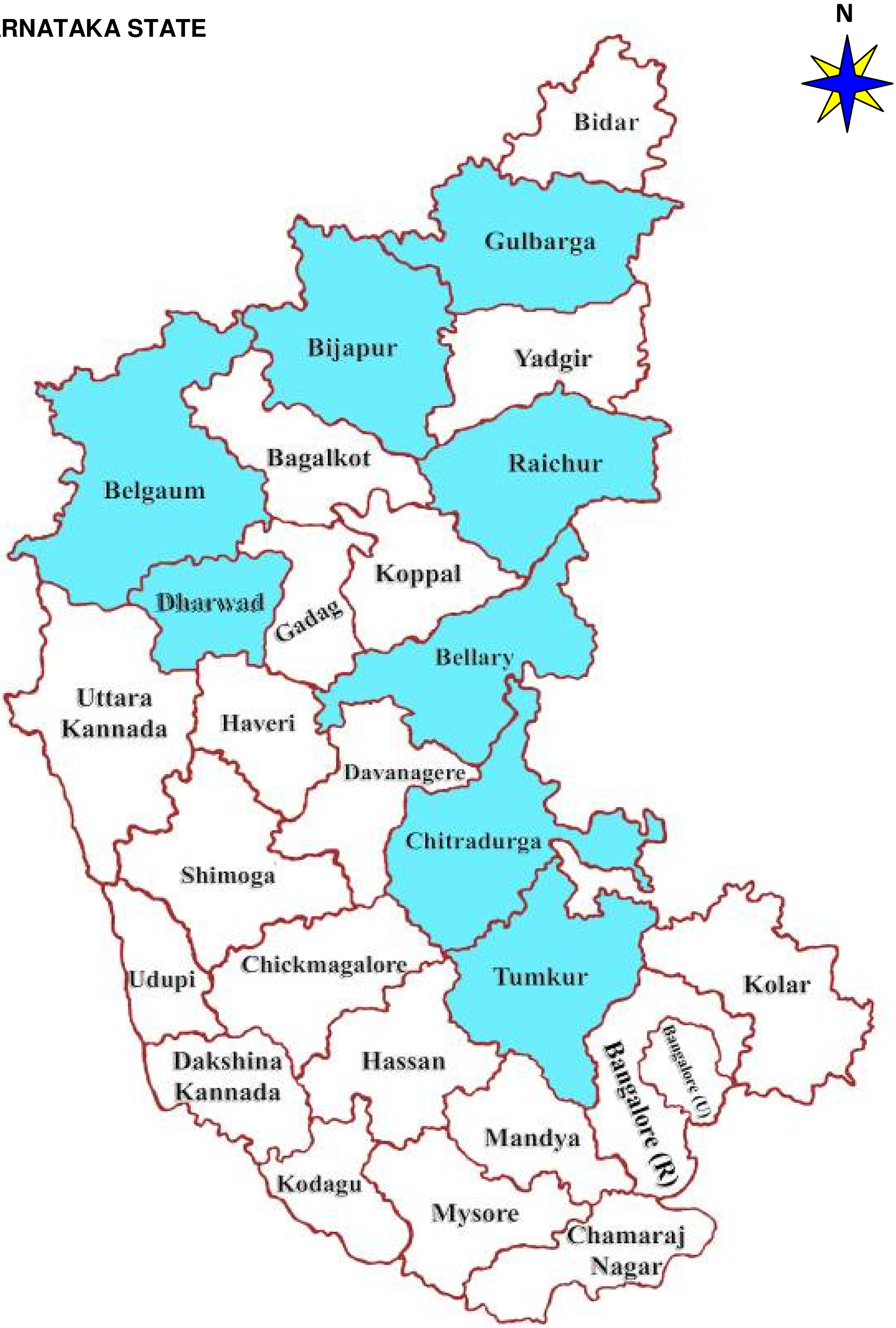

Fig. 2: Map showing pulses growing study districts of Karnataka

Table 3.5: District wise area under oilseeds and pulses in Karnataka for the triennium ending 2009-10 (Area in hectares)

Sl.No	Districts	Area under oilseeds	% to Karnataka	Area under pulses	% to Karnataka
1	Belgaum	190418	9.51	128901	5.20
2	Bellary	143358	7.16	65942	2.66
3	Bidar	65020	3.25	195769	7.90
4	Bijapur	306140	15.30	446147	17.99
5	Chitradurga	196499	9.82	57355	0.02
6	Dharwad	266807	13.33	271855	10.96
7	Gulbarga	205538	10.27	706306	28.49
8	Raichur	330077	16.49	123578	4.98
9	Mysore	60659	3.03	167287	6.75
10	Tumkur	114532	5.72	65040	0.03
	Karnataka	2001388	100	2479503	100

Source: Directorate of Economics and Statistics, Bangalore

Table 3.6: Average area under pulses and oilseeds in Karnataka from 2007-08 to 2009-10 (Ha)

District	Pigeon pea	Chickpea	Ground nut	Sunflower
Bagalkot	3347.00	45991.33	21176.00	111488.12
Bangalore-urban	643.33	0.00	156.33	17.66
Bangalore-rural	2265.33	66.33	3105.67	189.33
Belgaum	5199.00	52370.00	62901.33	42281.00
Bellary	9636.67	36665.33	69587.67	107169.67
Bidar	65988.67	37821.00	1285.67	14766.67
Bijapur	58460.33	120307.67	68039.00	247091.33
Chamarajanagar	2030.00	3154.00	13530.00	15882.67
Chikmagalure	706.67	6679.33	4438.33	16559.33
Chitradurga	8126.33	11942.00	131137.67	62582.00
Dakshin Kannada	0	0	0	0
Davanagere	4670.67	4170.00	17847.33	19183.33
Dharawad	3153.33	47377.00	36443.00	10895.67
Gadag	2201.33	45641.00	53410.67	96663.00
Gulbarga	397293.00	155885.67	48623.00	119354.00
Hassan	2102.33	2221.33	1261.00	15638.67
Haveri	2943.00	1200.67	20282.33	14604.33
Kodagu	5.00	6.67	21.67	0
Kolar	4187.00	0	20476.33	2762.00
Koppal	9912.67	19947.67	35373.33	102142.33
Mandya	936.67	76.33	2248.67	16.67
Mysore	3973.67	1706.33	7779.00	2321.00
Raichur	14927.00	66364.00	41774.67	212547.67
Shimoga	456.00	44.33	1769.00	2021.33
Tumkur	14166.00	944.67	138207.67	14268.33
Udupi	0	1.33	2078.67	8.67
Uttar Kannada	79.67	12.67	3089.67	132.00
Ramnagar*	3681.50	8.50	7802.50	-
Chikkaballapur*	7634.00	81.00	44188.00	-

Source: Directorate of Economics and Statistics, Bangalore

Table 3.7: Selected farm respondents from the study area

	District	Taluks	Village	Farmers	
				Beneficiary	Non beneficiary
1	Tumkur	Pavagada	Nagalamadike	10	10
			Y.N.Hosakote	10	10
			Roppa	10	10
2	Bijapur	Bijapur	Hittanhalli	10	10
			Jumanal	10	10
			Sarwad	10	10
3	Gulbarga	Jewaragi	Harawal	10	10
			Nelogi	10	10
			Sonna	10	10
4	Gulbarga	Chittapur	Shahabad	10	10
			Tonashelli	10	10
			Honagunta	10	10
			Sub-total	120	120
			Total	240	

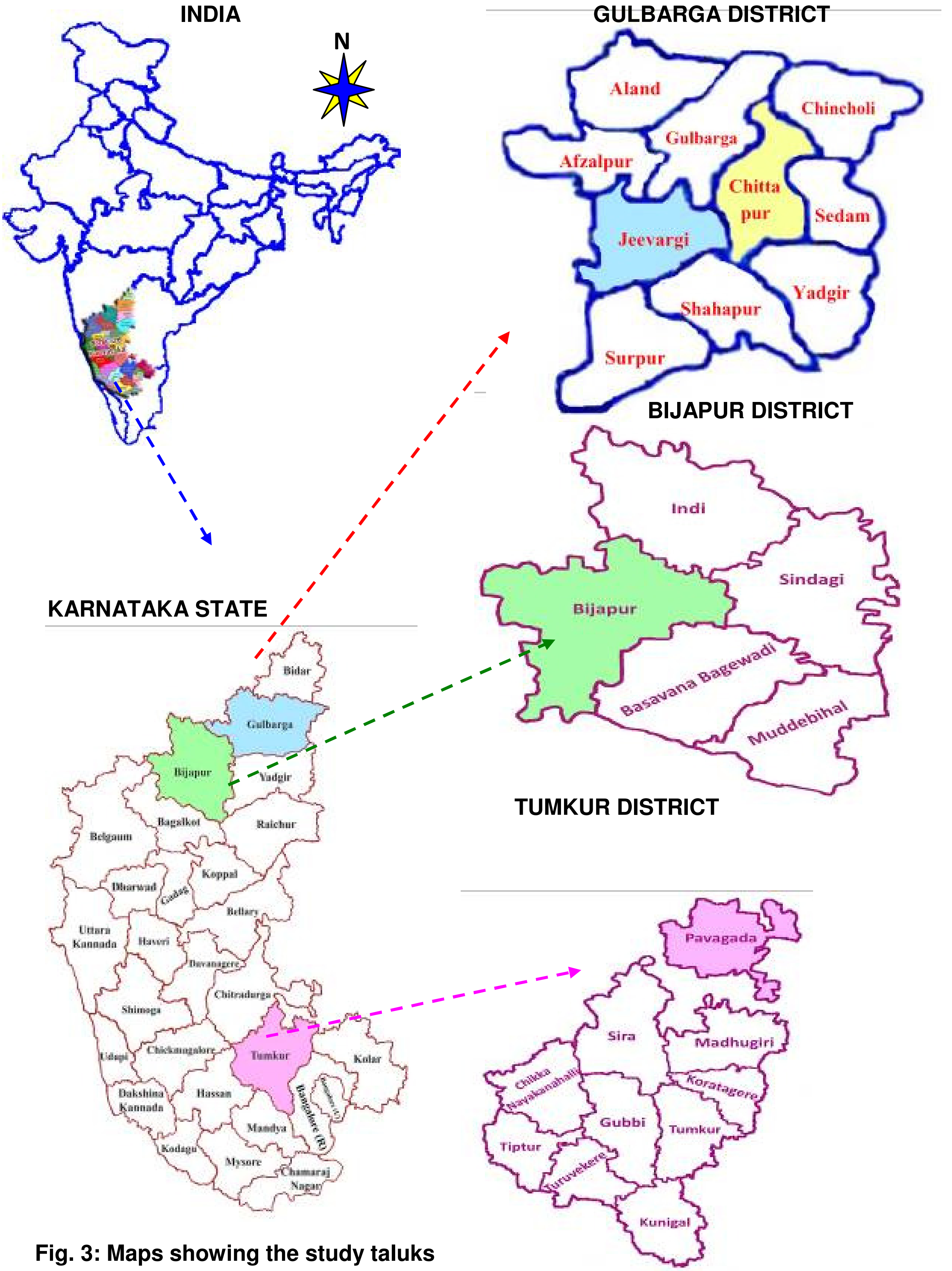

Fig. 3: Maps showing the study taluks

3.1.3 Gulbarga district

The geographical area of Gulbarga district is 10,955 hectares consisting of five taluks. The total population in the district is around 1064300 (as per 2001 census), out of which rural population constitutes 14.85 lakhs. The climate of the district is semi-arid type. Dry climate for most part of the year. Soils of the district comprises of deep black, medium black and lateritic soils.

The district is ideally suited for cultivation of pigeon pea and chickpea in terms of their soil characteristics and agro climatic features. The percentage of net sown area to total area comes to about 87 per cent. The normal rainfall ranged 575.2 mm and actual rainfall with 642 mm. The main food crops of the district are jowar, maize, wheat, pigeon pea, chickpea green gram *etc.*, the important commercial crops in this area are sugarcane. Pigeon pea covers about 3, 77,775 hectares of land constituting 35.68 per cent of total gross cropped area. Chickpea covers about 2, 08,465 hectares of land constituting 19.69 per cent of total gross cropped area. Irrigation through wells is the main source of irrigation accounting for 39.11 cent for Gulbarga district.

Table 3.2 shows the land utilization pattern of the study districts and Table 3.3 shows area under crops in study districts.

3.2 Sampling Procedure

3.2.1 Delineation of the study area

Karnataka state is selected as it is one of the major oilseeds and pulses growing states in the country and also the Technology Mission on Oilseeds and Pulses scheme has been implemented in the state. Karnataka stands 6th and 5th position with respect to area under oilseeds and pulses, respectively (Table 3.4).

3.2.2 Selection of oilseed and pulse crops

In Karnataka, the highest area is under groundnut among oilseeds followed by sunflower with the area of 8.17 lakh hectares and 7.94 lakh hectares respectively, which accounts for 40.87 per cent and 39.68 per cent respectively (2009-10). These two crops have been covered under Technology Mission on Oilseeds. Hence among oilseeds groundnut and sunflower were taken for study. Among pulses chickpea and pigeon pea occupied major area in Karnataka with the area of 9.72 lakh hectares and 6.04 lakh hectares respectively, which accounts for 39.20 per cent and 24.36 per cent respectively (2009-10) and was covered under Technology Mission on Pulses. Hence chickpea and pigeon pea crops were chosen for the study.

3.2.3 Selection of districts

Although Karnataka is a major oilseeds and pulses growing state, looking at the relative importance of the area under oilseeds and pulses, from out of 19 undivided districts, 8 districts *viz.*, Belgaum, Bellary, Bijapur, Chitradurga, Dharwad, Gulbarga, Raichur and Tumkur were selected under oilseeds (Fig. 1) and for pulses Belgaum, Bellary, Bidar, Bijapur, Dharwad, Gulbarga, Raichur and Mysore were selected (Fig. 2). These eight districts together accounted for 87.69 per cent and 84.92 per cent of the total area under oilseeds and pulses respectively in the state (Table 3.5).

3.2.4 Selection of sample farmers

Multistage sampling technique was adopted for selection of the sample farmers. In the state for each crop selected one major oilseed and pulses growing district was selected. Hence, the primary data was collected from Tumkur district for groundnut crop, Bijapur district for sunflower crop and Gulbarga district for pigeon pea and chickpea (Table 3.6) as these districts have major area in respective crops and these districts are covered under Technology Mission on Oilseeds and Pulses. At the next stage one taluk under each crop having maximum area was chosen purposively. At the final stage, from each selected taluk, three villages having maximum area were selected purposively and in each village ten beneficiaries and ten non-beneficiaries randomly were selected which makes a total sample size of 240 sample farmers. This is depicted in Table 3.7. Out of ten farmers, five small farmers and five large farmers were selected both in case of beneficiaries and non- beneficiaries. The selected taluks in Tumkur for groundnut crop, Bijapur for sunflower crop, Gulbarga for pigeon pea and Gulbarga for chickpea are shown in Fig. 3.

3.3 Nature and sources of data

In the present study, both primary and secondary data were used.

To study the growth rates of oilseeds and pulses, district -wise time series data on the area, yield and production of the total oilseeds, groundnut, sunflower, total pulses, pigeon pea and chickpea were collected from Directorate of Economics and Statistics (DES), Government of Karnataka, Bangalore. The data were collected for the period from 1972-73 to 2009-10 for total oilseeds and groundnut. The data for total pulses, pigeon pea and chickpea were collected from 1980-81 to 2009-10. The data with respect to sunflower were collected from the period 1978-79 to 2009-10, owing to meagre acreage and production of the crop during the earlier years.

Cost of cultivation data on sunflower for northern dry zone (Bijapur), groundnut for central dry zone (Tumkur), pigeon pea for northern eastern dry zone (Gulbarga) and chickpea for northern eastern dry zone (Gulbarga)and Karnataka as a whole for all crops were collected from Karnataka state Department of Agriculture, Bangalore. The data was collected from the period 1980 to 2008 in oilseed and pulse crops, as the data on cost of cultivation was available only from 1980 upto 2008. The data on investment on oilseeds schemes were collected from 1986 upto 2008 and for pulses schemes from 1990 to 2008 from Karnataka State Department of Agriculture, Bangalore.

To assess the impact of TMO on oilseeds the study period has been divided into two sub-periods, as Period –I (1972-73 to 1985-86), Period –II (1986-87 to 2009-10) and overall (1972-73 to 2009-10). In case of sunflower crop, Period –I (1978-79 to 1985-86), Period-II (1986-87 to 2009-10) and Overall period (1978-79 to 2009-10).Period-I represents the Pre-TMOP and Period-II represents the Post TMOP period. Similarly, to assess the impact of TMOP on pulses the study period has been divided into sub-periods, as Period –I (1980-81 to 1989-90), Period –II (1990-91 to 2009-10) and Overall (1980-81 to 2009-10). Period-I represents the Pre-TMOP and Period-II represents the Post TMOP period. For the convenience of analysis the divided districts were considered as undivided districts as the data used for analysis is from 1972 in oilseeds and in pulses from 1980.

Primary data for the present study on crop yield, cropping pattern, input usage and cost of cultivation of beneficiaries and non-beneficiaries were obtained for the year 2011-12 from the selected sample famers through personal interview method with the help of pre–tested and structured schedule.

3.4 Statistical tools applied

3.4.1 Compound growth rate analysis

Growth rate in area, production and yield of groundnut and total oilseeds were computed for a period of 38 years from 1972-73 and 2009-10 and for pigeon pea, chickpea and total pulses were computed for a period of 30 years from 1980-81 to 2009-10. Sunflower crop growth in area, production and yield of groundnut and total oilseeds were computed for a period of 31 years from 1978-79 and 2009-10. In the present study, compound growth rates in area, production and productivity of sunflower, groundnut, total oilseeds, pigeon pea, chickpea and total pulses in Karnataka as well as 8 districts in oilseed crops and 8 district in pulse crops were estimated by using the exponential growth function (Angles, 2001) of the form,

$Y_t = a\, b^t\, e^{Ut}$ ……………………. (1)

Where,

Y_t = area/production/ yield, of respective crops in year ‘t.

a = Intercept

b = Regression coefficient

t = Year which takes values 1, 2 … n.

U_t = Disturbance term in year‘t’.

The equation (1) was transformed into log-linear and written as

$\log Y_t = \log a + t \log b + U_t$ ……………… (2)

Equation (2) was estimated by using Ordinary Least Square (OLS) technique.

The compound growth rate (g) was then estimated by the identity given in equation (3)

g = (b-1) x 100 ……………. (3)

Where,

$\hat{g}$ = Estimated compound growth rate per annum in percentage.

$\hat{b}$ = Antilog of regression coefficient of t, *i.e.*, log b

3.4.2 Tabular analysis

Tabular analysis was carried out to analyze the impact of Technology Mission on oilseeds and pulses economy. Primary data from farmers were used to obtain meaningful results on the impact of Technology Mission on their crop yield, change in cropping pattern and difference in input usage of beneficiaries and non-beneficiaries.

3.4.3 Budgeting technique

Cost and returns of beneficiaries and non-beneficiaries were analysed using budgeting technique.

3.4.4 Decomposition analysis

The extent of variability in area, production and productivity of respective crops were analyzed through Coefficient of Variation (CV).

$$C.V. = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

In order to analyze the sources of instability in respective crop production, a method developed by Hazell (1982) was adopted. This method uses statistical identities to provide an exact decomposition of the components of change in the variance of oilseeds and pulses production.

To estimate the variability in production of ground nut and total oilseeds the entire study period was divided into two sub periods namely Pre – TMO and Post – TMO periods. Period-I from 1972-73 to 1985-86, while Period – II from 1986-87 to 2009-10. In case of sunflower, Period-I from 1978-79 to 1985-86, while Period – II from 1986-87 to 2009-10. Similarly, to estimate the variability in production of pigeon pea, chickpea and total pulses, the entire study period was divided into two sub periods namely Pre – TMOP, Post – TMOP. Period-I from 1981-82 to 1989-90, while Period – II from 1990-91 to 2009-10. The time series data on area and productivity of total pulses was detrended to remove the trend component, using linear trend equation of the form

$Y_t = a + b_t + U_t$ …………….. (4)

Where,

Y_t = area in hectare/ yield in kg/ha

t = time period in years

a = intercept

b = regression coefficient

U_t = residual term

The residuals were computed from the equation (4) and were then centered around their respective means for both periods. The resultant detrended time series data were of the following form.

$Y_t = \bar{Y} + U_t$ …………….. (5)

Where,

$\bar{Y}$ = Mean yield

U_t = error in't' year

The production of respective crops was computed using following equation.

$P_t = A_t \times Y_t$ …………… (6)

Where,

P_t = Production of respective crops in year 't'

A_t = Area under respective crops in year 't'

Y_t = Yield of respective crops in year 't'

The production variance and co-variance were decomposed to know the sources of change between the periods.

The variance in production during Period- I for respective crops can be expressed as

$V(P_1) = \bar{A}_1^2 V(Y_1) + \bar{Y}_1^2 V(A_1) + 2 \bar{A}_1 \bar{Y}_1 COV(A_1, Y1) - COV(A_1, Y1)^2 + R_1$………….. (7)

Where,

$V(P_1)$	= Variance of production in Period-I
$\bar{A}_1$	= Mean area in Period-I
$\bar{Y}_1$	= Mean yield in Period-I
$V(A_1)$	= Variance of area in Period-I
$V(Y_1)$	= Variance of yield in Period-I
$Cov(A_1, Y_1)$	= Covariance of area and yield in Period-I
R_1	= Residuals in Period-I

Table 3.8: Components of change in the average production of respective crops

Sl. No.	Sources of change	Symbols	Components of change
1.	Change in mean yield	$\Delta\bar{Y}$	$\bar{A}_1\Delta\bar{Y}$
2.	Change in mean area	$\Delta\bar{A}$	$\bar{Y}_1\Delta\bar{A}$
3.	Interaction between changes in mean area and mean yield	$\Delta\bar{A}\Delta\bar{Y}$	$\Delta\bar{A}_1\Delta\bar{Y}$
4.	Change in area – yield covariance	Δ Cov(A,Y)	Δ Cov(A,Y)

Table 3.9: Components of change in the variance of respective crops production

Sl. No.	Description change	Symbols	Components of change
1.	Change in mean yield	$\Delta\bar{Y}$	$[2\bar{A}_1, \Delta\bar{Y}\,Cov(A_1,Y_1) + [2\bar{Y}_1\Delta\bar{Y} + (\Delta\bar{Y})^2]\,V(A_1)$
2.	Change in mean area	$\Delta\bar{A}$	$[2\bar{Y}_1, \Delta\bar{A}\,Cov(A_1,Y_1) + [2\bar{A}_1\Delta\bar{A} + (\Delta\bar{A})^2]\,V(Y_1)$
3.	Change in yield variance	$\Delta V(Y)$	$(\bar{A}_1)^2\,\Delta V(Y)$
4.	Change in area variance	$\Delta V(A)$	$(\bar{Y}_1)^2\,\Delta V(A)$
5.	Change in area yield covariance	Δ Cov (A, Y)	$[2\bar{A}_1\bar{Y}_1 - 2Cov(A_1,Y_1)]\,\Delta Cov(A,Y) - [\Delta Cov(A,Y)]^2$
6.	Interaction between changes in mean yield and mean area	$\Delta\bar{A}, \Delta\bar{Y}$	$2(\Delta\bar{Y})(\Delta\bar{A})\,Cov(A_1,Y_1)$
7.	Interaction between changes in mean area and yield variance	$\Delta\bar{A}, \Delta V(Y)$	$[2\bar{A}_1)(\Delta\bar{A}) + (\Delta\bar{A})^2]\,\Delta V(Y)$
8.	Interaction between changes in mean yield and area variance	$\Delta\bar{Y}, \Delta V(A)$	$[2(\bar{Y}_1)(\bar{Y}) + (\Delta\bar{Y}^2)]\,\Delta V(A)$
9.	Interaction between changes in mean area and yield and changes in area-yield Covariance	$\Delta\bar{Y}, \Delta\bar{A}, \Delta Cov(A,Y)$	$[2(\bar{Y}_1)(\Delta\bar{A}) + 2(\bar{A}_1)(\Delta\bar{Y}) + 2(\Delta\bar{A})(\Delta\bar{Y})]\,\Delta Cov(A,Y)$
10.	Changes in residual	Δ R	$\Delta V(A\ Y)$ – Sum of other components

Similarly, each variable in Period-II can be expressed in terms of its counterpart in Period-I, plus the change in the variable between the two periods.

For example, $\overline{A}_2 = \overline{A}_1 + \Delta\overline{A}$ and $\overline{Y}_2 = \overline{Y}_1 + \Delta\overline{Y}$

Where,

$$\Delta\overline{A} = \overline{A}_2 - \overline{A}_1$$

$$\Delta\underline{Y} = \underline{Y}_2 - \underline{Y}_1$$

Therefore, the change in the variance of production of respective crops between two periods is given by,

$$\Delta V(P) = V(P_2) - V(P_1)$$

And this can be decomposed into various components as shown in Table 3.8. and 3.9.

3.4.5 Analysis of Total Factor Productivity (TFP)

Total factor productivity concept implies an index of total output per unit of total factor inputs. TFP growth measures the increase in output *i.e.* not accounted for by the increase in total inputs. Changes in total factor productivity index can be used as one of the measures such as output per unit of individual inputs and have limitations as indicators of real productivity change *i.e.* partial productivity measures. Thus, total factor productivity index measures the growth in net output *i.e.* not accounted for by the growth in basic factor input such as land, labour and capital. It is superior to partial approach as it is composite measure of productivity, which is related to output of all inputs simultaneously.

Solow (1957) was the first to propose a growth accounting framework, which attributes the growth in TFP to that part of growth in output, which cannot be explained by growth in factor inputs like land, labour and capital. The other approaches used for measurement of productivity are the parametric approach and non-parametric approach. Among these, the accounting approach is popular because it is simple to calculate and requires no econometric estimation and therefore, the data requirement is minimal. The use of TFP indices gained prominence since 1976, 1978 proved that Theil-Tornquist discrete approximation to the Divisia index is consistent in aggregation and superlative to a linear homogenous trans logarithmic production function. Thus, the Divisia-Tornqvist index was used in the present study for computing Total Output Index (TOI), Total Input Index (TII) and Total Factor Productivity index (TFPI).

Five inputs *viz;* seed, human labour, bullock labour, fertilizers, FYM were considered for analysis. Seed was taken in kilograms, bullock labour input as a number of bullock pairs in days, FYM input taken as a tonne per hectare and human labour as male or female in days.

In the state, one major oilseed and pulses growing district was selected for each crop. Hence, the data was collected from Tumkur district for groundnut crop, Bijapur district for sunflower crop and Gulbarga district for pigeon pea and chickpea. The data on these inputs were collected from the records of the State Cost of Cultivation Scheme of Karnataka operated in the State Agricultural Department, Bangalore. Share of each input cost was computed as proportion to the total production cost. Input cost share and input quantity data for each districts were used for computing the input index. The farm harvest price and production of crop at district level were used to compute the output index. The value of a grain and byproduct were included into output index. The total factor productivity index was computed by dividing the output index by input index for each crop (Pillai, 2001). By specifying TOI, TII equal to one in the initial year, the following equations provided the total output index, total input index and total factor productivity index. Though for the earlier analysis that is growth rates and decomposition analysis the period of 38 years (1972-2009) for oilseeds and 30 years (1980-2009) for pulses was considered with sub periods, for the present analysis of Total Factor Productivity the period from 1980 to 2008 was considered in oilseed and pulse crops. Therefore, for further analysis the study period is divided as Period I (1980 - 1985) in oilseeds and 1980-1989 in pulses. Period II (1986 - 2008) in oilseeds and in pulses (1990-2008) and overall Period (1980 – 2008) in oilseeds and pulses. This is because the cost of cultivation data was available after 1980.

TFP indices were computed as follows:

Total Output Index (TOI)

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

Total Input Index (TII)

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

Total Factor Productivity Index (TFPI):

$$TFPI_t = (TOI_t/TII_t) \times 100$$

Where,

R_{it} = share of j^{th} crop output in total revenue in year t

Q_{jt} = output of j^{th} crop in year t

S_{it} = share of input i in total input cost in year t

X_{it} = is the quantity of input i in year t.

Growth rate in TFP = Growth rate of TOI – Growth rate of TII

For productivity measure over a long period of time, chaining indices for successive time periods are preferable. With chain linking, an index is calculated for two successive periods *i.e.* t and t-1 (sample from time t = 0 and t = T) and the separate indices were then multiplied together. Chain linking index takes into account the changes in relative values/cost throughout the period of study.

Returns to research investment

Changes in output other than that generated by changes in inputs can be induced by research, extension, human capital, infrastructure, price policy and climatic factors. As an input into investment decisions, it is useful to understand the relative importance of productivity enhancing factors in determining productivity growth.

In order to assess the determinants of total factor productivity (TFP), the oilseeds and pulses TFP index was regressed on oilseeds scheme investment and pulses scheme investment respectively per hectare of area and year, which is linear trend variable. The time series data from the different years were pooled. Estimation was undertaken using a fixed effects approach for the pooled cross section time series data set. Using the elasticity of TFP with respect to investment, one can easily estimate the value of marginal product (additional product value) of scheme investment (R).

$$EVMP (R) = bx (V/R)$$

Where,

'R' = Investment

'V'= Value of the production associated with TFP

'b'= TFP elasticity of investment

Estimated in the TFP determinant equation above, the benefit stream is generated under the assumption that the benefit of investment made in oilseeds and pulses schemes in period (t-1) will start generating a benefit after a lag of years at an increasing rate in the beginning, remain constant for a period of time and thereafter decline following the typical inverted V shape curve. The investment of one rupee in year (t-1) will generate a benefit equal to 0.1 EVMP in year t + 1 years and so on. This benefit stream can then be discounted at the rate, say 'r' at which the present value of the stream of benefit is equal to one. Thus 'r' is considered as the marginal internal rate of return to oilseeds and pulses schemes investment.

RESULTS

In consistence with the objectives of the study, the data collected from different sources were analysed. The results of the investigation and analysis are presented under the following heads.

4.1 Growth performance of oilseeds and pulses

4.1.1 Growth rates in area, production and yield of oilseeds

4.1.2 Growth rates in area, production and yield of pulses

4.2. Impact of Technology Mission on Oilseeds and Pulses economy

4.2.1 Impact of Technology Mission on Oilseeds on oilseeds economy

4.2.2 Impact of Technology Mission on Oilseeds and Pulses on pulses economy

4.3 Instability in oilseeds and pulses production

4.3.1 Instability in oilseeds production

4.3.2 Instability in pulses production

4.4 Returns to investment on Technology Mission on Oilseeds and Pulses

4.1 Growth performance of oilseeds and pulses

4.1.1 Growth rates in area, production and yield of oilseeds

Groundnut

The results of the Compound Growth Rate analysis of area, production and productivity of groundnut in the selected districts as well as for the state of Karnataka as a whole are presented in Table 4.1.

In Belgaum district, area showed negative growth of -1.69 per cent per annum during Period I and in the same period both production and yield showed positive growth of 2.30 per cent per annum, which was found non-significant and 4.24 per cent per annum, which was found significant at five per cent level of significance respectively. During Period-II, both area and yield exhibited negative growth resulting in negative growth in production. During overall period, the area and production growth was negative of -2.21 per cent per annum and -1.64 per cent per annum respectively and yield showed a marginal growth of 0.380 per cent per annum and found non-significant.

In Bellary district, area showed negative growth of -1.85 per cent per annum in Period-I. In the same period both production and yield showed positive growth of 2.93 per cent per annum, which was found non- significant and 5.40 per cent per annum, which was found significant at one per cent level of significance respectively. During Period-II, both area and yield exhibited negative growth resulting in negative growth in production. During overall period, both the production and yield was negative of -0.38 per cent per annum and -1.37 per cent per annum respectively whereas, area showed a marginal growth of 1.80 per cent per annum and found significant at one per cent level of significance.

In Bijapur district, during Period-I both the area and production exhibited negative growth, whereas yield showed a marginal growth of 0.28 per cent per annum but was found to be non-significant. Similar trend was observed in Period-II, both area and production showed declining growth whereas yield showed positive growth of 1.93 per cent per annum, which was found to be significant at five per level of significance. During overall period, area showed declining growth whereas both production and yield showed positive growth of 0.62 per cent per annum, which was found non-significant and 1.97 per cent per annum, which was found significant at one per cent level of significance respectively.

In Chitradurga district, during Period-I the area showed positive growth of 10.26 per cent per annum, which was found significant at one per cent level of significance and in the same period both production and yield showed positive and insignificant growth. During Period-II, area, production and yield showed negative growth of -0.99,-1.77 and -1.74 per cent per annum respectively. During overall period area and production showed positive significant growth of 5.13 per cent per annum and 4.55 per cent per annum respectively, whereas yield showed negative growth of -1.72 per cent per annum.

Table 4.1: District wise compound growth rate of area, production and yield of groundnut in Karnataka

(Per cent per annum)

Districts	Period I			Period II			Overall period		
	A	P	Y	A	P	Y	A	P	Y
Belgaum	-1.69	2.30	4.24*	-2.72**	-4.06**	-0.88	-2.21**	-1.64**	0.38
Bellary	-1.85	2.93	5.40**	-0.243	-4.27**	-4.04**	1.08**	-0.38	-1.37**
Bijapur	-0.90	-0.77	0.28	-2.18**	-0.69	1.93*	-1.01**	0.62	1.97**
Chitradurga	10.26**	4.43	0.37	-0.99	-1.77	-1.74*	5.13**	4.55**	-1.72**
Dharwad	5.38	4.22	2.19	-1.32**	-3.12*	-1.27	0.36	1.09	0.48
Gulbarga	-1.05	4.14	2.06	-4.31**	-3.43**	0.91	-1.35**	0.19	1.08*
Raichur	1.31**	4.05*	2.66	-2.84**	-3.16**	-0.34	-1.22**	-1.02*	0.24
Tumkur	7.33**	4.56	-2.43	-0.94**	-4.51**	-3.60**	3.21**	1.89*	-1.26*
Karnataka	0.38	2.24	2.22	-1.76**	-3.63**	-1.84**	0.16	0.17	-0.04

Note: ** and * indicates significance at 1 and 5 per cent level respectively

Table 4.2: District wise compound growth rate of area, production and yield of sunflower in Karnataka

(Per cent per annum)

Districts	Period I			Period II			Overall period		
	A	P	Y	A	P	Y	A	P	Y
Belgaum	58.83**	35.89*	-6.26	4.83**	7.13**	2.21**	11.79**	12.96**	1.05
Bellary	86.60**	70.29**	1.63	-0.06	0.72	-0.71	7.44**	5.70**	-1.86**
Bijapur	122.91**	76.61**	-0.42	1.22	2.37	-0.90	10.76**	10.14**	-2.28**
Chitradurga	68.05**	45.83**	3.47	-0.34	-0.29	0.23	9.38**	7.44**	-1.64**
Dharwad	102.01**	65.04**	-5.79	3.53**	4.05**	-1.55	12.51**	11.80**	-2.39**
Gulbarga	49.72**	28.36**	-4.88	0.20	2.06	1.86*	8.98**	8.78**	-0.18
Raichur	50.27*	43.58*	-1.21	5.86**	4.52	-1.36	16.74**	14.24**	-2.20**
Tumkur	-9.80	-13.54	-20.72	6.26**	8.62	2.22*	20.49**	19.80**	5.43
Karnataka	49.38*	38.18*	-1.05	1.42	1.46	0.04	8.84**	9.13**	-1.21**

Note: ** and * indicates significance at 1 and 5 per cent level respectively

In Dharwad district, during Period-I, the area, production and yield showed positive insignificant growth of 5.38 per cent per annum, 4.22 per cent per annum and 2.19 per cent per annum respectively. During Period-II, area, production and yield showed negative growth, whereas during overall period area, production and yield showed positive insignificant growth of 0.36 per cent per annum, 1.09 per cent per annum and 0.48 per cent per annum respectively.

In Gulbarga district, area showed negative growth of - 1.05 per cent per annum during Period-I whereas production and yield showed positive growth of 4.14 per cent per annum and 2.06 per cent per annum respectively and both found non-significant. During Period-II, both area and production exhibited negative growth of -2.84 per cent per annum and -3.16 per cent per annum respectively whereas yield showed positive growth of 0.91 per cent per annum. During overall period area showed negative growth of -1.35 per cent per annum whereas production and yield showed positive growth of 0.19 per cent per annum, which was found non–significant and 1.08 per cent per annum, which was found significant at five per cent level of significance respectively.

In Raichur district, during Period-I, the area, production and yield exhibited positive growth of 1.31 per cent per annum, which was found to be significant at one per cent, 4.05 per cent per annum, which was found significant at five per cent level of significance and 2.66 per cent per annum, which was found non- significant respectively. During Period-II, area, production and yield exhibited negative growth of -2.84 per cent per annum, -3.16 per cent per annum and -0.34 per cent per annum respectively. During overall period, area and production showed negative growth of -1.22 per cent per annum, -1.02 per cent per annum respectively whereas yield showed marginal growth of 0.24 per cent per annum.

In Tumkur district, during Period-I both the area and production showed positive growth of 7.33 per cent per annum, which was found to be significant at one per cent level of significance and 4.56 per cent per annum, which was found non-significant respectively whereas yield showed negative growth of -2.43 per cent per annum. During Period-II, area, production and yield showed negative growth of -0.94 per cent per annum, -4.51 per cent per annum and -3.60 per cent per annum respectively. During overall period, area and production showed positive growth of 3.21 per cent per annum and 1.89 per cent per annum respectively whereas yield showed negative growth of -1.26 per cent per annum.

The state as a whole, during Period-I showed positive growth in area, production and yield of 0.38 per cent per annum, 2.24 per cent per annum and 2.22 per cent per annum respectively. During Period-II, area, production and yield showed negative growth of -1.76 per cent per annum, -3.63 per cent per annum and -1.84 per cent per annum respectively. During overall period, area and production showed positive growth of 0.16 per cent per annum and 0.17 per cent per annum respectively whereas yield showed negative growth of -0.04 per cent per annum.

Sunflower

Area

It can be observed from Table 4.2 that overall growth performance of sunflower area in the state was to the tune of 8.83 per cent per annum. This indicated a sudden spurt in area under sunflower in the state for last three decades. Even much more than this, the first period recorded a growth rate of 49.38 per cent per annum, though it was slowed down to 1.42 per cent in the second period. Similar growth rates were observed across the districts.

During the Period-I, all the districts experienced very high double digit growth rates of area under sunflower except Tumkur. The growth rate across districts varied between 122.91 (Bijapur district) to 49.72 per cent (Gulbarga district), whereas in the second period, significant growths were registered in the districts of Belgaum (4.83 per cent), Dharwad (3.53 per cent), Raichur (5.83 per cent) and Tumkur (6.26 per cent).The remaining districts showed positive but non-significant growth rates except Bellary and Chitradurga which showed negative growth.

The results in respect of the output growth of sunflower in the state exhibited a picture almost similar to that of area. The growth rate of production at the state level during the entire period was 9.13 per cent per annum against 38.18 per cent during Period-I. In between these two, the second period registered a growth rate of 1.46 per cent per annum and was not statistically significant.

Production

The production performance of sunflower across the districts was similar to that of the state. During the overall period, all the districts under study showed a significant increase ranging between 5.70 per cent per annum (Bellary district) and 19.80 per cent per annum (Tumkur district).

During the Period-I, the districts of Bijapur (122.91 per cent), Dharwad (102.01 per cent) and Bellary (86.60 per cent) recorded a spurt in their growth rates as compared to other districts. Furthermore, Table 4.2 revealed that during Period-II, the same trend was not continued. Significant growth rates were registered only in the districts of Belgaum (7.13 per cent) and Dharwad (4.05 per cent). Others turned out to be non-significant. Chitradurga had showed negative growth of 0.34 per cent per annum.

Productivity

It can be seen from the table that over the years at the state level, sunflower productivity was found to decline substantially at the rate of 1.21 per cent per annum. The rate of deceleration during the Period-I was 1.05 per cent per annum whereas, during Period-II it has slightly increased to 0.04 per cent per annum which was very negligible.

The yield growth rates across the districts were not different from that of the state. During the entire period, the positive growth rates were observed only in Belgaum (1.05 per cent) and Tumkur (5.43 per cent) districts. The rest of the districts experienced a declining growth which was statistically significant except Gulbarga.

However, the truncated analysis revealed that the yield of sunflower was not encouraging during the Period-II in the districts of Belgaum (2.21 per cent), Gulbarga (1.86 per cent) and Tumkur (2.22 percent). In these districts the yield of sunflower recovered from substantial decelerating productivity growth during the Period-I to a high positive growth in the latter period. Thus, the productivity performance of sunflower was disheartening at the state level and across the districts.

Total oilseeds

The results of the Compound Growth Rate analysis of area, production and productivity of total oilseeds in the selected districts as well as for the state of Karnataka as a whole are presented in Table 4.3.

In Belgaum district, during Period -I area showed negative growth of -0.74 per cent per annum whereas production and productivity showed positive growth of 2.87 per cent per annum, which was found non-significant and 6.99 per cent per annum, which was found significant at five per cent of significance respectively. During Period-II, area and production exhibited positive growth of 0.82 per cent per annum, which was found significant at one per cent level of significance and 0.56 per cent per annum, which was found non-significant respectively whereas productivity showed declining growth of -0.25 per cent per annum. During overall period, area, production and productivity showed positive growth of 0.88 per cent per annum, which was found significant at one per cent level of significance, 0.33 per cent per annum, which was found significant at one per cent level of significance and 0.69 per cent per annum, which was found non-significant respectively.

In Bellary district, during Period-I the area, production and productivity showed positive significant growth of 5.02 per cent per annum, 7.18 per cent per annum and 12.24 per cent per annum respectively. During Period-II, area, production and productivity exhibited negative growth of -0.83 per cent per annum, -3.19 per cent per annum and -2.37 per cent per annum respectively. During overall period, both the area and production showed positive growth of 3.01 per cent per annum and 1.53 per cent per annum respectively whereas, productivity showed negative growth of -0.72 per cent per annum.

In Bijapur district, during Period-I both the area and production exhibited positive significant growth of 12.27 per cent per annum and 13.08 per cent per annum respectively whereas productivity showed a negative growth of -3.02 per cent per annum. During Period-II, area showed negative growth of-0.57 per cent per annum whereas production and productivity showed positive insignificant growth of 0.01 per cent per annum and 1.19 per cent per annum respectively. During overall period, area, production and productivity showed positive growth of 3.01 per cent per annum, which was found to be significant at one per cent level, 4.02 per cent per annum, which was found to be significant at one per cent and 0.33 per cent per annum, which was found non- significant respectively.

Table 4.3: District wise compound growth rate of area, production and yield of total oilseeds in Karnataka

(Per cent per annum)

Districts	Period I			Period II			Overall period		
	A	P	Y	A	P	Y	A	P	Y
Belgaum	-0.74*	2.87	6.99*	0.82**	0.56	-0.25	0.88**	0.33**	0.69
Bellary	5.02*	7.18*	12.24**	-0.83	-3.19**	-2.37**	3.01**	1.53*	-0.72
Bijapur	12.27**	13.08*	-3.02	-0.57	0.01	1.19	3.59**	4.02**	0.33
Chitradurga	22.34**	23.38**	14.93*	0.44	-1.38	-1.08	7.71**	1.15**	0.026
Dharwad	-0.15	4.91	1.78	1.73	-0.63	-0.28	1.43**	2.05**	0.33
Gulbarga	10.25	9.30	-0.08	-3.20**	-2.30**	0.921	1.30	1.66*	0.56
Raichur	3.53**	6.18**	5.26*	0.41	-1.06	-3.03**	2.66**	1.80**	-1.88**
Tumkur	0.72	4.23	8.83*	-0.64	-3.55**	-2.91*	3.52**	2.29*	-0.07
Karnataka	**2.44****	**4.52**	**4.51***	**-0.74**	**-1.65****	**-0.91***	**1.79****	**1.82****	**-0.037**

Note: ** and * indicates significance at 1 and 5 per cent level respectively

Table 4.4: District wise compound growth rate of area, production and yield of pigeon pea in Karnataka

(Per cent per annum)

Districts	Period I			Period II			Overall period		
	A	P	Y	A	P	Y	A	P	Y
Belgaum	5.22**	-4.64	-6.07	-6.01**	-6.21*	-0.21	-4.53**	-5.58**	-1.18
Bellary	-0.37	11.44*	-0.09	-3.39**	-2.99	0.42	-2.20**	-2.46*	-0.26
Bidar	4.90**	2.09	-0.06	3.01**	5.09*	2.01	2.44**	1.60	-0.83
Bijapur	5.96**	-5.19	-7.51	6.02**	6.99**	1.11	2.62**	3.34*	0.82
Dharwad	11.78**	-3.53	-5.03	-4.95**	-3.12	3.20	-3.41**	-2.88	1.01
Gulbarga	3.72*	3.15	0.07	4.05**	9.98	5.74*	2.67**	4.84**	2.11
Mysore	1.40	0.83	-4.58	-2.48**	0.34	2.60	-1.32**	0.66	1.68*
Raichur	8.5*	-0.19	-10.32	-10.15*	0.54	2.60	-8.56**	-2.71**	-1.57
Karnataka	6.68**	2.03	-2.14	2.52**	5.31**	2.72*	1.67**	2.48**	0.77

Note: ** and * indicates significance at 1 and 5 per cent level respectively

In Chitradurga district, during Period-I the area, production and productivity showed positive significant growth of 22.34 per cent per annum, 23.38 per cent per annum and 14.93 per cent per annum. During Period-II, area showed positive insignificant growth of 0.44 per cent per annum whereas production and productivity showed negative insignificant growth of -1.38 per cent per annum and -1.08 per cent per annum respectively. During overall period, area, production and productivity showed positive growth of 7.71 per cent per annum, which was found to be significant at one per cent, 1.15 per cent per annum, which was found significant at one per cent level of significance and 0.026 per cent per annum, which was found non- significant respectively.

In Dharwad district, during Period-I area showed negative growth of -0.15 per cent per annum whereas production and productivity showed positive insignificant growth of 4.91 per cent per annum and 1.78 per cent per annum respectively. During Period-II, area showed positive insignificant growth of 1.73 per cent per annum whereas production and productivity showed declining growth of -0.63 per cent per annum and -0.28 per cent per annum respectively. During overall period, area, production and productivity showed positive growth of 1.43 per cent per annum, which was found significant at one per cent level of significance, 2.05 per cent per annum, which was found significant at one per cent level of significance and 0.33 per cent per annum, which was found non- significant respectively.

In Gulbarga district, both area and production showed positive insignificant growth of 10.25 per cent per annum and 9.30 per cent per annum respectively during Period-I, whereas productivity showed negative growth of -0.08 per cent per annum. During Period-II, area and production showed negative growth of -3.20 per cent per annum and -2.30 per cent per annum respectively whereas productivity showed positive insignificant growth of 0.921 per cent per annum. During overall period, area, production and productivity showed positive growth of 1.30 per cent per annum, which was found non-significant, 1.66 per cent per annum which was found significant at five per cent level of significance and 0.56 per cent per annum, which was found non- significant respectively

In Raichur district, the area, production and productivity showed positive significant growth of 3.53 per cent per annum, 6.18 per cent per annum and 5.26 per cent per annum respectively during Period-I. During Period-II, area showed positive insignificant growth of 0.41 per cent per annum whereas production and productivity showed negative growth of -1.06 per cent per annum and -3.03 per cent per annum respectively. During overall period, both area and production showed positive significant growth of 2.66 per cent per annum and 1.80 per cent per annum respectively, whereas productivity showed negative growth of -1.88 per cent per annum, which was found significant at one per cent level of significance.

In Tumkur district, during Period-I area, production and productivity showed positive growth of 0.72per cent per annum, which was found non-significant, 4.23 per cent per annum, which was found non-significant and 8.88 per cent per annum, which was found significant at five per cent level of significance respectively. During Period-II area, production and productivity showed negative growth of -0.64 per cent per annum,-3.55 per cent per annum and -2.91per cent per annum. During overall period, both area and production showed positive significant growth of 3.52 per cent per annum and 2.29per cent per annum respectively, whereas productivity showed negative growth of -0.07 per cent per annum.

The state as a whole, during Period-I area, production and productivity showed positive growth of 2.44 per cent per annum, which was found significant at one per cent level of significance, 4.52 per cent per annum, which was found non-significant and 4.51 per cent per annum, which was found significant at five per cent level of significance respectively. During Period-II area, production and productivity showed negative growth of -0.74 per cent per annum,-1.65 per cent per annum and -0.91 per cent per annum. During overall period, area and production showed positive significant growth of 1.79 per cent per annum and 1.82 per cent per annum respectively, whereas productivity showed negative growth of -0.037.

4.1.2 Growth rates in area, production and productivity of pulses

Pigeon pea

The results of the Compound Growth Rate analysis of area, production and productivity of pigeon pea during different periods in selected districts and state as a whole are presented in Table 4.4.

Area

It can be observed from the table that during the Overall period, area under pigeon pea in the state registered a significant growth rate of 1.67 per cent per annum. Similar growth performance was observed in Bidar, Bijapur and Gulbarga districts and was statistically significant. The other districts showed negative growth, which was statistically significant. The highest positive growth (2.67 Per cent) was registered in Gulbarga district.

All the study districts (barring the district of Bijapur), experienced a positive significant growth in area during Period-I. In Mysore district, although growth in area was positive but found statistically non-significant. During the Period-II, the annual rate of increase in pigeon pea area was declining significantly in Belgaum (-6.01 per cent), Bellary (-3.39 per cent), Dharwad (-4.95 per cent), Mysore (-2.48 per cent) and Raichur (-10.15 per cent). Further the results revealed that with the exception of improvements are seen in Bidar, Bijapur and Gulbarga districts which showed positive significant growth. Similar trend was seen in state as a whole showed positive significant growth of 2.52 per cent per annum.

Production

It could be seen from Table 4.4 that the growth rate in production of pigeon pea during the Overall period was encouraging (2.48 per cent) in the state. The production performance of pigeon pea was much higher during Period-II than Period-I and Overall period.

During Overall period, all the districts witnessed a significant increase in output of pigeon pea except in the districts of Belgaum (-5.58 per cent), Bellary (-2.46 per cent), Dharwad (-2.88 per cent) and Raichur (-2.71 per cent). The highest production growth (4.84 per cent) was registered in Gulbarga district followed by Bijapur (3.34 per cent).

During Period –II production growth (5.31 per cent) was much encouraging than Period-I and Overall period in the state as well as across districts. Gulbarga district recorded the highest growth rate (9.98 per cent) during Period-II. All other districts also recorded positive growth except Belgaum, Bellary and Dharwad. During Period-I, state as a whole witnessed a growth in production of 2.03 per cent.

Productivity

The yield growth performance of pigeon pea at the state level during Overall period was found to be increase by 0.77 per cent per annum. The rate of increase was much higher (2.72 per cent) during Period-II as compared to Period-I. A similar trend was noticed in most of the districts.

The productivity growth of pigeon pea was negative in most of the districts and state as a whole during Period-I except Gulbarga which showed marginal positive growth of 0.07 per cent. During Period-II, the trend reversed that is all districts witnessed positive growth in yield except Belgaum district which showed negative growth of 0.21 per cent. By and large, the performance of pigeon pea productivity in the state as well as across the districts was satisfactory over the years.

Chickpea

The results of the Compound Growth Rate analysis of area, production and productivity of chickpea in the selected districts as well as for the state of Karnataka as a whole are presented in Table 4.5.

In Belgaum district, during Period -I area showed positive growth of 3.45 per cent per annum, which was found significant at five per cent of significance whereas production and productivity showed negative growth of -0.92 per cent per annum and -5.79 per cent per annum respectively. During Period-II area, production and productivity showed positive growth of 6.96 per cent per annum, which was found significant at one per cent level of significance, 6.85 per cent per annum, which was found significant at one per cent level of significance and 0.08 per cent per annum, which was found non-significant respectively.

Table 4.5: District wise compound growth rate of area, production and yield of chickpea in Karnataka

(Per cent per annum)

Districts	Period I			Period II			Overall period		
	A	P	Y	A	P	Y	A	P	Y
Belgaum	3.45*	-0.92	-5.79	6.96**	6.85**	0.08	4.06**	4.64**	0.60
Bellary	2.30	-6.78	-6.43	12.38**	14.72**	3.19**	7.61**	9.28**	1.54
Bidar	5.27**	0.11	-4.19	1.88	4.60*	3.10*	1.64**	0.88**	0.31
Bijapur	5.53**	3.73	-2.09	8.77**	10.52**	1.61	6.95**	8.95**	1.80
Dharwad	8.87*	7.20	-5.33	5.81**	6.36**	0.29	5.14**	6.17**	0.76**
Gulbarga	4.73**	2.91	-0.77	5.10	9.91**	4.22**	6.88	10.08**	3.00**
Mysore	1.07	-0.39	-1.76	4.79**	7.08**	2.61*	2.68**	3.80**	1.16
Raichur	7.08*	0.981	-6.92	11.80**	12.04**	0.24	7.66*	7.64**	-0.32*
Karnataka	**6.33****	**2.77**	**-3.49****	**6.62****	**8.75****	**2.08***	**6.00****	**7.15****	**1.39****

Note: ** and * indicates significance at 1 and 5 per cent level respectively

During overall period, area, production and productivity showed positive growth of 4.06 per cent per annum, which was found significant at one per cent level of significance, 4.64 per cent per annum, which was found significant at one per cent level of significance and 0.60 per cent per annum, which was found non-significant respectively.

In Bellary district, area showed positive insignificant growth of 2.30 per cent per annum during Period-I whereas production and productivity showed negative growth of -6.78 per cent per annum and -6.43 per cent per annum respectively. During Period-II, area, production and productivity exhibited positive growth of 12.38 per cent per annum, 14.72 per cent per annum and 3.19 per cent per annum respectively. During overall period, area, production and productivity showed positive growth of 7.61 per cent per annum, which was found significant at one per cent level of significance, 9.28 per cent per annum, which was found significant at one per cent level of significance and 1.54 per cent per annum, which was found non-significant respectively.

In Bidar district, during Period-I both the area and production exhibited positive growth of 5.27 per cent per annum, which was found significant at one per cent level of significance and 0.11 per cent per annum, which was found non-significant respectively whereas productivity showed declining growth of -4.19 per cent per annum. During Period-II, area, production and productivity showed positive growth of 1.88 per cent per annum, which was found non- significant, 4.60 per cent per annum, which was found significant at five per cent level of significance and 3.10 per cent per annum, which was found significant at five per cent level of significance respectively. The area, production and productivity showed positive growth of 1.64 per cent per annum, which was found significant at one per cent level of significance, 0.88 per cent per annum, which was found significant at one per cent level of significance and 0.31 per cent per annum, which was found non- significant respectively during overall period.

In Bijapur district, during Period-I both the area and production exhibited positive growth of 5.53 per cent per annum, which was found significant at one per cent level of significance and 3.73 per cent per annum, which was found non-significant respectively whereas productivity showed a negative growth of -2.09 per cent per annum. During Period-II, area, production and productivity showed positive growth of 8.77 per cent per annum, which was found significant at one per cent level of significance, 10.52 per cent per annum, which was found significant at one per cent level of significance and 1.61 per cent per annum, which was found non-significant respectively. Similar trend was seen in overall period, the area, production and productivity showed positive growth of 6.95 per cent per annum, which was found significant at one per cent level of significance, 8.95 per cent per annum which was found significant at one per cent level of significance and 1.80 per cent per annum, which was found non- significant respectively.

In Dharwad district, area and production showed positive growth of 8.87 per cent per annum, which was found significant at five per cent level of significance and 7.20 per cent per annum, which was found non-significant respectively during Period-I whereas productivity showed declining growth of -5.33 per cent per annum. During Period-II, area, production and productivity showed positive growth of 5.81 per cent per annum, which was found significant at one per cent level of significance, 6.36 per cent per annum, which was found significant at one per cent level of significance and 0.29 per cent per annum, which was found non-significant respectively. During overall period area, production and productivity showed positive growth of 5.14 per cent per annum, 6.17 per cent per annum and 0.76 per cent per annum, respectively.

In Gulbarga district, both area and production showed positive growth of 4.73 per cent per annum, which was found significant at one per cent level of significance and 2.91 per cent per annum, which was found non-significant respectively during Period-I, whereas productivity showed negative growth of -0.77 per cent per annum. During Period-II, area, production and productivity showed positive growth of 5.10 per cent per annum, which was found non-significant, 9.91 per cent per annum, which was found significant at one per cent level of significance and 4.22 per cent per annum, which was found significant at one per cent level of significance respectively. During overall period area, production and productivity showed positive growth of 6.88 per cent per annum, which was found non-significant, 10.08 per cent per annum, which was found significant at one per cent level of significance and 3.00 per cent per annum, which was found significant at one per cent level of significance respectively.

In Mysore district, during Period-I area showed positive insignificant growth of 1.07 per cent per annum whereas production and productivity showed negative growth of -0.39 per cent per annum and -1.76 per cent per annum respectively. During Period-II, area, production and productivity showed positive significant growth of 4.79 per cent per annum, 7.08 per cent per annum and 2.61 per cent per annum respectively. During overall period area, production and productivity showed positive growth of 2.68 per cent per annum, which was found significant at one per cent level of significance, 3.80 per cent per annum, which was found significant at one per cent level of significance and 1.16 per cent per annum, which was found non-significant respectively

In Raichur district, area and production showed positive growth of 7.08 per cent per annum, which was found significant at five per cent level of significance and 0.981 per cent per annum, which was found non-significant respectively during Period-I whereas productivity showed negative growth of -6.92 per cent per annum. During Period-II, area, production and productivity showed positive growth of 11.80 per cent per annum, which was found significant at one per cent level of significance, 12.04 per cent per annum, which was found significant at one per cent level of significance and 0.24 per cent per annum, which was found non- significant respectively. During overall period both area and production showed positive significant growth of 7.66 per cent per annum and 7.64 per cent per annum respectively, whereas productivity showed negative growth of -0.32 per cent per annum.

The state as a whole, during Period-I area and production showed positive growth of 6.33 per cent per annum, which was found significant at one per cent level of significance and 2.77 per cent per annum, which was found non-significant respectively whereas productivity showed negative growth of -3.49 per cent per annum. During Period-II area, production and productivity showed positive significant growth of 6.62 per cent per annum, 8.75 per cent per annum and 2.08 per cent per annum. Similar trend was seen in overall period, the area, production and productivity showed positive significant growth.

Total pulses

The growth rates of area, production and productivity of total pulses during different periods in the selected districts as well as for the state of Karnataka as a whole are presented in Table 4.6.

Area

It can be observed from the table during the entire period, area under total pulses in the state registered a significant positive growth rate of 1.39 per cent per annum. A similar growth performance was observed in most of the districts and was statistically significant in the districts of Bidar (3.52 per cent), Bijapur (2.62 per cent), Dharwad (2.21 per cent), Gulbarga (3.26 per cent) and Mysore (2.32 per cent). Bellary and Raichur showed positive but non-significant growth. Belgaum was the only district showed negative growth in area.During Period-II, growth in production (3.27 per cent) was more compared to Period-I (1.17 per cent) and Overall period. The highest growth in area during Period-II was observed in Mysore district (4.81 per cent) followed by Bijapur district (4.16 per cent). All the districts and state as a whole witnessed positive significant growth. During Period-I, in most of the districts and state as a whole experienced positive growth in area except Belgaum district (-0.66 per cent) and Mysore district (-1.55 per cent) which showed negative growth.

Production

The production performance of total pulses across the districts was similar to that of the state. During the overall period, all the districts under study showed increase in production growth except Belgaum, Mysore and Raichur districts which showed negative growth rate. The state witnessed growth of 2.35 per cent, which was encouraging. During Period-II growth in production witnessed a highest growth of 3.27 per cent as compared to Period-I (0.33 per cent). Across the districts similar trend was seen. The highest growth was noticed in Gulbarga district with 7.09 per cent followed by Bijapur and Raichur which showed same growth rate of 5.18 per cent. During Period-II, all districts positive significant growth rates Belgaum and Dharwad wherein growth rates were statistically non-significant. During Period-I, the highest negative growth rate was observed in Mysore district (-16.31 per cent) followed by Raichur (-15.13 per cent) and Belgaum (-3.24 per cent) districts and rest of districts showed positive growth.

Productivity

It can be seen from the table that over the years at the state level, total pulses productivity was found to decline substantially at the rate of 0.82 per cent per annum during Period-I, whereas during Period-II, the growth in yield has increased to 1.06 per cent per annum. Most of the districts exhibited positive growth in productivity except the districts of Belgaum (-0.84 per cent), Bidar (-0.42 per cent) and Dharwad (-0.98 per cent).

Table 4.6: District wise compound growth rate of area, production and yield of total pulses in Karnataka

(Per cent per annum)

Districts	Period I			Period II			Overall period		
	A	P	Y	A	P	Y	A	P	Y
Belgaum	-0.66	-3.24	-2.60	1.70**	0.84	-0.84	-0.13	-0.46	-0.33
Bellary	3.10*	2.91	-0.16	1.56*	3.39**	1.80*	0.16	1.56*	1.40*
Bidar	7.96	3.91	0.37	1.18**	0.75	-0.42	3.52**	0.99	-1.28
Bijapur	2.82*	0.25	-2.51	4.16**	5.18**	0.56	2.62**	3.92**	-0.13
Dharwad	2.80	1.31	-1.43	2.62**	1.55	-0.98	2.21**	1.78	-0.36
Gulbarga	2.01**	1.95	-0.48	3.87**	7.09**	3.09*	3.26**	6.39**	2.06**
Mysore	-1.55	-16.31**	-0.38	4.81**	3.77**	0.66	2.32**	-1.39	1.00
Raichur	0.54	-15.13**	-1.04	2.71**	5.18**	3.22**	0.52	-2.64*	1.14
Karnataka	1.17*	0.33	-0.82	2.18**	3.27**	1.06	1.39**	2.35**	0.95**

Note: ** and * indicates significance at 1 and 5 per cent level respectively

Table 4.7: General characteristics of groundnut growers in the study area

(n=60)

Sl. No.	Particulars	Unit	Beneficiary	Non-beneficiary
1	Age	Years	46.45	47.88
2	Education			
	Illiterate	No.	6 (20.0)	11 (36.6)
	Primary	No.	11 (36.6)	9 (30.0)
	High school	No.	6 (20.0)	4 (13.3)
	College	No.	7 (23.3)	6 (20.0)
3	Occupation			
	Agriculture as main occupation	No.	28 (93.3)	27 (90.0)
	Agriculture as subsidiary occupation	No.	2 (6.6)	3 (1.0)
4	Family size	No.	4.66	4.62
5	Land holdings			
	Irrigated	Ha	0.76 (25.6)	0.6 (24.0)
	Rainfed	Ha	2.21 (74.4)	1.9 (76.0)
	Total	Ha	2.97 (100.0)	2.5 (100.0)
6	Average area under groundnut	Ha	1.53 (51.51)	1.12 (45.0)
7	Varieties used			
a.	JI-24	No	13 (43.33)	8 (26.67)
b.	Ajay	No	7 (23.33)	0
c.	TMV-2	No	10 (33.33)	0
d.	Local	No	0	22 (73.33)

Note: Figures in parentheses indicates percentage to total samples

Table 4.8: Cropping pattern of groundnut growers in the study area (ha)

(n=60)

Sl. No.	Crops	Beneficiary	Non-beneficiary
I	*Kharif*		
1	Pigeon pea	0.50 (14.53)	0.44 (15.17)
2	Groundnut	1.53 (44.44)	1.12 (38.62)
3	Green gram	0.12 (3.47)	0.08 (2.75)
4	Paddy	0.13 (3.77)	0.19 (6.55)
5	Ragi	0.31 (9.01)	0.25 (8.62)
	Total *Kharif*	2.59 (75.2)	2.08 (71.7)
II	*Rabi*		
1	Jowar	0.16 (4.65)	0.19 (6.55)
2	Chickpea	0.31 (9.01)	0.21 (7.21)
3	Total *Rabi*	0.47 (13.6)	0.40 (13.8)
III	Perennial crops		
1	Coconut	0.21 (6.10)	0.22 (7.58)
2	Arecanut	0.17 (4.94)	0.20 (6.89)
3	Sub total	0.38 (11.0)	0.42 (14.2)
	Gross cropped area	3.44	2.90
	Net cropped area	2.97	2.50
	Cropping intensity (%)	147.47	146.00

Note: Figures in parentheses indicate percentage to the total gross cropped area

Table 4.9: Labour use pattern in groundnut cultivation

(Per ha), (n=60)

Particulars	Beneficiary			Non-beneficiary		
	Human labour (mandays)	Bullock labour (pair days)	Machine labour (hrs)	Human labour (mandays)	Bullock labour (pair days)	Machine labour (hrs)
Ploughing	1.61	-	8.45	1.47	-	7.88
Harrowing	2.69	5.95	-	2.57	5.4	-
Loading, transportation and spreading of FYM	10.38	-	5.25	7.7	-	2.95
Sowing	8.18	3.85	-	8.08	4.03	-
Fertilizer application	4.7	-	-	3.78	-	-
Weeding	27.1	-	-	27.7	-	-
Inter cultivation	2.16	4.7	-	2.11	4.33	-
PPC application	2.55	-	-	2.7	-	-
Harvesting	22.68	-	-	22.5	-	-
Total	82.05	14.5	13.7	79.31	13.75	10.83

During Overall period, the productivity growth in total pulses was 0.95 per cent per annum. Most of the study districts showed encouraging positive growth except Belgaum district, Bidar district, Bijapur district and Dharwad districts wherein they showed negative growth in yield.

4.2 Impact of Technology Mission on Oilseeds and Pulses economy

4.2.1 Impact of Technology Mission on Oilseeds on oilseeds economy

4.2.1.1 General characteristics of growers of groundnut in the study area

An understanding of general characters of the sample farmers is expected to provide a bird's eye view of the general features prevailing in the study area. Therefore, an attempt has been made in the study to analyze some of the important characters of the sample farmers. The general characteristics about groundnut growers are presented in Table 4.7.

The average age of beneficiaries growing groundnut was 46.45 years where as that of non-beneficiaries was 47.88 years. It was observed that majority of the sample farmers both beneficiaries (80.00 per cent) and non-beneficiaries (63.33 per cent) were literate having their education ranging from primary to college level and in both the cases the main occupation was agriculture.

From the table it could be seen that the average size of the family of both beneficiaries and non- beneficiaries was about five members. With regard to landholding the average land holding was 2.97 ha, of which 25.6 per cent was irrigated and 74.4 per cent was rainfed in case of beneficiaries whereas, the average land holding of non- beneficiaries was 2.50 ha, of which 24.0 per cent was irrigated land and 76.0 per cent was under rainfed. Average area under groundnut cultivation by beneficiaries and non- beneficiaries was 1.53 ha (51.51%) and 1.12 ha (45.0%) respectively. 43.33 per cent, 23.33 per cent, 33.33 per cent of the beneficiaries grown JI-24, Ajay and TMV-2 varieties of groundnut in study area respectively whereas, the varieties grown by the non- beneficiaries were JL-24 (26.67%) and Local (73.33%).

4.2.1.2 Cropping pattern of groundnut growers in the study area

Cropping pattern of sample farmers presented in Table 4.8 indicated that both the categories of farmers have grown variety of crops in both the seasons. Red gram, ground nut, green gram, paddy, ragi, jowar, chickpea, coconut and arecanut were the common crops grown. In *Kharif* season, groundnut occupied 44.44 per cent and 38.62 per cent of the gross cropped area of beneficiary farms and non-beneficiary farms respectively followed by pigeon pea(16.86 per cent and 15.17 per cent), ragi (9.01% and 8.62%), paddy (3.77% and 6.55%) and green gram (3.47% and 2.75%) in both the types of farms.

During *Rabi* season, chickpea occupied 9.02 per cent and 7.21 per cent of the gross cropped area and jowar occupied 4.65 per cent and 6.55 per cent in beneficiary farms and non-beneficiary farms respectively. Among perennial crops, coconut was the major crop grown in beneficiary farms (6.10%) followed by arecanut (4.94%) whereas in case of non-beneficiary farms arecanut was the major one (7.58%) followed by coconut (6.89%), thus the gross cropped area was higher in case of beneficiary farms (3.44 ha) than non-beneficiary farms (2.90 ha) with cropping intensity of 147.47 per cent and 146.00 per cent respectively.

4.2.1.3 Labour use pattern in groundnut cultivation

The quantity of labour used in the different operations of beneficiaries and non-beneficiaries for a hectare area of groundnut cultivation are presented in the Table 4.9. Beneficiaries, for ploughing used 1.61 man days of human labour and 8.45 machine hours, for harrowing 2.69 man days and 5.95 pair days of bullock labour were used. For transportation of FYM, 5.25 machine hours were used. About 10.38 man days of human labour were used for spreading of FYM. For sowing operation 8.18 man days and 3.85 pair days of bullock labour were used. For fertilizer application 4.7 man days and for weeding 27.1 man days of human labour were used. For intercultivation operations about 2.16 man days of human labour and 4.7 pair days of bullock labour were used. About 2.55 man days of human labour were used for PPC application and for harvesting 22.68 man days of human labour was used. In case of beneficiaries total of 13.7 machine hours, 14.5 pair days of bullock labour and 82.05 man days human labour were used in groundnut cultivation.

Non-beneficiaries, for ploughing used 1.47 man days and 7.88 machine hours, for harrowing 2.57 man days and 5.4 pair days were used. For transportation of FYM 2.95 machine hours were used. About 7.7 man days human labour were used for spreading of FYM.

Table 4.10: Input use pattern and output obtained in groundnut cultivation

(Per ha), (n=60)

Sl. No.	Particulars	Units	Beneficiary	Non-beneficiary
1	Seeds	Kgs	125.7	115.83
2	Human labour	Man days	82.05	79.31
3	Bullock labour	Pair days	14.5	13.8
4	Tractor labour	Hours	13.7	10.8
5	Farm yard manure (FYM)	Tonnes	7.8	5.1
6	Fertilizers			
a.	N	kgs	38.97	32.31
b.	P	kgs	69.13	60.28
c.	K	kgs	39.47	35.67
d.	Gypsum	kgs	126.63	101.94
7	PPC	₹	728.3	702.7
8	Output	Qtls.	27.2	21.8

For sowing operation 8.08 man days and 4.03 pair days of bullock labour were used. For fertilizers application 3.78 man days and for weeding 27.7 man days were used. In case of inter cultivatin operation about 2.11 man days of human labour and 4.33 pair days of were used. About 2.7 man days human labour were used for PPC application and for harvesting 22.5 man days were used. In case of non- beneficiaries total of 10.83 machine hours, 13.75 pair days and 79.31 man days were used in groundnut cultivation.

4.2.1.4 Input use pattern and output obtained in groundnut cultivation

The pattern of inputs used per hectare of groundnut cultivation and output obtained by both beneficiaries and non- beneficiaries are presented in the Table 4.10. About 125.7 kgs and 115.83 kgs of seeds were used by beneficiaries and non- beneficiaries respectively. The beneficiaries used 82.05 man days of human labour whereas non-beneficiaries used 79.31 man days of human labour. Bullock labour used by beneficiaries and non-beneficiaries were 14.5 pair days and 13.8 pair days respectively. About 13.7 hours and 10.8 hours of tractor labour were used by beneficiaries and non-beneficiaries respectively. 7.8 tonnes of FYM were used by beneficiaries whereas non beneficiaries used 5.1 tonnes. Beneficiary farmers used 38.97, 69.13, 39.47 and 126.63 kgs of N, P, K and gypsum respectively whereas non-beneficiary farmers used 32.31, 60.28, 35.67 and 101.94 kgs of N, P, K and gypsum respectively. Beneficiaries spen t ₹ 728.3 for PPC whereas non-beneficiaries spent ₹ 702.7.

The output obtained by beneficiaries for per hectare of groundnut cultivation was 27.2 quintals whereas non-beneficiaries obtained 21.8 quintals.

4.2.1.5 Costs and returns in cultivation of groundnut

Table 4.11 depicted the details of cost of cultivation and returns structure of groundnut by beneficiaries and non-beneficiaries. The data on variable costs revealed that cost of the inputs incurred by beneficiaries (₹ 41001.85/ha) were higher than that incurred by the non- beneficiaries (₹ 35766.33/ha). The total cost of cultivation worked out to be ₹ 50573.33/ha in case of beneficiaries and ₹ 45362.23/ha in case of non- beneficiaries. The analysis of gross returns showed that there was a wide variability in the gross returns realized for groundnut between both the groups of farmers. It was ₹ 98958.6/ha among beneficiaries and ₹ 78333.85/ha in case of non- beneficiaries. The net returns realized was highest in case of beneficiaries at ₹ 48385.28/ha while, it was less among non-beneficiaries at ₹ 32971.63/ha with respective benefit cost ratios of 1.96 and 1.73 which indicated higher returns for every one rupee invested by beneficiaries in groundnut than non-beneficiaries. The increase in cost in beneficiary farms over non-beneficiary farms was ₹ 5211.1 and increase in gross returns was ₹ 20624.75 and net additional returns observed was ₹ 15413.65 in beneficiary farms for groundnut (Fig. 4).

4.2.1.6 General characteristics of sunflower growers in the study area

The results presented in Table 4.12 revealed that, the average age of the beneficiaries was 45.61 years where as that of non-beneficiaries was 46.90 years. The majority of the sample farmers both beneficiaries (73.33 per cent) and non-beneficiaries (70.00 per cent) were literate having their education ranging from primary to college level and in both the cases their main occupation was

agriculture. The analysis on occupational pattern among the farmers showed that for 63.33 per cent of beneficiaries, agriculture was the main occupation as compared to 73.33 per cent of non- beneficiaries. This revealed almost similar occupational pattern among the sample respondents in both the categories.The average size of the family was almost the same between five to six members both among beneficiaries and non-beneficiaries and it evidently justified random selection of sample farmers in both the categories. The average farm size was relatively larger (3.39 ha) among beneficiaries when compared to non-beneficiaries (3.42 ha). Both the group had no irrigation facility and operated under rainfed condition. Average area under sunflower cultivation by beneficiaries and non- beneficiaries was 1.51 ha and 1.29 ha respectively. The sunflower hybrids grown by the beneficiaries in the study area were ITC (30.0%), DSH-1 (20.0%), Mahyco (36.67%) and KBSH-22 (13.33%) whereas, the hybrids grown by the non- beneficiaries were KBSH-22(26.67%), Local (60.0%) and DSH-1(13.33%).

4.2.1.7 Cropping pattern of sunflower growers in the study area

The area under different crops by the sample farmers is presented in Table 4.13. Results indicated that red gram, onion, green gram, sunflower, bajra, wheat, jowar and chickpea were the common crops grown by both the beneficiary and non-beneficiary farmers. In *Kharif* season, sunflower occupied 29.21 per cent of the gross cropped area in beneficiary farms followed by green gram (12.38%), pigeon pea (9.28%), onion (8.32%) and bajra (6.38%) and whereas in case of non-beneficiary farms sunflower occupied 25.85 per cent gross cropped area followed by green gram (11.62%), bajra (11.62%), pigeon pea (10.22%) and onion (9.22%).

Table 4.11: Costs and returns in cultivation of groundnut

(₹/ha), (n=60)

Sl. No.	Particulars	Beneficiary	Per cent	Non-beneficiary	Per cent
I. Variable cost					
1	Human labour	9428.75	18.64	9258.575	20.41
2	Bullock labour	5096.975	10.08	4823.65	10.63
3	Machine labour	5481.65	10.84	4338.775	9.56
4	Seeds	6913.5	13.67	5938.35	13.09
5	Farm yard manure	5849.775	11.57	3843.75	8.47
6	Fertilizers	4820.525	9.53	4520.675	9.97
7	PPC	728.325	1.44	702.725	1.55
8	Interest on working capital @ 7%	2682.375	5.30	2339.85	5.16
	Subtotal (I)	41001.85	81.07	35766.33	78.85
II. Fixed cost					
1	Rental value of land	7587.5	15.00	7587.5	16.73
2	Land revenue	62.5	0.12	62.5	0.14
3	Depreciation	972.95	1.92	994.95	2.19
4	Interest on fixed capital @11%	948.525	1.88	950.95	2.10
Subtotal (II)		9571.475	18.93	9595.9	21.15
Total cost of cultivation (I)+ (II)		50573.33	100.00	45362.23	100.00
Gross returns		98958.6		78333.85	
Net returns		48385.28		32971.63	
B:C		1.96		1.73	
Increase in cost in beneficiary farms over non-beneficiary farms			5211.1		
Increase in returns in beneficiary farms over non-beneficiary farms			20624.75		
Net additional returns			15413.65		

Table 4.12: General characteristics of sunflower growers in the study area

(n=60)

Sl. No.	Particulars	Unit	Beneficiary	Non-beneficiary
1	Age	Years	45.61	46.9
2	Education			
	Illiterate	No.	8 (26.6)	9 (30.0)
	Primary	No.	6 (20.0)	12 (40.0)
	High school	No.	11 (36.6)	7 (23.3)
	College	No.	5 (16.6)	2 (6.6)
3	Occupation			
	Agriculture as main occupation	No.	19 (63.3)	22 (73.3)
	Agriculture as subsidiary occupation	No.	11 (36.6)	8 (26.6)
4	Family size	No.	5.91	6.13
5	Land holdings			
	Irrigated	Ha	-	-
	Dry land	Ha	3.39 (100.0)	3.42 (100.0)
	Total	Ha	3.39 (100.0)	3.42 (100.0)
6	Average area under sunflower	Ha	1.51 (44.5)	1.29 (37.7)
7	Varieties used			
a.	ITC	No	9 (30)	0
b.	DSH-1	No	6 (20)	4 (13.33)
c.	Mahyco	No	11 (36.67)	0
d.	KBSH-22	No	4 (13.33)	8 (26.67)
e.	Local	No	0	18 (60.00)

Note: Figures in parentheses indicates percentage to total samples

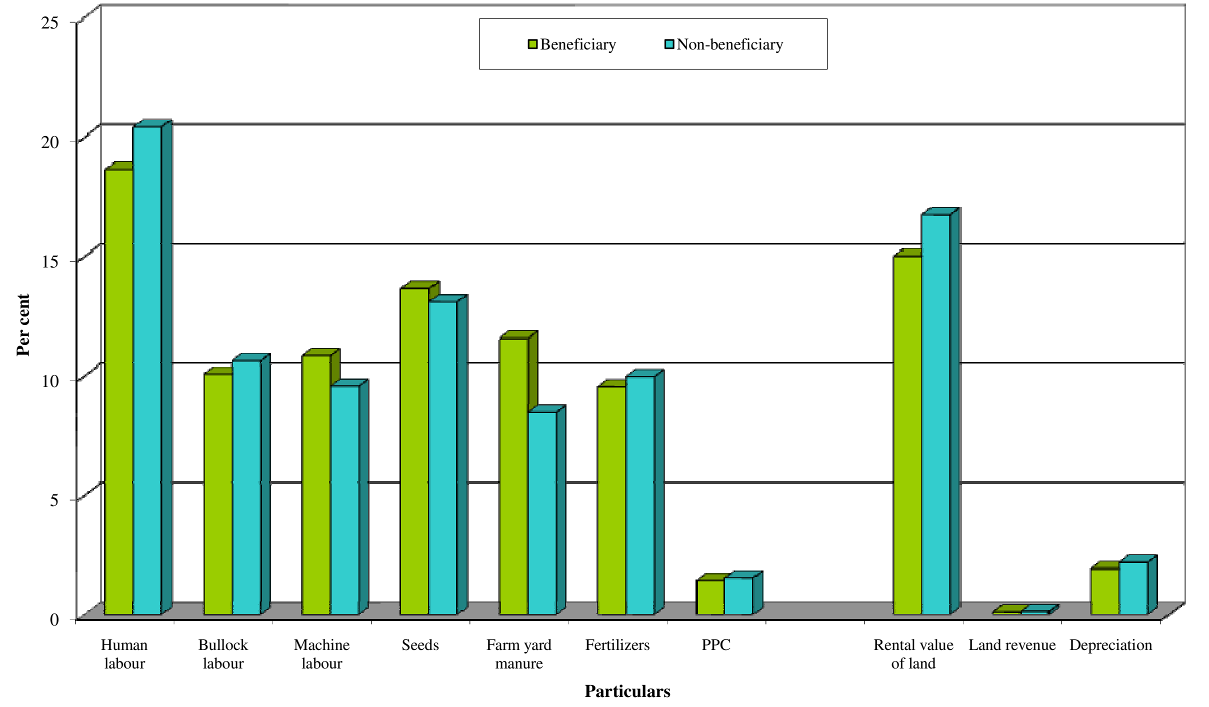

Fig. 4: Costs and returns in cultivation of groundnut

Fig 4 :Costs and returns in cultivation of groundnut

Table 4.13: Cropping pattern of sunflower growers in the study area

(ha), (n=60)

Sl. No	Crops	Beneficiary	Non-beneficiary
I	*Kharif*		
1	Pigeon pea	0.48 (9.28)	0.51 (10.22)
2	Onion	0.43 (8.32)	0.46 (9.22)
3	Green gram	0.64 (12.38)	0.58 (11.62)
4	Sunflower	1.51 (29.21)	1.29 (25.85)
5	Bajra	0.33 (6.38)	0.58 (11.62)
	Total *Kharif*	3.3 (65.5)	3.42 (68.5)
II	*Rabi*		
1	Wheat	0.37 (7.16)	0.42 (8.42)
2	Jowar	0.89 (17.21)	0.71 (14.23)
3	Chickpea	0.52 (10.06)	0.44 (8.82)
4	Total *Rabi*	1.78 (34.4)	1.57 (31.4)
	Gross cropped area	5.17 (100.00)	4.99 (100.00)
	Net cropped area	3.39	3.42
	Cropping intensity (%)	152.50	145.91

Note: Figures in parentheses indicate percentage to the total gross cropped area

Table 4.14: Labour use pattern in sunflower cultivation

(Per ha), (n=60)

Particulars	Beneficiary			Non-beneficiary		
	Human labour (mandays)	Bullock labour (pair days)	Machine labour (hrs)	Human labour (mandays)	Bullock labour (pair days)	Machine labour (hrs)
Ploughing	1.31	-	9.53	1.60	-	8.93
Harrowing	3.16	7.03	-	3.49	5.82	-
Loading, transportation and spreading of FYM	9.7	-	4.7	7.8	-	2.65
Sowing	9.1	4.18	-	9.6	3.92	-
Fertilizer application	3	-	-	3.57	-	-
Weeding	30.1	-	-	32.7	-	-
Inter cultivation	2.06	3.02	-	2.13	2.73	-
PPC application	2.7	-	-	2.9	-	-
Harvesting	25.0	-	10.3	27.28	-	8.28
Total	86.13	14.2	24.5	91.07	12.48	19.85

Table 4.15: Input use pattern and output obtained in sunflower cultivation

(Per ha), (n=60)

Sl. No.	Particulars	Units	Beneficiary	Non-beneficiary
1	Seeds	Kgs	7.8	5.1
2	Human labour	Man days	86.13	91.07
3	Bullock labour	Pair days	14.23	12.5
4	Tractor labour	Hours	24.5	19.8
5	Farm yard manure (FYM)	Tonnes	8.15	5.4
6	Fertilizers			
a.	N	kgs	60.93	68.87
b.	P	kgs	72.47	80.63
c.	K	kgs	67.93	75.28
d.	Gypsum	kgs	50.77	88.22
7	PPC	₹	1925.7	1977.8
8	Output	Qtls.	21.45	17.07

In *Rabi* season, jowar occupied 17.21per cent of the gross cropped area in the case of beneficiary farms followed by chickpea (10.06%) and wheat (7.16%), whereas in the case of non-beneficiary farms also jowar occupied 14.23 per cent of the gross cropped area followed by chickpea (8.82%) and wheat (8.42%), thus the gross cropped area was higher in case of beneficiary farms (5.17ha) than non-beneficiary farms (4.99 ha). The cropping intensity worked out for beneficiaries was 152.50 per cent as against only 145.91 per cent in case of non-beneficiaries.

4.2.1.8 Labour use pattern in sunflower cultivation

On an average for ploughing beneficiaries used 1.31 man days of human labour and 9.53 machine hours and for harrowing 3.16 man days of human labour and 7.03 pair days of bullock labour (Table 4.14). For transportation of FYM 4.7 machine hours was used. About 9.7 man days human labour were used for spreading of FYM. For sowing operation 9.1 man days and 4.18 pair days of bullock labour were used. For fertilizers application 3 man days and for weeding 30.1 man days of human labour were used. During intercultivation operation about 3.02 pair days of bullock labour were employed. About 2.7 man days human labour was used for PPC application and for harvesting 25 man days of human labour and 10.3 machine hours were used. In case of beneficiaries total of 24.5 machine hours, 14.2 pair days of bullock labour and 86.13 man days human labour were used in sunflower cultivation.

On an average for ploughing non-beneficiaries used 1.60 man days of human labour 8.93 machine hours was used, for harrowing 3.49 man days of human labour and 5.82 pair days of bullock labour was used. For transportation of FYM 2.65 machine hours was used. About 7.8 man days human labour were used for spreading of FYM. For sowing operation 9.6 man days and 3.92 pair days of bullock labour were used. For fertilizers application 3.57 man days and for weeding 32.7 man days of human labour were used. For intercultivation operation about 2.73 pair days of bullock labour was used. About 2.9 man days human labour was used for PPC application and for harvesting 27.28 man days of human labour and 8.28 machine hours were used. In case of non-beneficiaries total of 19.85 machine hours, 12.48 pair days of bullock labour and 91.07 man days of human labour were used in sunflower cultivation.

4.2.1.9 Input use pattern and output obtained in sunflower cultivation

The pattern of inputs used per hectare of sunflower cultivation and output obtained by both beneficiaries and non- beneficiaries are presented in the Table 4.15. About 7.8 kgs and 5.1 kgs of seeds were used by beneficiaries and non- beneficiaries, respectively. The beneficiaries used 86.13 man days of human labour whereas non-beneficiaries used 91.07 man days of human labour. Bullock labour used by beneficiaries and non-beneficiaries were 14.23 pair days and 12.5 pair days respectively. About 24.5 hours and 19.8 hours of tractor labour were used by beneficiaries and non-beneficiaries respectively. FYM of 8.15 tonnes was used by beneficiaries whereas non beneficiaries used 5.4 tonnes. About 60.93 kgs of N, 72.47 kgs of P, 67.93 kgs of K and 50.77 kgs of gypsum were used by beneficiary whereas non- beneficiaries used 68.87 kgs of N, 80.63 kgs of P, 75.28 kgs of K and 88.22 kgs of gypsum. Beneficiaries spent ₹ 1925.7 on plant protection chemicals whereas, non-beneficiaries spent ₹1977.8.

The output obtained by the beneficiaries for per hectare of sunflower cultivation was 21.45 quintals whereas non-beneficiaries obtained 17.07 quintals.

4.2.1.10 Costs and returns in cultivation of sunflower

The per hectare cost of cultivation of sunflower crop of beneficiaries and non-beneficiaries are presented in the Table 4.16. Perusal of the table indicated that the total cost of sunflower cultivation in beneficiary farms was more than that of non-beneficiary farms. The average cost of cultivation per hectare of sunflower of beneficiaries was ₹ 55114.3 as against ₹ 49381.03 among non-beneficiaries. In the total cost, variable costs accounted for a major share. The proportion of variable cost was ₹ 46313.08 and ₹ 40663.13 accounting for 84.03 per cent and 82.35 per cent of the total cost of cultivation of sunflower crop of beneficiaries and non-beneficiaries respectively.

There was variability in the returns realized in case of sunflower between both the groups of farmers. Eventually, the gross returns were found to be more among beneficiaries (₹ 91166.35/ ha) than non-beneficiaries (₹ 71685.45/ha). The net income gained was highest in case of beneficiaries at ₹ 36052.05 per hectare compared to non-beneficiaries (₹ 22304.4/ha). The study thus revealed that per hectare difference in gross returns (21.36%) and net returns (19.11%) on beneficiary farms were higher as compared to non-beneficiary farms. The benefit-cost ratio worked out was 1.65 and 1.45

respectively in case of beneficiaries and non-beneficiaries. The increase in cost in beneficiary farms over non-beneficiary farms was ₹ 5733.27 and increase in gross returns was ₹ 19480.9 and net additional returns observed was ₹ 13747.65 in beneficiary farms for sunflower (Fig. 5). Thus, the study depicted that similar trend of higher gross and net returns were found among beneficiaries as was observed in case of groundnut.

4.2.2 Impact of Technology Mission on Oilseeds and Pulses on pulses economy

4.2.2.1 General characteristics of pigeon pea growers in the study area

The general characters of the pigeon pea growers are presented in Table 4.17. The average age of beneficiaries growing pigeon peawas 41.9 years where as that of non-beneficiaries was 45.9 years.

The results on educational status revealed that about 96.66 per cent of the beneficiaries were illiterates and remaining were found literate. While, around 10 per cent of non- beneficiaries were in the illiterate group. It was found that the literacy rate was high among beneficiaries when compared to non- beneficiaries and in both the cases the main occupation of them was agriculture.

Form the table it could also be seen that the average size of the family of both beneficiaries and non-beneficiaries was about five members. With regard to landholding the average land holding of beneficiaries was 6.21 ha, which was rainfed where as in case of non- beneficiaries the average land holding was 5.69 ha, which was also totally rainfed. Average area under pigeon pea cultivation by beneficiaries and non- beneficiaries was 1.80 ha (29.0%) and 1.45 ha (25.4%) respectively. 33.33 per cent, 26.67 per cent, 23.33 and 16.67 per cent of the beneficiaries grew Asha, Maruti, S-I and Pragati varieties of pigeon peain study area respectively whereas, the varieties grown by the non-beneficiaries were Local (60.0%), Pragati (16.67%), Asha (13.33%) and Maruti (10.0%)

4.2.2.2 Cropping pattern of pigeon pea growers in the study area

Cropping pattern of sample farmers presented in Table 4.18 indicated that both the beneficiary and non-beneficiary have grown variety of crops in both the seasons. red gram, chilli, green gram, cotton, bajra, sunflower, jowar and chickpea were the common crops grown. In *Kharif* season, pigeon peaoccupied 19.40 per cent of the gross cropped area in beneficiary farms followed by green gram (13.47%), chilli (12.72%), cotton (11.31%) and bajra (10.02%), whereas chilli was the major crop with 22.15 per cent of gross cropped area grown by non-beneficiaries followed by Pigeon pea(17.75%), cotton (16.28%) and green gram (12.60%).In *Rabi* season, chickpea occupied 14.76 per cent of the gross cropped area in beneficiary farms followed by jowar (12.82%) and sunflower (5.50%). In non- beneficiary farms also jowar occupied 16.03 per cent of the gross cropped area followed by chickpea (14.32%), thus the gross cropped area was higher in case of beneficiary farms (9.28 ha) than non-beneficiary farms (8.17 ha) with cropping intensity of 149.44 per cent and 143.59 per cent respectively.

4.2.2.3 Labour use pattern in pigeon pea cultivation

The quantity of labour used in the different operations of beneficiaries and non-beneficiaries for an hectare area of pigeon pea cultivation are presented in the Table 4.19. Beneficiaries, for ploughing used 1.81 man days of human labour and 8.1 machine hours were used for an hectare, for harrowing 4.12 man days and 7.05 pair days of bullock labour was used. For transportation of FYM 3.35 hours of machine was used. About 9.2 man days human labour were used for spreading of FYM. For sowing operation 10.7 man days and 3.52 pair days of bullock labour were used. For fertilizers application 4.5 man days and for hand weeding 23 man days of human labour were used. For intercultivation operation about 2.14 man days of human labour and 5.17 pair days of bullock labour were used. About 7.7 man days human labour was used for PPC application and for harvesting 22.8 man days of human labour and 10.77 machine hours were used. Total of 22.23 machine hours, 15.75 pair days and 85.97 man days were used by beneficiaries in pigeon peacultivation.

Non- beneficiaries, for ploughing 2.13 man days of human labour and 9.52 machine hours was used, for harrowing 3.17 man days of human labour and 5.45 pair days of bullock labour was used. For sowing operation 10.45 man days and 3.47pair days of bullock labour were used. For fertilizers application 4.57 man days and for weeding 27.22 man days of human labour were used. For intercultivation operation about 2.11 man days of human labour and 4.77 pair days of bullock labour was used. About 10.1 man days human labour was used for PPC application and for harvesting 23.77 man days of human labour and 8.2 machine hours were used. Total of 17.73 machine hours, 13.70 pair days and 83.52 man days were used by non-beneficiaries in pigeon pea cultivation.

Table 4.16: Costs and returns in cultivation of sunflower

(₹/ha), (n=60)

Sl. No.	Particulars	Beneficiary	Per cent	Non-beneficiary	Per cent
I. Variable cost					
1	Human labour	9671.88	17.55	10341.28	20.94
2	Bullock labour	7115.2	12.91	6388.57	12.94
3	Machine labour	8445.63	15.32	6919.17	14.01
4	Seeds	5479.98	9.94	3053.42	6.18
5	Farm yard manure	5916.65	10.74	4094.77	8.29
6	Fertilizers	4728.2	8.58	5227.9	10.59
7	PPC	1925.73	3.49	1977.82	4.01
8	Interest on working capital @ 7%	3028.25	5.49	2660.2	5.39
	Subtotal (I)	46313.08	84.03	40663.13	82.35
II. Fixed cost					
1	Rental value of land	6875	12.47	6875	13.92
2	Land revenue	75	0.14	75	0.15
3	Depreciation	979.02	1.78	903.97	1.83
4	Interest on fixed capital @11%	872.2	1.58	863.93	1.75
Subtotal (II)		8801.26	15.97	8717.9	17.65
Total cost of cultivation (I)+ (II)		55114.3	100.00	49381.03	100.00
Gross returns		91166.35		71685.45	
Net returns		36052.05		22304.4	
B:C		1.65		1.45	
Increase in cost in beneficiary farms over non-beneficiary farms			5733.27		
Increase in returns in beneficiary farms over non-beneficiary farms			19480.9		
Net additional returns			13747.65		

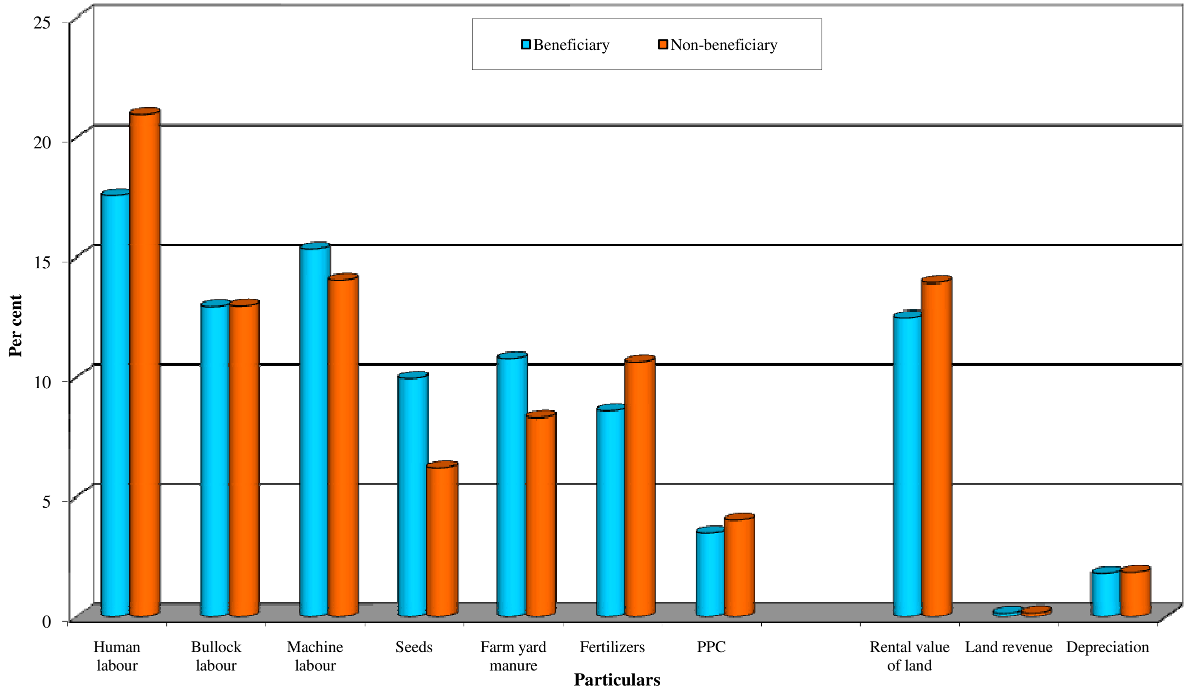

Fig. 5: Costs and returns in cultivation of sunflower

Fig 5 : Costs and returns in cultivation of sunflower

Table 4.17: General characteristics of pigeon pea growers in the study area

(n=60)

Sl. No.	Particulars	Unit	Beneficiary	Non-beneficiary
1	Age	Years	41.9	45.9
2	Education			
	Illiterate	No.	1 (3.3)	3 (10.0)
	Primary	No.	7 (23.3)	5 (16.6)
	High school	No.	12 (40.0)	10 (33.3)
	College	No.	10 (33.3)	12 (40.0)
3	Occupation			
	Agriculture as main occupation	No.	28 (93.3)	23 (76.6)
	Agriculture as subsidiary occupation	No.	2 (6.6)	7 (23.3)
4	Family size	No.	5.1	5.4
5	Land holdings			
	Irrigated	Ha	-	-
	Dry land	Ha	6.21 (100.0)	5.69 (100.0)
	Total	Ha	6.21 (100.0)	5.69 (100.0)
6	Average area under Pigeon pea	Ha	1.8 (29.0)	1.45 (25.4)
7	Varieties used			
a.	Asha	No	10 (33.33)	4 (13.33)
b.	Maruti	No	8 (26.67)	3 (10)
c.	S-I	No	7 (23.33)	0
d.	Pragati	No	5 (16.67)	5 (16.67)
e.	Local	No	0	18 (60.00)

Note: Figures in parentheses indicates percentage to total samples

Table 4.18: Cropping pattern of pigeon pea growers in the study area

(ha), (n=60)

Sl. No.	Crops	Beneficiary	Non-beneficiary
I	*Kharif*		
1	Pigeon pea	1.80 (19.40)	1.45 (17.75)
2	Chilli	1.18 (12.72)	1.81 (22.15)
3	Green gram	1.25 (13.47)	1.03 (12.60)
4	Cotton	1.05 (11.31)	1.33 (16.28)
5	Bajra	0.93 (10.02)	-
	Total *Kharif*	6.21 (67.0)	5.69 (69.6)
II	*Rabi*		
1	Chickpea	1.37 (14.76)	1.17 (14.32)
2	Jowar	1.19 (12.82)	1.32 (16.03)
3	Sunflower	0.51 (5.50)	-
4	Total *Rabi*	3.07 (33.0)	2.48 (30.3)
	Gross cropped area	9.28 (100.00)	8.17 (100.00)
	Net cropped area	6.21	5.69
	Cropping intensity (%)	149.44	143.59

Note: Figures in parentheses indicate percentage to the total gross cropped area

Table 4.19: Labour use pattern in pigeon pea cultivation

(Per ha), (n=60)

Particulars	Beneficiary			Non-beneficiary		
	Human labour (mandays)	Bullock labour (pair days)	Machine labour (hrs)	Human labour (mandays)	Bullock labour (pair days)	Machine labour (hrs)
Ploughing	1.81	-	8.1	2.13	-	9.52
Harrowing	4.12	7.05		3.17	5.45	
Loading, transportation and spreading of FYM	9.2	-	3.35	-	-	-
Sowing	10.7	3.52	-	10.45	3.47	-
Fertilizer application	4.5	-	-	4.57	-	-
Weeding	23		-	27.22	-	-
Inter cultivation	2.14	5.17	-	2.11	4.77	-
PPC application	7.7	-	-	10.1	-	-
Harvesting	22.8	-	10.77	23.77	-	8.2
Total	**85.97**	**15.75**	**22.23**	**83.52**	**13.7**	**17.73**

4.2.2.4 Input use pattern and output obtained in pigeon pea cultivation

The pattern of inputs used for per hectare pigeon pea cultivation and output obtained by both beneficiaries and non- beneficiaries are presented in the Table 4.20. About 10.7 kgs and 13.15 kgs of seeds were used by beneficiaries and non- beneficiaries respectively. The beneficiaries used 85.97 man days of human labour whereas non-beneficiaries used 83.52 man days of human labour. Bullock labour used by beneficiaries and non-beneficiaries are 15.75 pair days and 13.7 pair days respectively. About 22.22 hours and 17.72 hours of tractor labour were used by beneficiaries and non- beneficiaries respectively. FYM of 5.9 tonnes was used by beneficiaries. Beneficiary farmers used 50.92, 89.05, 67.09 and 22.08 kgs of N, P, K and sulphur respectively whereas non-beneficiary farmers used 65.37, 90.07, 75.33 and 18.01 kgs of N, P, K and sulphur respectively. Beneficiaries spent ₹ 2909.33 on PPC whereas non-beneficiaries spent ₹ 2570.35.

The output obtained by beneficiaries for per hectare of pigeon pea cultivation was 12.8 quintals whereas non-beneficiaries obtained 10.63 quintals.

4.2.2.5 Costs and returns in cultivation of pigeon pea

Per hectare cost of cultivation of pigeon pea crop of beneficiaries and non-beneficiaries are presented in the Table 4.21. Perusal of the table indicated that the total cost of pigeon pea cultivation in beneficiary farms was more than that of non-beneficiary farms. The average cost of cultivation per hectare of pigeon pea of beneficiaries was ₹ 41029.23 as against ₹ 36644.4 among non-beneficiaries. In the total cost, variable costs accounted for a major share. The proportion of variable cost was ₹ 32909.08 and ₹ 28432.6 accounting for 80.21 per cent and 77.60 per cent of the total cost of cultivation of pigeon pea crop of beneficiaries and non-beneficiaries respectively signified the additional expenditure made on variable inputs by beneficiaries on various modern inputs that influenced directly towards increased productivity of crops and further, their timely availability and use in the production process resulted in yield differences.

There was variability in the returns realized in case of pigeon pea between both the groups of farmers. Eventually, the gross returns were found to be more among beneficiaries (₹ 62555.9/ ha) than non-beneficiaries (₹ 51162.35/ha). The net income gained was highest in case of beneficiaries at ₹ 21526.68 per hectare compared to non-beneficiaries at ₹14517.95 per hectare. The study thus revealed that per hectare difference in gross returns (18.21 per cent) and net returns (32.54 per cent) on beneficiary farms were higher as compared to non-beneficiary farms. The benefit-cost ratio worked out was 1.52 and 1.4 respectively in case of beneficiaries and non- beneficiaries indicating large returns for every one rupee invested in the cultivation of crops among beneficiaries. The increase in cost of beneficiary farms over non-beneficiary farms was ₹ 4384.83 and increase in gross returns was ₹ 11393.55 and net additional returns observed was ₹ 7008.73 in beneficiary farms for pigeon pea (Fig. 6).

4.2.2.6 General characteristics of chickpea growers in the study area

The results presented in Table 4.22 revealed that, the average age of the beneficiaries was 40.8 years where as that of non-beneficiaries was 44.7 years. The majority of the sample farmers both beneficiaries (83.33%) and non-beneficiaries (93.33%) were literate having their education ranging from primary to college. The analysis on occupational pattern among the farmers showed that for 90.0 per cent of beneficiaries, agriculture was the main occupation as compared to 83.33 per cent of non- beneficiaries. This revealed almost similar occupational pattern among the sample respondents in both the categoriesThe average size of the family was almost the same between five to six members both among beneficiaries and non- beneficiaries. Average land holding of beneficiaries was 6.13 ha, which was rainfed and in cse of non- beneficiaries the average land holding was 5.96 ha, which was rainfed. Average area under chickpea cultivation by beneficiaries and non-beneficiaries was 1.91 ha and 1.69 ha respectively. The chickpea varieties grown by the beneficiaries in the study area were A-I (50.0%), GBS-962 (23.33%) and ICCV-10 (26.67%) and where as the varieties grown by the non- beneficiaries were A-I (26.67%), GBS-962(6.67%) and Local (66.67%).

4.2.2.7 Cropping pattern of chickpea growers in the study area

Cropping pattern of sample farmers given in Table 4.23 indicated that both the beneficiary and non-beneficiary have grown variety of crops in both the seasons. Red gram, chilli, green chickpea, cotton, bajra, sunflower, jowar and chickpea were the common crops grown. In *Kharif* season, green gram occupied 15.76 per cent of the gross cropped area in beneficiary farms followed by pigeon pea (14.06%), cotton (12.63%), chilli (12.37%) and bajra (7.55%), whereas in case of non-beneficiary farms pigeon pea occupied 18.23 per cent gross cropped area followed by green gram (16.16%), cotton (14.42%), chilli (11.25%) and bajra (4.60%).

Table 4.20: Input use pattern and output obtained in pigeon pea cultivation

(Per ha), (n=60)

Sl. No.	Particulars	Units	Beneficiary	Non-beneficiary
1	Seeds	Kgs	10.7	13.15
2	Human labour	Man days	85.97	83.52
3	Bullock labour	Pair days	15.75	13.7
4	Tractor labour	Hours	22.22	17.72
5	Farm yard manure (FYM)	Tonnes	5.9	-
6	Fertilizers			
a.	N	Kgs	50.92	65.37
b.	P	Kgs	89.05	90.07
c.	K	Kgs	67.09	75.33
d.	Sulphur	Kgs	22.08	18.01
7	PPC	₹	2909.33	2570.35
8	Output	Qtls.	12.8	10.63

Table 4.21: Costs and returns in cultivation of pigeon pea

(₹/ha), **(n=60)**

Sl. No.	Particulars	Beneficiary	Per cent	Non-beneficiary	Per cent
I. Variable cost					
1	Human labour	9828.02	23.95	9139.4	24.94
2	Bullock labour	6208.77	15.13	5218.47	14.24
3	Machine labour	5118.57	12.48	4339.37	11.84
4	Seeds	1032.27	2.51	856.025	2.33
5	Farm yard manure	2606.25	6.35	-	-
6	Fertilizers	3052.92	7.44	4448.9	12.14
7	PPC	2909.33	7.09	2570.35	7.01
8	Interest on working capital @ 7%	2152.92	5.25	1895.07	5.17
	Subtotal (I)	32909.08	80.21	28432.6	77.6
II. Fixed cost					
1	Rental value of land	6250	15.23	6250	17.06
2	Land revenue	20	0.05	20	0.05
3	Depreciation	1045.45	2.55	1128.02	3.08
4	Interest on fixed capital @11%	804.7	1.96	813.27	2.22
Subtotal (II)		8120.15	19.79	8211.8	22.41
Total cost of cultivation (I)+ (II)		41029.23	100.00	36644.4	100.00
Gross returns		62555.9		51162.35	
Net returns		21526.68		14517.95	
B:C		1.52		1.4	
Increase in cost in beneficiary farms over non-beneficiary farms			4384.83		
Increase in returns in beneficiary farms over non-beneficiary farms			11393.55		
Net additional returns			7008.73		

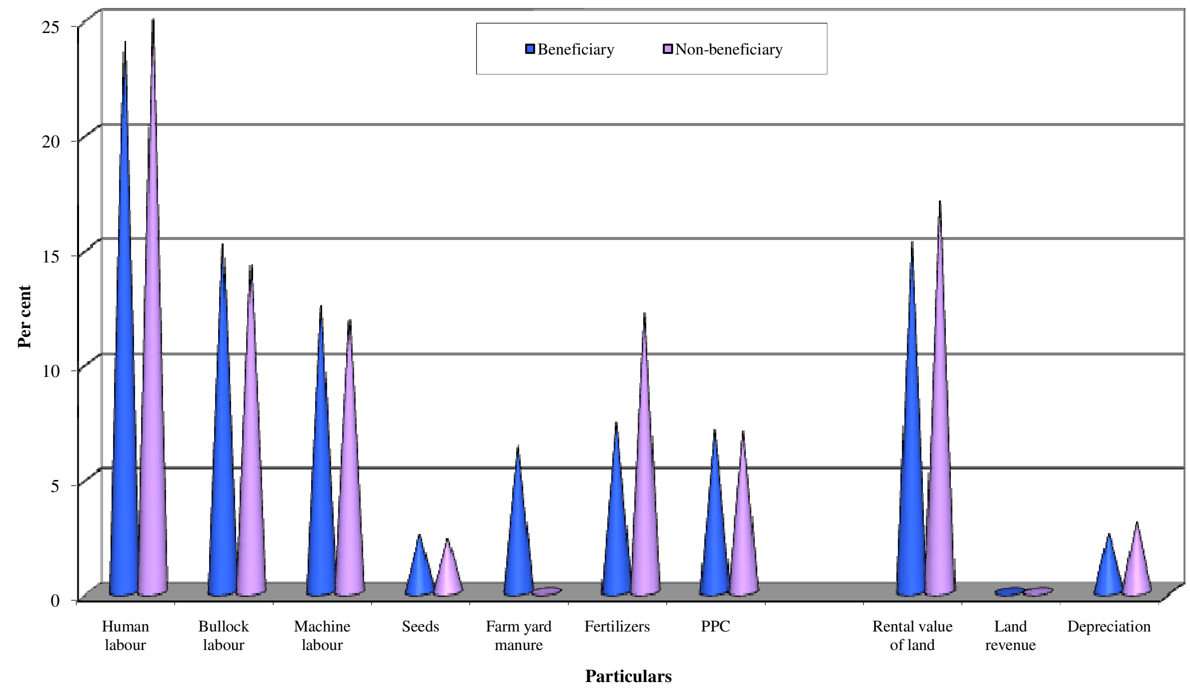

Fig. 6: Costs and returns in cultivation of pigeon pea

Fig 6 : Costs and returns in cultivation of pigeon pea

Table 4.22: General characteristics of chickpea growers in the study area

(n=60)

Sl. No.	Particulars	Unit	Beneficiary	Non-beneficiary
1	Age	Years	40.8	44.7
2	Education			
	Illiterate	No.	5 (16.6)	2 (6.6)
	Primary	No.	7 (23.3)	5 (16.6)
	High school	No.	6 (20.0)	14 (46.6)
	College	No.	12 (40.0)	9 (30.0)
3	Occupation			
	Agriculture as main occupation	No.	27 (90.0)	25 (83.3)
	Agriculture as subsidiary occupation	No.	3 (1.0)	5 (16.6)
4	Family size	No.	6.3	5.7
5	Land holdings			
	Irrigated	Ha	-	-
	Dry land	Ha	6.13 (100.0)	5.96 (100.0)
	Total	Ha	6.13 (100.00	5.96 (100.0)
6	Average area under Chickpea	Ha	1.91 (31.1)	1.69 (28.3)
7	Varieties used			
a.	A-I	No	15 (50.00)	8 (26.67)
b.	GBS-962	No	7 (23.33)	2 (6.67)
c.	ICCV-10	No	8 (26.67)	0
d.	Local	No	0	20 (66.67)

Note: Figures in parentheses indicates percentage to total samples

Table 4.23: Cropping pattern of chickpea growers in the study area

(ha), (n=60)

Sl. No.	Crops	Beneficiary	Non-beneficiary
I	*Kharif*		
1	Pigeon pea	1.08 (14.06)	1.15 (18.23)
2	Chilli	0.95 (12.37)	0.71 (11.25)
3	Green gram	1.21 (15.76)	1.02 (16.16)
4	Cotton	0.97 (12.63)	0.91 (14.42)
5	Bajra	0.58 (7.55)	0.29 (4.60)
	Total *Kharif*	4.79 (62.3)	4.08 (64.6)
II	*Rabi*		
1	Chickpea	1.91 (24.87)	1.69 (26.78)
2	Jowar	0.55 (7.16)	0.38 (6.02)
3	Sunflower	0.43 (5.60)	0.16 (2.54)
4	Total *Rabi*	2.89 (37.6)	2.23 (35.3)
	Gross cropped area	7.68 (100.00)	6.31 (100.00)
	Net cropped area	4.79	4.08
	Cropping intensity (%)	160.33	154.66

Note: Figures in parentheses indicate percentage to the total gross cropped area

Table 4.24: Labour use pattern in chickpea cultivation

(Per ha), (n=60)

Particulars	Beneficiary			Non-beneficiary		
	Human labour (mandays)	Bullock labour (pair days)	Machine labour (hrs)	Human labour (mandays)	Bullock labour (pair days)	Machine labour (hrs)
Ploughing	1.39	-	8.28	1.43	-	7.8
Harrowing	2.61	5.4	-	2.38	5.45	-
Loading, transportation and spreading of FYM	7.83	-	3.4	7.23	-	2.9
Sowing	8.8	4.6	-	7.85	4.2	-
Fertilizer application	3.45	-	-	3.78	-	-
Weeding	25.78	-	-	30.13	-	-
Inter cultivation	2.1	3.67	-	2.37	3.48	-
PPC application	4.57	-	-	6.28	-	-
Harvesting	16.35	-	4.25	15.3	-	4.1
Total	72.88	13.675	15.925	76.75	13.13	14.8

In *Rabi* season, chickpea occupied 24.87 per cent of the gross cropped area in case of beneficiary farms followed by jowar (7.16%) and sunflower (5.60%), whereas in case of non-beneficiary farms also chickpea occupied 26.78 per cent of the gross cropped area followed by jowar (6.02%) and sunflower (2.54%), thus the gross cropped area was higher in case of beneficiary farms (7.68 ha) than non-beneficiary farms (6.31 ha) with cropping intensity of 160.33 per cent and 154.66 per cent respectively.

4.2.2.8 Labour use pattern in chickpea cultivation

The pattern of labour used in the different operations of beneficiaries and non-beneficiaries for an hectare area of chickpea cultivation are presented in the Table 4.24. Beneficiaries for ploughing used 1.39 man days of human labour and 8.28 machine hours, for harrowing 2.61 man days of human labour and 5.4 pair days of bullock labour were used. For transportation of FYM 3.4 hours of machine labour was used. About 7.83 man days human labour were used for spreading of FYM. For sowing operation 8.8 man days and 4.6 pair days of bullock labour were used. For fertilizers application 3.45 man days and for weeding 25.78 man days of human labour were used. For intercultivation operation about 2.1 man days of human labour 3.67 pair days of bullock labour was used. About 4.57 man days human labour was used for PPC application and for harvesting 16.35 man days of human labour and 4.25 machine hours were used.

Non- beneficiaries used 1.43 man days of human labour and 7.8 machine hours for ploughing, for harrowing 5.45 pair days of bullock labour was used. For transportation of FYM 2.9 machine hours was used. About 7.23 man days human labour were used for spreading of FYM. For sowing operation 7.85 man days and 4.2 pair days of bullock labour were used. For fertilizers application 3.78 man days and for weeding 30.13 man days of human labour were used. For intercultivation operation about 2.37 of human labour and 3.48 pair days of bullock labour was used. About 6.28 man days human labour was used for PPC application and for harvesting 15.3 man days of human labour and 4.1 machine hours were used.

4.2.2.9 Input use pattern and output obtained in chickpea cultivation

The pattern of inputs used for per hectare chickpea cultivation and output obtained by both beneficiaries and non- beneficiaries are presented in the Table 4.25. About 51.82 kgs and 49.2 kgs of seeds were used by beneficiaries and non- beneficiaries respectively for an hectare of area. The beneficiaries used 72.88 man days of human labour whereas non-beneficiaries used 76.65 man days of human labour. Bullock labour used by beneficiaries and non-beneficiaries were 13.67 pair days and 13.12 pair days respectively. About 15.92 hours and 14.8 hours of tractor labour were used by beneficiaries and non-beneficiaries respectively. FYM of 5.65 tonnes was used by beneficiaries whereas non beneficiaries used 4.67 tonnes. Beneficiaries used 59.91 kgs and 126.37 kgs N and K respectively whereas non- beneficiaries used 67.34 kgs of N and 131.29 kgs of P respectively. Beneficiaries spent ₹ 2457.6 on the usage of PPC whereas non-beneficiaries spent ₹2230.93.

The output obtained by beneficiaries for per hectare of chickpea cultivation was 10.9 quintals whereas non-beneficiaries obtained 8.92 quintals.

4.2.2.10 Costs and returns in cultivation of chickpea

Table 4.26 furnishes the details of cost of cultivation of chickpea crop by beneficiaries and non-beneficiaries. The average cost of cultivation per hectare of chickpea of beneficiaries was ₹ 41525.68 which was more than that of non-beneficiaries (₹ 40370.93). In the total cost, variable costs accounted for a major share both in beneficiaries and non-beneficiaries. The proportion of variable cost was ₹ 33421.65 and ₹ 32279.35 accounting for 80.48 per cent and 80.00 per cent of the total cost of cultivation of chickpea crop of beneficiaries and non-beneficiaries respectively.

There was a large difference (20.48 per cent) in gross returns between beneficiaries (₹ 56963.08/ha) and non-beneficiaries (₹ 45292.4 /ha). While, the net returns were more than three times in case of beneficiaries (₹ 15437.4 /ha) when compared to non-beneficiaries (₹ 4921.47/ha) and the difference worked out to be 68.11 per cent. The benefit-cost ratio was more (1.37) in case of beneficiaries compared to non-beneficiaries (1.12). The increase in cost in beneficiary farms over non-beneficiary farms was ₹ 1154.75 and increase in gross returns was ₹ 11670.68 and net additional returns observed was ₹ 10515.93 in beneficiary farms for chickpea (Fig. 7). Thus, the study depicted that similar trend of higher gross and net returns were found among beneficiaries as was observed in case of pigeon pea.

Table 4.25: Input use pattern and output obtained in chickpea cultivation

(Per ha), (n=60)

Sl. No.	Particulars	Units	Beneficiary	Non-beneficiary
1	Seeds	Kgs	51.82	49.2
2	Human labour	Man days	72.88	76.65
3	Bullock labour	Pair days	13.67	13.12
4	Tractor labour	Hours	15.92	14.8
5	Farm yard manure (FYM)	Tonnes	5.65	4.675
6	Fertilizers	Kgs		
a.	N	Kgs	59.91	67.34
b.	P	Kgs	126.37	131.29
7	PPC	₹	2457.6	2230.93
8	Output	Qtls.	10.9	8.925

Table 4.26: Costs and returns in cultivation of chickpea

(₹/ha), **(n=60)**

Sl. No.	Particulars	Beneficiary	Per cent	Non-beneficiary	Per cent
I. Variable cost					
1	Human labour	7973.78	19.20	8583.03	21.26
2	Bullock labour	5407.1	13.02	5055.35	12.52
3	Machine labour	4884.6	11.76	4815.28	11.93
4	Seeds	2809.43	6.77	2463.93	6.10
5	Farm yard manure	4540.55	10.93	3072.83	7.61
6	Fertilizers	3162.15	7.61	4196.28	10.39
7	PPC	2457.6	5.92	2230.93	5.53
8	Interest on working capital @ 7%	2186.48	5.27	2111.73	5.23
	Subtotal (I)	**33421.65**	**80.48**	**32279.35**	**80.00**
II. Fixed cost					
1	Rental value of land	6250	15.05	6250	15.48
2	Land revenue	20	0.05	20	0.05
3	Depreciation	1030.92	2.48	1019.7	2.53
4	Interest on fixed capital @11%	803.1	1.93	801.87	1.99
Subtotal (II)		8104.03	19.52	8091.58	20.0
Total cost of cultivation (I)+ (II)		41525.68	100.00	40370.93	100.00
Gross returns		56963.08		45292.4	
Net returns		15437.4		4921.47	
B:C		1.37		1.12	
Increase in cost in beneficiary farms over non-beneficiary farms					1154.75
Increase in returns in beneficiary farms over non-beneficiary farms					11670.68
Net additional returns					10515.93

4.3 Instability in oilseeds and pulses production

4.3.1 Instability in oilseeds production

The instability in production of oilseeds was analysed using decomposition procedure outlined by Hazell. As a prelude to the instability in production of oilseeds, the sources of change in the average production were examined and presented under the following head.

4.3.1.1 Sources contributing to the changes in average production of groundnut

The results of components of change in mean production of groundnut in the selected districts as well as for Karnataka state as a whole are presented in Table 4.27.It may be observed that the change in mean area accounted for 57.25 per cent of the increased average production, whereas the change in mean yield 29.17 per cent of increased production. The covariance between yield and area accounted for 8.51 per cent of the increased production and interaction between mean area and yield accounted for just 5.07 per cent of the increased production.

Among the major groundnut growing districts only Bijapur and Raichur experienced a fall in mean area of groundnut. The remaining districts witnessed an expansion in their mean area. The change in mean area contributed more than the change in mean yield towards increasing groundnut production in the district of Belgaum, Bellary, Chitradurga, Raichur and Tumkur whereas the change in mean yield contributed more than the change in mean area towards increasing groundnut production in the district of Bijapur, Dharwad and Gulbarga.

Most of the change (101.09 per cent) was accounted by ‘Others’ districts. This shows that most of the change in mean production at the state level came from non-traditional groundnut growing districts.

4.3.1.2 Sources of instability in groundnut production

The components of change in variance in groundnut production between the Period-I and Period-II in the selected districts as well as for Karnataka state as a whole are presented in Table 4.28.At the state level, change in variance of production was mainly contributed by change in area yield covariance (39.66 per cent). This component was contributed substantially by ‘Others’ districts (34.9 per cent). The change in area yield covariance increased during second period in most of the districts.

Change in area variance was the second important component, which contributed significantly (23.71 per cent), to the increase in the variance of groundnut production in the state. This component was substantially contributed by ‘others’ districts (24.7 per cent). Interaction between changes in mean area and mean yield covariance contributed 11.15 per cent of the increase in variance of production of groundnut in the state. Most of this change came from ‘Others’ districts (14.29 per cent) and Dharwad (1.18 per cent) whereas in the remaining districts it showed relatively low effect.

Similarly, change in yield variance, interaction between changes in mean yield and area variance, interaction between changes in mean area and yield variance, change in residuals and change in mean area contributed in the order of 10.39, 4.38, 3.93, 3.81 and 3.21 per cent towards increased instability of groundnut production at the state level. On the contrary, the component which helped in reduction of instability was change in mean yield (-0.15%).

Further, it could be observed from the table that the variance of groundnut production in ‘Others’ and Chitradurga districts increased by 24.97 per cent and 22.84 per cent respectively between the two periods under study. The increase in variance of production in ‘Others’ district was mainly due to covariance of area yield and with respect to Chitradurga district the increase in variance of production was mainly due to yield variance. However the major share (29.64 per cent) of increased variance between the two periods was observed in Gulbarga district which was mainly due to change in mean area.

The analysis further revealed that production was stabilized in Bellary and Raichur districts. The stabilization in Bellary district was due to decline in area variance during the Period-II in this district. The stabilization in Raichur district was due to decline in interaction between changes in mean area and yield covariance during the Period-II in this district.

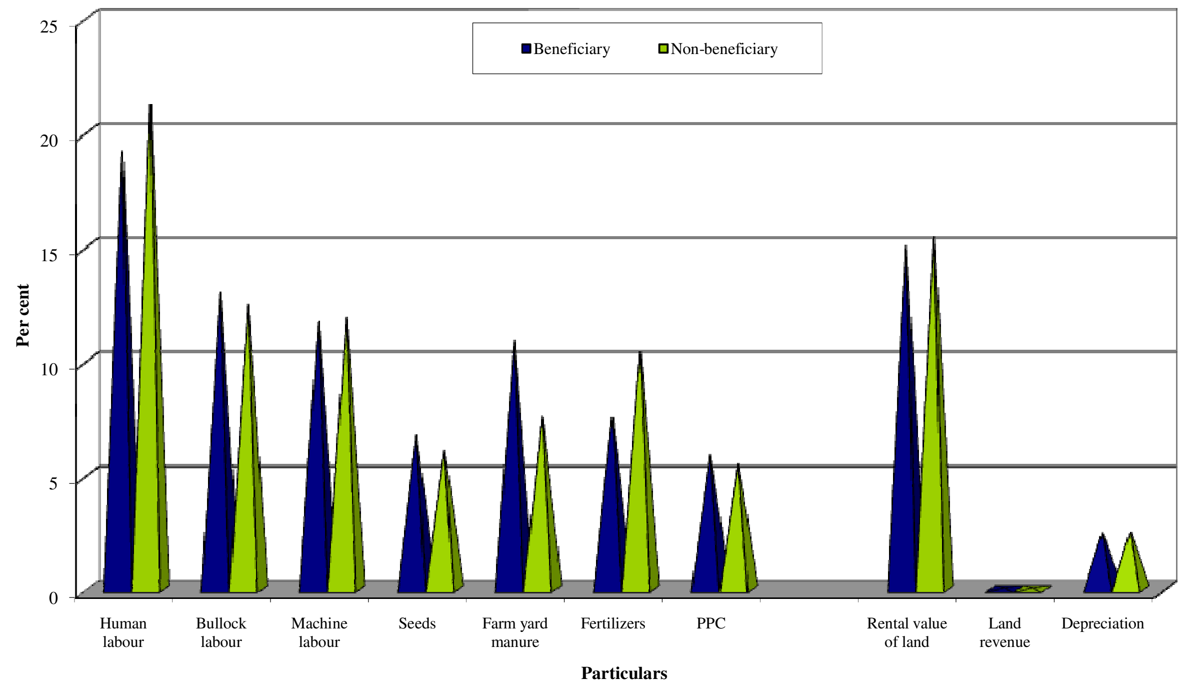

Fig. 7: Costs and returns in cultivation of chickpea

Fig 7 : Costs and returns in cultivation of chickpea

Table 4.27: Components of change in average groundnut production in the study districts and the state

(Per cent)

Source of Change/District	Change in mean yield	Change in mean area	Interaction between changes in mean area and mean yield	Change in yield and area covariance	District wise contribution to the change in production
Belgaum	-0.45	0.38	0.23	-1.01	-0.86
Bellary	-2.89	3.37	-6.59	2.7	-3.42
Bijapur	5.23	-0.56	-3.72	-0.2	0.75
Chitradurga	-0.76	3.1	-11	0.1	-8.56
Dharwad	3.11	0.1	0.24	0.36	3.81
Gulbarga	4.98	-0.53	-1.09	-1.13	2.23
Raichur	-0.92	2.11	0.95	0.06	2.2
Tumkur	0.07	1.57	0.51	0.61	2.76
others	20.8	47.71	25.54	7.02	101.09
State	29.17	57.25	5.07	8.51	100

Table 4.28: Sources of change in the variance of average groundnut production in the study districts and the state

(Per cent)

Sl. No.	Source of Change	Belgaum	Bellary	Bijapur	Chitradurga	Dharwad	Gulbarga	Raichur	Tumkur	Others	State
1	Change in mean yield	0.02	0.06	-0.01	0.01	0.03	-1	0.06	0.02	0.66	-0.15
2	Change in mean area	-0.09	0.11	4.11	0.05	1.95	52	0.02	-1.36	-53.67	3.12
3	Change in yield variance	-0.31	-0.67	0.24	19.6	0.54	5.33	0.03	1.66	-16.03	10.39
4	Change in area variance	0.83	-5.81	0.27	0.23	1.78	0.26	-0.07	1.52	24.7	23.71
5	Interaction between changes in mean yield and mean area	0	0	0	0	0	0	0	0	0	0
6	Change in area yield covariance	0.3	0.52	-0.33	2.14	1.04	-1.52	1.2	1.41	34.9	39.66
7	Interaction between changes in mean area and yield variance	0.2	-0.27	-0.39	0.65	7.42	-26.2	-0.03	0.16	22.39	3.93
8	Interaction between changes in mean yield and area variance	0.48	3.4	0.03	-0.08	0.65	0.12	-0.15	0.04	-0.11	4.38
9	Interaction between changes in mean area and yield covariance	-0.34	0.94	-0.24	0.42	1.18	-3.12	-2.28	0.3	14.29	11.15
10	Change in residual	0.07	0.06	2.08	-0.18	-0.13	3.77	0.02	0.28	-2.16	3.81
	Total change in variance of production	1.16	-1.66	5.76	22.84	14.46	29.64	-1.2	4.03	24.97	100

Table 4.29: Components of change in average sunflower production in the study districts and the state

(Per cent)

Source of Change/District	Change in mean yield	Change in mean area	Interaction between changes in mean area and mean yield	Change in yield and area covariance	District wise contribution to the change in production
Belgaum	-1.06	2.64	-1.96	0.23	-0.15
Bellary	0.35	1.28	1.92	0.08	3.63
Bijapur	0.68	0.97	0.89	0.31	2.85
Chitradurga	0.32	1.06	1.08	0.09	2.54
Dharwad	1.00	1.31	1.99	0.16	4.47
Gulbarga	-1.09	2.96	-1.60	0.21	0.49
Raichur	2.93	1.34	2.64	0.42	7.33
Tumkur	5.27	1.25	1.82	0.45	8.79
others	-18.51	139.13	-50.78	0.22	70.05
State	-10.11	151.94	-44.00	2.17	100.00

4.3.1.3 Sources contributing to the changes in average production of sunflower

The components of change in average production of sunflower between the two periods are depicted in Table 4.29.

The detailed analysis of the components of change in average production of sunflower between the two periods revealed that the change in mean area accounted for 151.94 per cent of the increased average production and that of covariance between yield and area accounted for just 2.17 per cent of the increased average production. The interaction between mean area and yield contributed negatively to increased production (44.0%). Similarly, change in mean yield contributed negatively and substantially (-10.11%) to the increased production.

District-wise analysis revealed that all the districts in terms of mean area recorded positive contribution to increased mean production. Some districts showed decline in mean yield such as Belgaum (1.06 per cent), Gulbarga (1.09 per cent) and 'Others' districts (18.51 per cent). However, the change in its mean area was more than enough to offset the declining effect of mean yield in these districts. The component of the change in mean yield had a substantial share in Tumkur and Raichur districts. However, the change in mean area was the major source of increased production in most of the districts. Unlike other districts, the major source of change in increased mean production in Bellary district was the interaction between mean area and yield. Of the total change of 3.63 per cent, 1.92 per cent was due to this component.

Most of the change was accounted by 'Others' districts (70.05 per cent) followed by Tumkur (8.79 per cent) and Raichur (7.33 per cent). This shows that most of the change at the state level came from non-traditional sunflower growing districts.

4.3.1.4 Sources of instability in sunflower production

The components of change in variance of sunflower production are presented in Table 4.30. It can be seen from the table that interaction between changes in mean yield and area variance accounted for 91.28 per cent of the total change in variance of sunflower production in the state. This component was mainly contributed by the districts included as 'Others' (95.23 per cent). This component has shown an increased variance during the Period-II.

Change in mean area contributed significantly (78.34 per cent) to the increased variance of sunflower production. This component was mainly contributed by 'Others' districts (76.52 per cent) and Tumkur (4.16 per cent).In addition Interaction between changes in mean area and yield covariance, Interaction between changes in mean yield and mean area and Change in area yield covariance registered 31.18, 3.12 and 2.13 per cent of the increased variance of sunflower production in the state, respectively.

On the contrary, the components helped in reduction of instability were change in mean yield, change in area variance, change in yield variance and Interaction between changes in mean area and yield variance. The main contributors of change in area variance were found to be Gulbarga and 'Others' districts. The main contributors of change in yield variance were Bijapur and 'Others' districts.

The overall perusal of the table revealed that the production of sunflower was stabilized in Belgaum, Bellary, Dharwad, Raichur and Tumkur districts. Interaction between changes in mean yield and mean area and change in area yield covariance components contributed more towards stabilizing sunflower production in Tumkur district.

4.3.1.5 Sources contributing to the changes in average production of total oilseeds

It can be observed from the Table 4.31 that a substantial change in mean area (62.21 per cent) resulted in increased total production of total oilseeds. The change in mean yield and interaction between mean area and yield accounted for 23.85 per cent and 15.7 per cent of the change in average production, respectively. Whereas the covariance between yield and area contributed negatively (1.37 per cent). The change in mean area contributed substantially to the increase in total oilseeds production in all the districts barring Bellary, Chitradurga and Raichur wherin the change in mean yield contributed to the increase in total oilseeds production.

Further, it can be revealed from the table that among districts, the contribution of change in mean area was highest in 'others' districts (51.22 per cent). The change in covariance between yield and area was found negative and negligible in most of the districts, whereas the interaction term contributed positively in all districts. All the districts contributed positively to the total oilseeds production except Dharwad.

Thus, the foregoing results of analysis of change in average production of major oilseed crops and total oilseeds in Karnataka revealed that the contribution of components towards change in mean production was similar in different oilseed crops. In case of groundnut, both change in area and change in mean yield contributed positively to the increased average production in the state but change in area is the major contributor towards increased average production. In case of sunflower change in area contributed positively and majorly and positively to increased average production whereas, change in mean yield contributed negatively towards average production. In case of total oilseeds also change in mean area played the major role to increased production by offsetting other negative components. Overall it could be concluded that in case of major oilseed crops and total oilseeds change in mean area was major contributor of increased average production.

4.3.1.6 Sources of instability in total oilseeds production

The various components contributing to changes in variance of total oilseeds production are presented in Table 4.32. Interaction between changes in mean area and yield variance contributed significantly to instability in total oilseeds production in the state (199.60 per cent).This component was contributed majorly by 'others' districts and Belgaum.

Other important sources of instability for total oilseeds production was found to be the change in yield variance, interaction between changes in mean area and yield covariance and change in area yield covariance which accounted for 114.09, 25.25 and 23.03 per cent of the total variation respectively. It was observed from the table that changes in residuals absorbed most of the source of instability in total oilseeds production in the state though it is an unimportant source from the view of stabilization policy measures.

Change in mean area (-238.59 per cent) was an important factor which reduced variance of total oilseeds production in the state. 'Others' (-249.32 per cent) districts constituted the major share of this component across the district. Change in mean yield (-44.58%), change in area variance (-7.80%), interaction between changes in mean yield and mean area (-6.88%) and interaction between changes in mean yield and area variance (-4.43%) were the other components which helped in reduction of instability in total oilseeds production in state.

The table further revealed that among the districts, 'Others' district (205.08 per cent) and Dharwad (52.57 per cent) contributed to the highest share to the total instability of total oilseeds production. The major source of former was interaction between changes in mean area and yield variance whereas for the later was change in area variance. Belgaum, Chitradurga, Raichur and Tumkur contributed to the stability of total oilseeds production in the state.

The foregoing instability analysis revealed that the magnitude and sources of insability varied for the major oilseed crops and total oilseeds at the state level and across the districts. The production of groundnut was destabilized mainly due to change in area yield covariance, whereas in case of sunflower, change in mean area and that of total oilseeds, interaction between changes in mean area and yield variance constituted the major sources of instability.

4.3.2 Instability in pulses production

4.3.2.1 Sources contributing to the changes in average production of pigeon pea

The components of change in the average production of pigeon pea production in the selected districts as well as for Karnataka state as a whole are presented in Table 4.33.

Table 4.30: Sources of change in the variance of average sunflower production in the study districts and the state

(Per cent)

Sl. No.	Source of Change	Belgaum	Bellary	Bijapur	Chitradurga	Dharwad	Gulbarga	Raichur	Tumkur	Others	State
1	Change in mean yield	2.63	-0.02	-0.04	-0.02	0.01	-0.11	0.05	18.9	-31.23	-9.83
2	Change in mean area	1.68	-7.23	3.61	-0.47	0.04	-0.03	0.06	4.16	76.52	78.34
3	Change in yield variance	1.49	-0.09	-0.62	-0.08	0.03	-0.07	0.22	0	-14.38	-13.5
4	Change in area variance	-4.06	-0.13	-0.23	-0.14	0.52	-3.05	-0.18	-0.87	-46.16	-54.3
5	Interaction between changes in mean yield and mean area	2.72	0.85	0.4	0.36	-0.12	-0.24	-0.52	-59.02	58.69	3.12
6	Change in area yield covariance	-1.7	0.12	0.39	0.12	-0.05	0.31	-0.42	-15.69	19.05	2.13
7	Interaction between changes in mean area and yield variance	0.58	-0.16	-0.14	-0.08	0.01	-0.02	0.03	5.14	-13.48	-8.12
8	Interaction between changes in mean yield and area variance	-4.35	0.36	0.43	0.28	-1.52	-2.24	0.68	2.41	95.23	91.28
9	Interaction between changes in mean area and yield covariance	-0.51	0.29	0.21	0.21	-0.03	0.08	-0.13	-1.26	32.32	31.18
10	Change in residual	-3.75	0.11	0.32	0.1	-0.04	0.07	-0.36	-12.12	-4.63	-20.3
	Total change in variance of production	-5.27	-5.9	4.33	0.29	-1.16	51.19	-0.58	-58.35	115.45	100

Table 4.31: Components of change in average total oilseeds production in the study districts and the state

(Per cent)

Source of Change/District	Change in mean yield	Change in mean area	Interaction between changes in mean area and mean yield	Change in yield and area covariance	District wise contribution to the change in production
Belgaum	0.39	2.70	1.04	-3.26	0.87
Bellary	1.58	0.84	0.92	0.27	3.60
Bijapur	1.03	1.04	0.63	0.19	2.89
Chitradurga	3.66	0.77	0.76	0.21	5.40
Dharwad	0.50	1.90	0.80	-8.06	-4.86
Gulbarga	0.45	1.69	0.80	0.16	3.10
Raichur	3.67	0.64	2.74	0.16	7.21
Tumkur	1.06	1.41	0.48	-1.23	1.72
Others	11.51	51.22	7.34	10.19	80.07
State	23.85	62.21	15.51	-1.37	100.00

Table 4.32: Sources of change in the variance of average total oilseeds production in the study districts and the state

(Per cent)

Sl. No.	Source of Change	Belgaum	Bellary	Bijapur	Chitradurga	Dharwad	Gulbarga	Raichur	Tumkur	Others	State
1	Change in mean yield	-8.72	0.82	0.95	0.85	-18.97	0.77	1.90	-4.89	-17.29	-44.58
2	Change in mean area	4.16	0.49	1.33	0.27	2.32	2.10	1.04	-0.98	-249.32	-238.59
3	Change in yield variance	1.10	0.80	0.03	0.02	0.00	0.00	0.04	-0.03	112.13	114.09
4	Change in area variance	8.67	3.20	-0.97	-0.59	39.00	0.19	-4.62	-1.60	-51.08	-7.80
5	Interaction between changes in mean yield and mean area	-8.09	0.60	0.49	0.22	-13.22	0.84	6.45	-0.91	6.74	-6.88
6	Change in area yield covariance	-10.86	-0.25	-0.21	-0.22	7.09	-0.12	-0.29	-1.14	29.03	23.03
7	Interaction between changes in mean area and yield variance	3.49	-0.02	-0.06	-0.01	-0.08	-0.08	-0.04	0.05	196.35	199.60
8	Interaction between changes in mean yield and area variance	2.84	6.24	-0.95	-1.01	25.16	0.14	-37.14	-0.80	1.09	-4.43
9	Interaction between changes in mean area and yield covariance	-11.32	-0.14	-0.10	-0.04	5.65	-0.11	-0.28	-0.33	31.92	25.25
10	Change in residual	-14.56	-0.14	-0.23	-0.14	5.61	-0.20	-0.26	-95.23	145.47	40.32
	Total change in variance of production	-33.30	11.59	0.27	-0.66	52.57	3.53	-33.21	-105.87	205.08	100

Table 4.33: Components of change in average pigeon pea production in the study districts and the state

(Per cent)

Source of Change/District	Change in mean yield	Change in mean area	Interaction between changes in mean area and mean yield	Change in yield and area covariance	District wise contribution to the change in production
Belgaum	0.39	0.89	-0.18	-3.55	-2.46
Bellary	0.56	0.88	-0.37	-17.51	-16.44
Bidar	-0.04	0.12	-0.02	0.54	0.60
Bijapur	0.54	1.32	0.28	1.34	3.48
Dharwad	-0.37	0.64	0.22	0.78	1.27
Gulbarga	0.52	1.39	0.26	1.27	3.43
Mysore	0.05	-0.52	-0.08	-0.62	-1.17
Raichur	0.26	0.89	-0.10	-1.24	-0.19
others	12.76	66.76	2.97	28.97	111.48
State	14.67	72.37	2.98	9.98	100.00

Table 4.34: Sources of change in the variance of average pigeon pea production in the study districts and the state

(Per cent)

Sl. No.	Source of Change	Belgaum	Bellary	Bidar	Bijapur	Dharwad	Gulbarga	Mysore	Raichur	Others	State
1	Change in mean yield	0.04	-0.23	130.17	1.67	-0.05	-6.45	0.00	0.00	-132.96	-7.81
2	Change in mean area	0.01	0.26	-0.53	-0.09	-0.01	-3.00	0.00	0.00	2.67	-0.69
3	Change in yield variance	-0.06	104.20	2.67	-1.76	-0.02	1.35	0.00	-0.01	-90.74	15.63
4	Change in area variance	0.06	0.13	0.17	0.24	-0.03	0.79	0.00	-0.01	12.02	13.37
5	Interaction between changes in mean yield and mean area	0.00	-0.26	0.28	0.18	0.01	-1.75	0.00	0.00	1.47	-0.07
6	Change in area yield covariance	0.21	-6.59	1.15	2.58	0.04	1.77	0.00	0.01	47.75	46.92
7	Interaction between changes in mean area and yield variance	0.04	-87.50	1.21	-0.83	0.02	0.61	0.00	0.00	93.45	7.00
8	Interaction between changes in mean yield and area variance	-0.01	-0.06	-0.03	0.05	-0.01	0.13	0.00	0.00	1.05	1.12
9	Interaction between changes in mean area and yield covariance	-0.10	4.49	5.37	0.97	-0.04	0.60	0.00	0.00	0.69	11.98
10	Change in residual	0.05	-1.16	-39.25	2.03	-0.07	3.37	0.00	0.00	47.59	12.56
	Total change in variance of production	0.24	13.28	101.20	5.03	-0.15	-2.58	0.00	-0.01	-17.01	100.00

Table 4.35: Components of change in average chickpea production in the study districts and the state

(Per cent)

Source of Change/District	Change in mean yield	Change in mean area	Interaction between changes in mean area and mean yield	Change in yield and area covariance	District wise contribution to the change in production
Belgaum	0.18	1.16	1.37	2.24	4.94
Bellary	0.57	1.09	1.23	0.38	3.27
Bidar	-0.11	0.57	-2.08	0.37	-1.25
Bijapur	0.30	1.26	0.77	0.73	3.06
Dharwad	0.26	1.07	1.39	1.19	3.91
Gulbarga	0.30	1.39	0.63	0.73	3.05
Mysore	0.13	1.38	2.25	0.39	4.16
Raichur	-1.33	0.71	-3.37	1.32	-2.67
Others	3.41	65.66	15.65	-3.19	81.53
State	3.71	74.29	17.84	4.16	100.00

Table 4.36: Sources of change in the variance of average chickpea production in the study districts and the state

(Per cent)

Sl. No.	Source of Change	Belgaum	Bellary	Bidar	Bijapur	Dharwad	Gulbarga	Mysore	Raichur	Others	State
1	Change in mean yield	0.02	2.25	0.00	-0.75	0.01	-0.53	0.09	0.03	-1.21	-0.09
2	Change in mean area	0.86	0.55	-5.69	-17.08	-1.72	-25.63	-6.41	0.33	56.84	2.05
3	Change in yield variance	-0.02	-3.50	0.00	0.33	-0.02	0.04	0.01	-0.05	3.28	0.07
4	Change in area variance	0.59	0.89	-2.45	1.04	0.72	2.95	1.27	0.37	33.12	38.50
5	Interaction between changes in mean yield and mean area	0.18	7.00	-0.23	0.67	0.07	1.56	1.56	-0.56	-10.39	-0.14
6	Change in area yield covariance	0.65	0.64	0.06	0.72	0.26	0.50	0.14	1.02	0.15	4.14
7	Interaction between changes in mean area and yield variance	-0.39	-14.12	0.25	1.58	-0.26	0.14	0.55	-0.22	14.87	2.40
8	Interaction between changes in mean yield and area variance	0.70	1.02	10.36	0.60	0.95	1.19	2.17	-2.00	5.72	20.71
9	Interaction between changes in mean area and yield covariance	4.83	1.30	2.35	1.55	1.48	0.79	1.99	4.17	10.93	29.39
10	Change in residual	0.54	0.72	0.07	1.22	0.27	0.66	0.53	0.93	-1.97	2.97
	Total change in variance of production	7.97	-3.24	4.72	-10.12	1.74	-18.35	1.90	4.02	111.36	100

It may be observed that the change in mean area accounted for 72.37 per cent of the increased average production, whereas the change in mean yield 14.67 per cent of increased production. The covariance between yield and area accounted for 9.98 per cent of the increased production and interaction between mean area and yield accounted for just 2.98 per cent of the increased production.

Among the major pigeon pea growing districts only Mysore experienced a fall in mean area of red gram. The remaining districts witnessed an expansion in their mean area. The change in mean area contributed more than the change in mean yield towards increasing pigeon pea production in the district of Belgaum, Bellary, Bidar, Bijapur, Dharwad, Gulbarga Raichur and others. Most of the change (111.48 per cent) was accounted by 'others' districts. This shows that most of the change in mean production at the state level came from non-traditional pigeon pea growing districts. Further, from the table it can be revealed that Belgaum, Bellary, Mysore and Raichur districts contributed negatively to average pigeon pea production.

4.3.2.2 Sources of instability in pigeon pea production

The components of change in variance in pigeon pea production between the Period-I and Period-II in the selected districts as well as for Karnataka state as a whole are presented in Table 4.34. At the state level, change in variance of production was mainly contributed by change in area yield covariance (46.92 per cent). This component was contributed substantially) by 'Others' districts (47.75 per cent) and Bijapur district (2.58 per cent). The change in area yield covariance increased during second period in most of the districts.

Change in yield variance was the second important component, which contributed significantly (15.63 per cent), to the increase in the variance of pigeon peaproduction in the state. This component was substantially contributed by Bellary district (104.20 per cent). Change in area variance contributed 13.37 per cent of the increase in variance of production of pigeon peain the state. Most of this change came from 'Others' districts (12.02 per cent) whereas in the remaining districts it showed relatively low effect.

Similarly, Interaction between changes in mean area and yield covariance, Interaction between changes in mean area and yield variance and Interaction between changes in mean yield and area variance contributed in the order of 11.98, 7.00 and 1.12 per cent towards increased instability of pigeon peaproduction at the state level. On the contrary, the components helped in reduction of instability were change in mean yield (-7.81 per cent), change in mean area (0.69 per cent) and Interaction between changes in mean yield and mean area (-0.07 per cent).

Further, it could be observed from the table that the variance of pigeon pea production in Bidar and Bellary districts increased by 101.20 per cent and 13.28 per cent respectively between the two periods under study. The increase in variance of production in Bidar district was mainly due to change in mean yield and with respect to Bellary district the increase in variance of production was mainly due to change in yield variance.

The analysis further revealed that production was stabilized in Dharwad, Gulbarga, Raichur and 'Others' districts. The stabilization in Dharwad, Gulbarga and 'Others' districts were due to decline in change in mean yield..

4.3.2.3 Sources contributing to the changes in average production of chickpea

The components of change in average production of chickpea between the two periods are depicted in Table 4.35. The detailed analysis of the components of change in average production of chickpea between the two periods revealed that the change in mean area accounted for 74.29 per cent of the increased average production and that of the interaction between mean area and yield accounted for 17.84 per cent of the increased average production. Similarly covariance between yield and area accounted for 4.16 per cent and change in mean yield which accounted 3.17 per cent of the increased average production of chickpea.

District wise analysis revealed that all the districts in terms of mean area recorded positive contribution to increased mean production whereas some districts showed decline in mean yield such as Bidar (0.11 per cent) and Raichur (1.33 per cent). The change in mean area was the major source of increased production in most of the districts. Unlike other districts, the major source of change in increased mean production in Belgaum districts was the covariance between area and yield. Of the total change of 4.94 per cent, 2.94 per cent was due to this component. In case of Bellary, Dharwad and Mysore the major contributor of change in increased mean production was interaction between mean area and yield. Of the total change of 3.27, 3.91 and 4.16 per cent, 1.23, 1.39 and 2.25 per cent respectively was due to this component. All districts contributed positively towards increased average production of Chickpea barring Bidar and Raichur districts.

Most of the change was accounted by 'others' districts (81.53 per cent). This shows that most of the change at the state level came from non-traditional chickpea growing districts.

4.3.2.4 Sources of instability in chickpea production

The components of change in variance of chickpea production are presented in Table 4.36. It can be seen from the table that change in area variance accounted for 38.50 per cent of the total change in variance of chickpea production in the state. This component was mainly contributed by the districts included as 'Others' (33.12 per cent) and Gulbarga (2.95 per cent).This component has shown an increased variance during the Period-II.

Interaction between changes in mean area and yield covariance contributed significantly (29.39 per cent) to the increased variance of chickpea production. This component was mainly contributed by 'Others' districts (10.93 per cent) and Belgaum (4.83 per cent).In addition, interaction between changes in mean yield and area variance, change in area yield covariance, interaction between changes in mean area and yield variance, change in mean area and change in yield variance registered 20.71, 4.14, 2.40, 2.0 5 and 0.07 per cent of the increased variance of chickpea production in the state, respectively.

On the contrary, the components helped in reduction of instability were interaction between changes in mean yield and mean area and change in mean yield. The main contributors of interaction between changes in mean yield and mean area were found to be 'Others' and Raichur districts. The main contributors of change in mean yield were Bijapur and 'Others' districts.

The overall perusal of the table revealed that the production of chickpea was stabilized in Bellary, Bijapur and Gulbarga districts. Change in mean area and change in mean yield components contributed more towards stabilizing chickpea production in Gulbarga district.

4.3.2.5 Sources contributing to the changes in average production of total pulses

It can be observed from the Table 4.37 that a substantial change in mean area (66.09 per cent) resulted in increased total production of total pulses. The change in mean yield and interaction between mean area and yield accounted for 25.05 per cent and 7.01 per cent of the change in average production, respectively. Whereas the covariance between yield and area contributed just 1.98 per cent. The change in mean area contributed substantially to the increase in total pulses production in all the districts barring, Dharwad and Raichur wherein the change in mean yield contributed to the increase in total pulses production.

Further, it can be revealed from the table that among districts, the contribution of change in mean area was highest in 'others' districts (62.53 per cent).The change in covariance between yield and area and the interaction term was found negative and negligible in some of the districts.. Most of the districts contributed positively to the total pulses production except Bellary, Bidar and Raichur.

Thus, the foregoing results of analysis of change in average production of major pulse crops and total pulses in Karnataka revealed that the contribution of components towards change in mean production was similar in different pulse crops. In case of red gram, both change in area and change in mean yield contributed positively to the increased average production in the state but change in area is the major contributor towards increased average production. In case of Chickpea also both change in area and change in mean yield contributed positively to the increased average production in the state but change in area is the major contributor towards increased average production. In case of total pulses also similar trend was observed. Overall it could be concluded that in case of major pulse crops and total pulses change in mean area was the major contributor of increased average production.

4.3.2.6 Sources of instability in total pulses

The various components contributing to changes in variance of production are presented in Table 4.38. Change in area yield covariance contributed significantly to instability in total pulses production in the state (35.77 per cent). This component was contributed majorly by 'others' districts and Mysore. Change in area variance is the second most important component contributed to instability in total pulses production in the state (25.05 per cent).This component was contributed majorly by 'others' districts and Bellary.

Table 4.37: Components of change in average total pulses production in the study districts and the state

(Percent)

Source of Change/District	Change in mean yield	Change in mean area	Interaction between changes in mean area and mean yield	Change in yield and area covariance	District wise contribution to the change in production
Belgaum	-2.82	0.64	7.00	0.46	5.28
Bellary	0.14	-0.91	-0.52	0.20	-1.09
Bidar	-0.35	0.30	-0.16	-0.93	-1.13
Bijapur	0.76	1.32	0.53	0.70	3.30
Dharwad	3.55	0.72	2.79	-2.02	5.05
Gulbarga	0.92	1.30	0.43	0.42	3.06
Mysore	0.68	1.33	0.68	0.84	3.52
Raichur	0.23	-1.14	-1.93	0.04	-2.80
Others	21.91	62.53	-1.81	2.27	84.81
State	25.02	66.09	7.01	1.98	100.00

Table 4.38: Sources of change in the variance of average total pulses production in the study districts and the state

(Per cent)

Sl. No.	Source of Change	Belgaum	Bellary	Bidar	Bijapur	Dharwad	Gulbarga	Mysore	Raichur	Others	State
1	Change in mean yield	-0.29	2.85	0.98	-7.33	-0.73	33.61	21.53	-24.61	-12.23	13.78
2	Change in mean area	0.14	22.88	-0.31	11.79	-1.63	0.00	64.83	-194.50	100.69	3.89
3	Change in yield variance	0.11	0.23	-1.53	-9.99	-5.36	1.17	7.46	0.28	15.02	7.39
4	Change in area variance	-0.16	5.88	0.55	0.56	0.18	1.29	0.49	1.17	15.09	25.05
5	Interaction between changes in mean yield and mean area	4.80	8.00	0.11	-0.71	-1.14	0.00	0.00	0.00	-10.82	0.24
6	Change in area yield covariance	0.18	0.70	0.81	2.44	-1.17	1.73	2.67	0.78	27.63	35.77
7	Interaction between changes in mean area and yield variance	-0.35	-1.00	-0.59	-6.53	-4.08	0.48	7.42	-2.75	12.3	4.90
8	Interaction between changes in mean yield and area variance	-1.80	3.23	-0.34	0.21	0.71	0.39	0.24	2.01	1.17	5.82
9	Interaction between changes in mean area and yield covariance	-0.74	3.07	1.18	1.31	-1.25	0.63	2.03	11.60	-2.29	15.54
10	Change in residual	-0.21	-2.29	-0.53	-3.27	-0.68	-3.50	-10.86	-2.83	11.79	-12.38
	Total change in variance of production	1.69	43.55	0.33	-11.52	-15.16	35.81	95.81	-208.86	158.35	100.00

Table 4.39: Annual Growth in Input, Output and TFP Index of Various Crops in Karnataka

(%)

	Crop	Input	Output	TFP	Share of TFP in output growth
	Groundnut				
	Period-I	12.5	15.56	2.72	17
Tumkur	Period-II	-0.085	0.081	0.166	205
	Overall period	0.5	1.75	1.25	71
	Groundnut				
	Period-I	7.32	14.18	6.85	48
Karnataka	Period-II	-1.31	9.76	10.89	112
	Overall period	0.55	3.59	3.02	84
	Sunflower				
	Period-I	-26.57	-1.41	25.15	Negative
Bijapur	Period-II	0.47	0.025	-0.45	Negative
	Overall period	-25.13	-88.81	-63.7	72
	Sunflower				
	Period-I	10.35	11.41	1.06	9
Karnataka	Period-II	-0.47	-0.92	-0.45	49
	Overall period	4.12	5.23	1.18	23
	Pigeon pea				
	Period-I	0.41	-8.42	-8.83	105
Gulbarga	Period-II	-1.42	-0.61	0.82	Negative
	Overall period	-0.22	0.21	0.43	205
	Pigeon pea				
	Period-I	2.4	6.69	4.28	64
Karnataka	Period-II	1.8	4.07	3.28	81
	Overall period	1.28	4.24	2.96	70
	Chickpea				
	Period-I	2.75	2.32	-0.42	Negative
Gulbarga	Period-II	-0.94	-0.47	-0.48	102
	Overall period	0.14	0.33	-0.19	Negative
	Chickpea				
	Period-I	2.93	2.66	0.27	10
Karnataka	Period-II	-0.339	-0.68	-0.34	50
	Overall period	0.27	0.44	0.17	38

Other important sources of instability for total pulses production were found to be the interaction between changes in mean area and yield and change in area-yield covariance, change in mean yield, change in the yield variance, interaction between changes in mean yield and area variance, interaction between changes in mean area and yield variance, interaction between changes in mean yield and area variance, change in mean area and interaction between changes in mean yield and mean area which accounted for 15.54, 13.78,7.39, 5.82,4.90, 3.89 and 0.24 per cent of the total variation respectively.

It was observed from the table that change in residuals (-12.38 per cent) is the only component which absorbed most of the source of stability in total pulses production in the state though it is an unimportant source from the view of stabilization policy measures.

The table further revealed that among the districts, 'Others' district (158.35 per cent) Dharwad (95.81 per cent) and Bellary (43.55 per cent) contributed the highest share to the total instability of total pulses production. The major source was change in mean area for these districts. Bijapur, Dharwad and Raichur contributed to the stability of total pulses production in the state.

The foregoing instability analysis revealed that the magnitude and sources of instability varied for the major pulse crops and total pulses at the state level and across the districts. The production of pigeon peaand total pulses were destabilized mainly due to change in area yield covariance and in case of chickpea, change in area variance constituted the major sources of instability.

4.4 Returns to investment on Technology Mission on Oilseeds and Pulses

4.4.1 TFP growth by crops at selected districts and at state Level

TFP analysis has covered the period from 1980-81 to 2008-09. These years were further divided into three sub-periods as Period I (1980 - 1985) in oilseeds and pulses, Period II (1986 - 2008) in oilseeds and in pulses (1990-2008) and overall Period (1980 – 2008) in oilseeds and pulses.

The estimates of average annual TFP growth for groundnut, sunflower, pigeon pea and chickpea for their respective major districts and the state as a whole are shown in Table 4.39. It can be observed from the table that TFP of groundnut has registered positive growth during Period –I, Period-II and overall period in Tumkur district. Higher output growth triggered by technological change has resulted in positive TFP growth. Annual growth in TFP was impressive at 2.72 per cent during Period-I when compared to 0.166 per cent during Period-II. For the entire period of analysis, TFP has risen at 1.25 per cent. Overall, the contribution of TFP to output growth was found to be 71 per cent. In state as a whole the growth in output and TFP of groundnut was positive in both Period-I and Period-II. During Overall period of analysis, the respective growth in output and TFP was 3.59 per cent and 3.02 per cent. TFP has contributed about 84 per cent to output growth.

In case of sunflower, input and output index have showed negative growth during Period-I in Bijapur district. However, high input growth as compared to output growth has resulted in negative TFP growth of -0.45 per cent during Period-II. Overall, TFP of sunflower has registered negative growth of 63.7 per cent. In case of Karnataka sunflower has registered output growth of 11.41 per cent during Period-I. But, a higher growth of inputs over output during Period-II resulted in negative TFP growth. However during Overall period TFP of sunflower registered positive growth of 1.18 per cent.

In case of pigeon pea, high input growth as compared to output growth has resulted in negative TFP growth of 8.83 per cent during Period-I in Gulbarga district. Input and output index have showed negative growth during Period-II. However, Overall, TFP of pigeon pea has registered positive growth of 0.43 per cent. In case of Karnataka pigeon pea the growth in output and TFP was positive in both Period-I and Period-II. During Overall period of analysis, the respective growth in output and TFP was 4.24 per cent and 2.96 per cent. TFP has contributed about 70 per cent to output growth.

It can be observed from the table that TFP of chickpea has registered negative growth in all periods in Gulbarga district. In the state as a whole chickpea has registered output growth of 2.66 per cent during Period-I. But, a higher growth of inputs over output during Period-II resulted in negative TFP growth of -0.34 per cent. Overall, TFP of chickpea has registered positive growth of only 0.17 per cent.

4.4.2 Returns to investment on Technology Mission on Oilseeds and Pulses

Estimates of regression coefficients which measure the effect of various sources of TFP were used to compute elasticity of TFP with respect to investment. TFP elasticity with respect to TMO investment was 0.0484 for groundnut and 0.0296 for sunflower (Table 4.40). TFP elasticity with respect to TMO investment was 0.0438 for pigeon pea and 0.0177 for chickpea.

The inverse of this elasticity gives investment flexibility which represents the required increase in investment to increase in TFP by 1 per cent. These estimates show that to achieve 1 per cent increase in TFP, the investments in oilseeds need to be increased by 20.66 per cent for groundnut and 33.78 per cent for sunflower. To achieve 1per cent increase in TFP, the investments in pulses need to be increased by 22.83 per cent for pigeon pea and 36.10 per cent for chickpea.

4.4.3 Value of Marginal Product

The Estimated Value of Marginal product (EVMP) of investment is presented in Table 4.41. The results revealed that additional investment of rupee one in TMO scheme generated more than ₹ 1 on an average in groundnut whereas less than ₹ 1 in sunflower. Additional investment of rupee one in TMOP scheme generated more than ₹ 1 on an average in pigeon pea whereas less than ₹ 1 in chickpea. Highest marginal product was achieved in groundnut where additional investment of ₹ 1 generated additional output worth ₹.1.98.

4.4.4 Internal Rate of Return

The internal rate of return (IRR) to investment for crops was estimated following the assumption given in the methodology section and the results are presented in Table 4.42. During the period 1986-2008, the overall internal rate of return to TMO scheme investment turned out to be 31 per cent for groundnut and 22 per cent for sunflower crop. During the period 1990-2008, the overall internal rate of return to TMOP scheme investment turned out to be 28 per cent for pigeon pea and 18 per cent for chickpea crop.

Table 4.40: Elasticity of TFP with respect to scheme investment for oilseeds and pulses in Karnataka

Crop	TFP elasticity	Investment flexibility (%)
Groundnut	0.0484	20.66
Sunflower	0.0296	33.78
Pigeon pea	0.0438	22.83
Chickpea	0.0177	36.10

Table 4.41: Estimated value of marginal product of investment in Oilseed and pulse crops

(In ₹)

Crop	EVMP
Groundnut	1.98
Sunflower	0.62
Pigeon pea	1.87
Chickpea	0.71

Table 4.42: Estimated marginal internal rate of return to scheme investment for oilseeds and pulses in Karnataka

(%)

Crop	IRR
Groundnut	31
Sunflower	22
Pigeon pea	28
Chickpea	18

DISCUSSION

The findings of the study which are presented in the previous chapter are discussed in detail in this chapter. The main focus here is to throw a light on some of the causes responsible for the major trends observed in the findings. Keeping in view the objectives of the study, the results are discussed under the following heads.

5.1 Growth performance of oilseeds and pulses

5.1.1 Growth rates in area, production and yield of oilseeds

5.1.2 Growth rates in area, production and yield of pulses

5.2 Impact of Technology Mission on Oilseeds and Pulses economy

5.2.1 Impact of Technology Mission on Oilseeds on oilseeds economy

5.2.2 Impact of Technology Mission on Oilseeds and Pulses on pulses economy

5.3 Instability in oilseeds and pulses production

5.4 Returns to investment on Technology Mission on Oilseeds and Pulses

5.1 Growth performance of oilseeds and pulses

5.1.1 Growth rates in area, production and yield of oilseeds

Groundnut

An overview of Table 4.1 showed that the growth rate of area, production and yield during Period-I was positive in most of the study districts except in Belgaum, Bellary, Bijapur and Gulbarga districts for area growth and also Bijapur and Tumkur district for production and yield growth respectively. During Period-II, the growth in area, production and yield was invariably negative in the entire study area except in Bijapur and Gulbarga districts for yield growth. The rate of decline in area was found to be highest in Gulbarga district followed by Raichur district whereas in production, Tumkur district followed by Bellary district. In terms of yield, lowest growth was found in Bellary followed by Tumkur. During Overall period, the growth in area, production and yield was positive in most of the study area except in Belgaum, Bijapur Gulbarga and Raichur districts for area growth and Belgaum, Bellary and Raichur districts for production growth. With respect to yield growth, Bellary, Chitradurga, Tumkur and the state as a whole showed negative growth. It is evident from the results of the study that Technology Mission on Oilseeds could not have much impact on groundnut production in major groundnut producing districts and also in state as a whole. Similar results were reported by Sonnad (2008), who documented that during Pre-WTO period, area under groundnut exhibited a growth rate of 1.58 per cent with area reaching a maximum of 8.71 million hectares during 1989-90. This may be perhaps due to the impact of Technology Mission on Oilseeds (TMO). On the contrary, during post-WTO period, *i.e.*, from1995-96 to 2006-07, groundnut exhibited a negative growth rate of -2.34 per cent per annum. Groundnut area had reached the minimum of 5.64 million hectares in 2006-07. This could be due to the substitution by soybean, the area of which increased to 8.33 million hectares in 2006-07 from 5.04 million hectares in 1995-96. Deshpande (2004) reported that the production started declining after the establishment of WTO due to decrease in area under cultivation, which could be attributed to import of edible oils and relatively stagnant real prices of groundnut. These factors acted as disincentives to the producers to expand area under the crop.

Although the implementation of TMO has overcome varietal constraints and agronomic constraints in groundnut production still there exist climatic constraints which hinder the groundnut growth as it is grown mostly in rainfed regions. Erratic rainfall is one of the major limiting factors for declining growth. Majority of years, sufficient rain is available in June-July for sowing and establishment of the crops whereas August-September are commonly drier with less rainy days. This situation adversely affects the groundnut production, since crop faces acute dry spell particularly during peg formation and pod development (Patil *et al.*, 1991). The other reasons are groundnut is cultivated on marginal and sub-marginal lands with soils of poor fertility. Groundnut crop suffers heavily from infestation of leaf minor and sucking pests like aphids, jassids and thrips and major diseases like bud necrosis, rust and leaf spot. Similar results were noticed in the studies of Addisu (2000) and Jeyanthi (2002).

The decline in growth of area, production and yield of groundnut during 1991-2000 was mainly due to gradual replacement of groundnut crop by jowar, cotton, soybean and sunflower in study area (Girish *et al.*, 2012). The state experienced declining growth rates in area, production and yield of groundnut in Period-II and Overall period was mainly due to the unremarkable growth performance of the crop observed in the study districts in Period-II and Overall period. The findings were in line with the findings of Ragavendra (2006).

Sunflower

Sunflower was introduced in India in 1969 as an important oilseed crop. The intensive cultivation of this crop started only from mid 70's. It was apparent from Table 4.2 that the state registered a highly significant increase in area (49.38 per cent per annum) during the Period-I (1978-79 to 1985-86) as compared to the Period –II (1986-87 to 2009-10). This was in line with the findings of Singh and Dhaliwal (1993) at All-India level and Addisu (2000) at state level. The rapid expansion of area under this crop was due to its important features like short duration, photo insensitiveness, adoption to a wide range of soils and climatic conditions and high yield per hectare as compared to the traditional oilseed crops like safflower and sesamum.

Most of the district recorded a positive growth in area during the Period-II. During this period the growth rates in Bijapur, Gulbarga and state were non-significant indicating stabilization of area under sunflower. To sum up, the growth analysis of sunflower area both at the aggregate and disaggregate level indicated that the bulk of the increase in area under oilseed crops had come from sunflower in the state. This is in conformity with the results of Singh and Srivastava (1995) who pointed out that most of the increase in area under oilseeds during the period 1951-52 to 1990-91 has come from soybean, sunflower and rapeseed-mustard. Similar result was reported by Adissu (2000). In Karnataka, sunflower area expanded during 1900s and 2000s by replacing crops like pearl millet and cotton and partly from increase in cropping intensity as stated in the report by Girish *et al.* (2012).

At the aggregate level, sunflower production was increasing at 9.13 per cent per annum during entire period as against 1.46 per cent per annum during Period-II. A more promising production growth recorded during the Period-I (38.18%). This was in line with the findings of Nagraj (1994) and Addisu (2000). This growth rate of sunflower production was achieved mainly through area expansion (49.38%) inspite of decrease in yield levels (-1.05%). This was also substantiated by Gupta (1989) and Addisu (2000).

The growth performance of sunflower production at the disaggregate level was almost similar to that of the aggregate level. All the districts registered a significant growth rate in output despite of the decrease in yield levels which was due to phenomenal expansion in area under this crop during the Period-I. During Period-II a significant positive growth in sunflower production was observed in Belgaum (7.13%) and Dharwad (4.05%) districts. The limited scope for expansion in the area has been the main reason for non-significant production performance of sunflower in the remaining districts.

The crop has attained almost its peak in area expansion within a very short time span. However, it was perplexing to note that the yield growth was declining in Period-I, Period-II and Overall period in most of the districts and state as a whole. Similar findings were obtained by Addisu (2000) and Talukdar (2002). The decline in yield was probably due to the fact that it is energy rich and nutrient exhaustive crop, causing depletion of nutrients in the soil. The absence of adequate fertilization, conjunctive application of inorganic and organic sources of nutrients and the lack of appropriate integrated phosphorus management system in red soils, sunflower yield levels have declined year after year (Mallikarjuna *et al.*, 1998). Further, sunflower is known to be susceptible to many diseases incited by fungi, bacteria and viruses of which sunflower mosaic virus is reported to cause a reduction of 32 to 43 per cent in yield levels of sunflower (Muniyappa *et al.,* 1996). Mundinamani (1993) reported that the strong reason for declining yield of sunflower was due to extension of the crop on marginal and sub-marginal lands in subsequent years of its introduction.

The results from the Table 4.2 clearly indicated that there was an impact of TMO on the sunflower crop in area expansion but not on yield growth. As suggested by Hegde (2004) that, a relatively better performance of groundnut crop in the pre-WTO period might be due to expansion in area, availability of improved oilseed production technology and its adoption, remunerative support prices and institutional support, particularly establishment of Technology Mission on Oilseeds (TMO) in 1986.

Total oilseeds

Total oilseeds area and production comprised of area and production of nine oilseeds grown in the state. It is evident from the Table 4.3 that the growth in area, production and yield of total oilseeds was positive in Period-I in the study area expect area growth in Belgaum and Dharwad and yield growth in Bijapur and Gulbarga. This was in sharp contradiction with the findings of Mundinamani(1993) who observed declining trend during Pre-green revolution period.

During Period-II most of the study area showed declining growth except in Belgaum and Dharwad for area growth and Bijapur and Gulbarga for yield growth. This was in line with the findings of Sonnad (2008).

From overall percievance of the Table 4.1 revealed that oilseeds have been gaining importance in the recent years. The growth in production of oilseeds was achieved mainly due to expansion of acreage and additional irrigated area rather than due to improvement in yield levels. In other words, the technologies developed for major oilseed crops have not made a significant dent in increasing oilseeds production. Also about 80-85 per cent of oilseeds cultivation takes place under rainfed condition predisposes the farmer to a risk factor for adoption of recommended technologies. The findings of overall period are on par with the findings of Mundinamani (1993) and Sonnad (2008).

Girish *et al.* (2012) reported that the positive trend during the 1980's could be due to government initiatives in the form of TMO as well as price and marketing support for oilseeds growers. The reverse trend during the 1990's was mainly due to decrease in oil prices relative to other crops and liberalization of edible oil imports in 1996-97. The government price support mechanism has continuously favoured wheat and rice crops and not the oilseed crops, which has led to lowered oilseed cultivation.

Thus we can conclude that the TMO had not showed much impact on oilseed area and yield in the state. Thus we reject the hypothesis1 of existence of positive impact of TMO on oilseeds economy in Karnataka. This can be substantiated by the report of Agricultural Statistics at a Glance (2010) which documented that following the constitution of TMO in 1986, India's oilseed production surpassed the target of 18 mt, fixed for the seventh Five Year Plan with an impressive annual growth rate of nearly six per cent in the short-run. The subsequent achievement of near self–sufficiency in edible oils during the early 1990's proved to be a temporary phenomenon as the country began to depend heavily on imports from the later part of decade to meet its domestic edible oil requirement. India's import bill for edible oils was more than ₹ 26,485 crore during 2009-10. Similar findings on WTO was found by Sonnad (2008) that it could be concluded that WTO did not influence the total area, production and yield under oilseeds in India while it acts as only substitution for sunflower and soybean to a maximum extent.

5.1.2 Growth rates in area, production and yield of pulses

The Compound Growth Rate of area, production and yield of pigeon pea, chickpea and total pulses in the selected districts as well as for the state of Karnataka as a whole along with the factors responsible for the same are discussed below.

Pigeon pea

Redgram/pigeon pea is one of the major pulse crops in the state. This crop covers about 25 per cent of the area under pulses. The growth analysis of pigeon pea (Table 4.4) indicated that area and production growth in most of the districts during Period-I was positive whereas yield showed negative growth. During Period-II in most of the districts growth in area showed negative trend which was also seen in the state as a whole that, it has decreased from 6.68 per cent per annum during Period-I to 2.52 per cent per annum during Period-II whereas production and yield growth has increased during Period-II than Period-I. Similar trend was seen in all districts as that of the state in Period-II.

During Period-I production growth was mainly due to the expansion of area rather than increase in yield. Similar trend was observed by Kandarapa Kumar Barman (1997), Sharanesh (1998) and Bindukumar (2006). The growth in the production during Period-II was largely on the account of yield improvement. The findings were in line with the results of Balappa *et al.* (1999) and Bindukumar (2006).

The decelerating growth rate of yield could be mainly due to the absence of improved /high yielding varieties and sensitiveness of the crop to climatic variations like heavy rainfall or drought condition during various developmental stages of the crop. Bindukumar (2006) reported that the dismal performance of pigeon pea was due to the fact that of pigeon pea is mainly grown in rainfed situation, as more than 95 per cent area is still rainfed. Farmers do not adopt recommended package of practices for the crop. Further, inadequate supply of improved varieties and large-scale incidence of pests and diseases are contributing to lower yields. The Table 4.4 depicts that there was an impact of TMOP on yield improvement and production growth but no impact was seen in area growth.

Chickpea

Chickpea/bengal gram is an important pulse crop grown exclusively during *Rabi* season under rainfed conditions. As in case of pigeon pea, in most of the study districts and state as a whole, area and production of chickpea showed positive growth and yield exhibited negative growth (Table 4.5). During Period-II area, production and yield exhibited positive growth of 6.62 per cent per annum, 8.75 per cent per annum and 2.08 per cent per annum and similarly in all study districts positive significant growth was seen. In overall period chickpea exhibited positive growth in study area except yield growth in Raichur.

The positive growth in production during Period-I was strongly because of area growth. This was supported with the findings of Goswami *et al.* (1995) found that increase in area contributed for higher growth rate in production of chickpea and total pulses in Phase-I. During Period-II production growth was majorly contributed by area expansion although the yield has increased from -3.49 per cent per annum during Period-I to 2.08 per cent per annum during Period-II. Similarly during overall period the production growth was due to area expansion. Similar findings were reported by Sharanesh (1998) and Kunnal *et al.* (2007). Thus there was an impact of TMOP on growth of area, production and yield of chickpea.

Total pulses

Total pulses area, production and yield comprised of area, production and yield of ten pulse crops grown in the state. The four pulse crops such as pigeon pea, chickpea, green gram and black gram accounted for lion share. The two pulse crops selected for the study are major among these four crops. Consequently, the growth performance of the area, production and yield of total pulses was influenced by these crops. The growth pattern of area, production and yield of total pulses followed the pattern of two pulses discussed above with few exceptions.

The growth in area and production during Period-I in study area was positive except in Belgaum and Mysore for area growth and Belgaum, Mysore and Raichur for production growth whereas almost all study districts and state showed negative growth in yield in same period. During Period-II area and production exhibited positive growth. In most of the study districts and state showed positive growth in yield except Belgaum, Bidar and Dharwad. During Overall period area, production and yield in most of study district exhibited positive growth except Belgaum for area, production and yield growth, Mysore and Raichur for production growth and Bidar, Bijapur and Dharwad for yield growth.

During Period-I yield showed negative growth. The probable reasons for this trend might be the untimely rainfall, complementarity (most of the pulse crops grown under intercropping system), severe attack of pests at various stages of growth and cultivation of pulses on marginal and sub-marginal lands. Sawant (1997) reported that the dismal performance of the two major pulses, namely gram and pigeon pea, was largely responsible for low level of output growth of all pulses after 1981. By and large, however, pulses represented a group of slow growing crops throughout the green revolution period. The production growth was mainly due to the expansion of area rather than increase in yield. Similar trend was observed by Goswami *et al.* (1995) and Sharanesh (1998). Similar to chickpea during Period-II production growth was majorly contributed by area expansion although the yield had increased from -0.82 per cent per annum during Period-I to 1.06 per cent per annum during Period-II. The expansion in area from 1.17 per cent per annum during Period-I to 2.18 per cent per annum during Period-II and yield improvement in Period-II is mainly through the intervention of Technology Mission on Oilseeds and Pulses. This can be substantiated by the findings of Rama Rao (2010) which documented that pulses production in Post-WTO era (1996-97 to 2005-06) showed tremendous growth (6.85%). Reason may be due to effective implementation of Technology Mission on Oilseeds and Pulses since 1990-91 in Andhra Pradesh and more importantly expansion of area of chickpea in *Rabi* season.

Similarly during overall period the production growth was due to area expansion. Similar findings were reported by Sharanesh (1998). The decline in yield growth during Overall period in few districts were due to reason that in these districts pulses are mainly grown in rainfed situation. The major reason suggested by Ramaswamy and Selvaraj (2002) for reduction in yield than other crops was that so far, only few hybrids of pulses were released with higher yield potentials because of inherent genetic problems in pulses breeding.

The hypothesis 1 was accepted as positive growth exists in area, production and productivity of pulses during Post Technology Mission period in the state.

5.2 Impact of Technology Mission on Oilseeds and Pulses economy

5.2.1 Impact of Technology Mission on Oilseeds on oilseeds economy

The study of general characteristic features of farmers relating to family composition, education status, land holdings, irrigation and occupational pattern was quite essential to get better insight in to their living condition and the same is presented in the following order.

5.2.1.1 General characteristics of growers of groundnut in the study area

General features of sample respondents (Table 4.7) revealed that the average age of beneficiaries was 46.45 years and that of non-beneficiaries was 47.88 years. The results on educational status revealed that about 20 per cent of the beneficiaries were illiterates and remaining were found literate. While, around 37 per cent of non- beneficiaries were in the illiterate group. It was found that the literacy rate was high among beneficiaries when compared to non-beneficiaries. It is noted fact that higher the education level more will be the knowledge and better will be the understanding capacity of the new technologies.

In respect to occupational pattern maximum of both beneficiaries (93.33 per cent) and non-beneficiaries (90.00 per cent) were having agriculture as the primary occupation. There existed nearly an equal family size between beneficiaries (4.66) and non- beneficiaries (4.62) with four to five members per family. It evidently justified random selection of sample farmers in both the categories.

The average size of the land holding was 2.97 ha, for beneficiaries and 7.85 ha for non-beneficiaries respectively. Both beneficiaries (25.6 per cent) and non-beneficiaries (24.0 per cent) had irrigation facility from various sources and around 74.4 per cent and 76.0 per cent of them, respectively had no irrigation facility and operated under rainfed condition. Groundnut was the major oilseed crop grown in the study area as average area allocated for the groundnut was 1.53 ha in case of beneficiaries and 1.12 ha for non- beneficiaries. All beneficiaries used improved seeds for cultivation of groundnut whereas more than 70 per cent non-beneficiaries used local seeds. Hence there exists yield difference among them.

5.2.1.2 Cropping pattern of groundnut growers in the study area

Cropping pattern followed by farmers in a particular area depends upon rainfall condition, irrigation facilities, commercial importance of the crops, climatic conditions of the area and technology intervention /facilities availability for cultivation of crops. Major crops grown by the sample farmers were considered and the crops cultivated by beneficiary and non-beneficiary groups were worked out to substitute influence of intervention of TMO on it.

The result in Tables 4.8 clearly distinguished the cropping pattern followed by both beneficiaries and non-beneficiaries. In *Kharif* season, groundnut occupied 44.44 per cent and 38.62 per cent of the gross cropped area of beneficiary farms and non-beneficiary farms respectively. Cereals occupied major share in area among non-beneficiaries (21.7 per cent) whereas the total area covered under pulses was more with 27.0 per cent on beneficiaries farms as against 25.1 per cent in case of non- beneficiaries. Similarly the area covered under oilseeds was more with 44.4 per cent on beneficiaries farms as against only 38.6 per cent in case of non- beneficiaries. The area covered under horticultural and plantation crops were also relatively more and accounted 11.04 per cent and 14.4 per cent in case of non- beneficiaries and beneficiaries, respectively.

These results showed the relevance and importance of inputs availability under TMO in determining area allocation under different crops. Eventually, the beneficiaries chose to have more area under oilseed crops when compared to non- beneficiaries.

Similarly, the cropping intensity was also found to be relatively high on beneficiary farms (147.47 per cent) compared to non-beneficiary farms (146.0 per cent). Similar findings of favourable effect of credit on cropping pattern were reported in the study conducted by Deorukhakar *et al.* (2007).

5.2.1.3 Labour use pattern in groundnut cultivation

The quantities of labour utilized (Table 4.9) were more in case of beneficiaries in all the major operations like ploughing, harrowing, loading, transportation and spreading of FYM, sowing, fertilizer application, weeding, intercultivation, PPC application and harvesting. This was mainly because of the timely operations and use of more quantity of inputs by beneficiaries than non-beneficiaries.

5.2.1.4 Input use pattern and output obtained in groundnut cultivation

The quantities of inputs utilized (Table 4.10) were more in case of beneficiaries in all the major inputs like seeds, labour, organic manure, chemical fertilizers and PPC in case of groundnut crop. This revealed more quantity of input utilization among the beneficiaries as against non-beneficiaries. This was mainly because of availability of adequate and timely availability of inputs through TMO scheme which helped them to use more quantity of inputs. These findings were in line with the findings of Shalini (2011) wherein she reported borrowers used more inputs than non borrowers because of availability of adequate institutional credit in time.

As a result the output obtained by beneficiaries (27.2 quintals) per hectare of groundnut cultivation was more than that of non-beneficiaries (21.8 quintals).

5.2.1.5 Costs and returns in cultivation of groundnut

A comparison of cost and returns structure of groundnut between beneficiaries and non-beneficiaries farms is presented in Table 4.11.

The total variable costs incurred on groundnut were more on the beneficiaries farms compared to those on the non- beneficiaries farms as a result of increased application of vital inputs. The average cost on seeds, manures, fertilizer and plant protection chemicals were more on beneficiaries farms when compared with non- beneficiaries. This revealed better input utilization and their timely application as opined by beneficiaries during the survey. This was mainly because of availability of inputs in time whenever they required.

The gross return among beneficiary farms per hectare for ground nut (₹ 98958.6) was significantly more than non-beneficiary farms (₹ 78333.85).It can be seen from the table that, the increase in total cost of beneficiary farms by ₹ 5211.1 over non-beneficiary plots. The reason identified were increased cost of seeds, FYM and recommended amount of fertilizer with gypsum. The net additional returns were ₹ 15413.65. All together enhanced the profit per rupee of cost on beneficiary farms when compared to non-beneficiary farms. It was mainly due to the timely availability of these inputs at right time by the beneficiaries and the knowledge they gained through training and demonstration conducted under TMO scheme. The results are on par with Deorukhakar *et al.* (2007) who indicated that gross income on beneficiary farm was approximately three times higher than non-beneficiary farms.

5.2.1.6 General characteristics of sunflower growers in the study area

The general characteristics of the respondents growing sunflower are presented in Table 4.12. The beneficiaries were younger compared to non-beneficiaries. Hence, middle age farmers are more aggressive in adopting technology related to sunflower production. It could be observed that non-beneficiaries had less number of years of schooling than beneficiaries in both the cases their main occupation was agriculture. The average size of the family was about six for both beneficiaries and non-beneficiaries and average land holding of beneficiaries was 3.39 ha and it was 3.42 ha in the case of non- beneficiaries. Both the group had no irrigation facility and operated under rainfed condition. Sunflower was the major oilseed crop cultivated in the study area by beneficiaries and non-beneficiaries was 1.51 ha and 1.21 ha respectively. The sunflower hybrids grown by the beneficiaries were ITC (30.0%), DSH-1 (20.0%), Mahyco (36.67%) and KBSH-22(13.33%), whereas the non-beneficiaries had grown more of local (60.0%) hybrids.

5.2.1.7 Cropping pattern of sunflower growers in the study area

The absolute area devoted to different crops by the beneficiaries and non-beneficiaries was ascertained for the agriculture year 2011-12. Table 4.13 indicated that on beneficiary and non-beneficiary farms the major crops grown during *Kharif* season were sunflower followed by onion, green gram, bajra and pigeon pea. During *Rabi* season jowar followed by chickpea and wheat. The area under sunflower was more in case of beneficiaries than non- beneficiaries. Similarly, both in *Kharif* and *Rabi* season the area under all crops was more in beneficiary farms than non-beneficiary.

These results showed the relevance and importance of inputs availability under TMO in determining area allocation under different crops to the beneficiaries because of which they chose to have more area under oilseed crops when compared to non- beneficiaries. The cropping intensity was also found to be relatively high on beneficiary farms (152.50%) compared to non-beneficiary farms (145.91%). Similar findings were reported by Shalini (2011), which was because of the impact of credit availability.

5.2.1.8 Labour use pattern in sunflower cultivation

The quantities of labour utilized (Table 4.14) were more in case of beneficiaries in all the major operations like ploughing, harrowing, loading, transportation and spreading of FYM, sowing, fertilizer application, weeding, intercultivation, PPC application and harvesting. This was mainly because of the timely carrying out the recommended operations by beneficiaries than non-beneficiaries.

5.2.1.9 Input use pattern and output obtained in sunflower cultivation

In the study area, both beneficiaries and non-beneficiaries used different types of inputs in the cultivation of sunflower. About six types of inputs were used in the cultivation of sunflower (Table 4.15). They were seeds, labours, FYM, fertilizer, Gypsum and PPC. The results revealed that more quantity of inputs were used among the beneficiaries as against non-beneficiaries. This was mainly because of availability of adequate and timely availability of inputs through TMO scheme.

As a result the output obtained by beneficiaries (21.45 quintals) for per hectare of sunflower cultivation was more than that of non-beneficiaries (17.07 quintals). The other reasons for increase in yield among beneficiaries were timely sowing of sunflower seeds in August ending which avoids rust manifestation and also they maintain optimum spacing. All these were possible due to intervention of TMO scheme in conducting training and guiding farmers.

5.2.1.10 Costs and returns in cultivation of sunflower

It is evident from the results presented in the Table 4.16 that, the cost of sunflower cultivation on beneficiary farms (₹ 55114.3 per hectare) was more when compared to that on non-beneficiaries farms (₹ 49381.03per hectare). The per hectare variable cost in cultivation of sunflower on beneficiary farms (₹ 46313.08) was higher as compared to that on non- beneficiary farms (₹ 40663.13). The average costs on inputs were more on beneficiaries farms when compared with non- beneficiaries. This revealed better input utilization and their timely application, which was mainly because of availability of inputs in time whenever they required.

The gross return among beneficiary farms per hectare for sunflower (₹ 91166.35) was more than non-beneficiary farms (₹ 71685.45). It was evident from the table that, the increase in total cost of beneficiary farms by ₹ 5733.27 over non-beneficiary plots. The reason identified were increased cost of seeds and FYM. The net additional returns were ₹ 13747.65. The profit per rupees was more in beneficiary farms as compared to non-beneficiary farms. It was mainly due to the use of high yielding varieties, timely availability of inputs under TMO scheme, timely sowing and maintaining optimum spacing by the beneficiaries. These findings were on par with the findings of Mishra and Mishra (2007) they reported that an increase in the yield of borrowing farms was due to the use of credit-financed inputs.

The hypothesis2 was accepted as there was positive impact of TMO on oilseeds economy.

5.2.2 Impact of Technology Mission on Oilseeds and Pulses on pulses economy

5.2.2.1 General characteristics of pigeon pea growers in the study area

General features of sample respondents (Table 4.17) revealed that the average age of beneficiaries was 41.9 years and that of non-beneficiaries was 45.9 years. The results on educational status revealed that about 3 per cent of the beneficiaries were illiterates and remaining were found literate. While, around 10 per cent of non- beneficiaries were in the illiterate group. It was found that the literacy rate was high among beneficiaries when compared to non-beneficiaries. It is noted fact that higher the education level more will be the knowledge and better will be the understanding capacity of the new technologies.

In respect to occupational pattern maximum of both beneficiaries (93.33%) and non-beneficiaries (76.6%) were having agriculture as their primary occupation. There existed nearly an equal family size between beneficiaries (5.1) and non- beneficiaries (5.4) with five members per family. It evidently justified random selection of sample farmers in both the categories.

The average size of the land holding was 6.21 ha, for beneficiaries and 5.69 ha for non-beneficiaries respectively. Both the group had no irrigation facility and operated under rainfed condition. Pigeon pea was the major pulse crop grown in the study area as average area allocated for the pigeon pea was 1.80 ha in case of beneficiaries and 1.45 ha for non- beneficiaries. All beneficiaries used improved varieties for cultivation of pigeon pea whereas more than 60 per cent non-beneficiaries used local seeds. Hence there exists yield difference among them.

5.2.2.2 Cropping pattern of pigeon pea growers in the study area

Major crops grown by the sample farmers were considered and the crops cultivated by beneficiary and non-beneficiary groups were worked out to substitute influence of intervention of TMOP on it.

The results in Tables 4.18 clearly distinguished the cropping pattern followed by both beneficiaries and non-beneficiaries. In *Kharif* season, pigeon pea occupied 19.40 per cent and 17.75 per cent of the gross cropped area of beneficiary farms and non-beneficiary farms respectively. The total area covered under pulses was more with 47.56 per cent on beneficiaries farms as against 44.67 per cent in case of non- beneficiaries. These results indicated the importance of inputs availability under TMOP in determining area allocation under different crops. Eventually, the beneficiaries chose to have more area under pulse crops when compared to non- beneficiaries.

Similarly, the cropping intensity was also found to be relatively high on beneficiary farms (149.44 per cent) compared to non-beneficiary farms (143.59 per cent). Similar findings of favourable effect of credit on cropping pattern were reported in the study conducted by Shalini (2011).

5.2.2.3 Labour use pattern in pigeon pea cultivation

The quantities of labour utilized (Table 4.19) were more in case of beneficiaries in all the major operations like ploughing, harrowing, loading, transportation and spreading of FYM, sowing, fertilizer application, weeding, intercultivation, PPC application and harvesting. This was mainly because of the timely operations and use of more quantity of inputs by beneficiaries than non-beneficiaries.

5.2.2.4 Input use pattern and output obtained in pigeon pea cultivation

The quantities of inputs utilized (Table 4.20) were more in case of beneficiaries in all the major inputs like seeds, labour, organic manure, chemical fertilizers and PPC in case of pigeon pea crop. This revealed more quantity of input utilization among the beneficiaries as against non-beneficiaries. This was mainly because of availability of adequate and timely availability of inputs through TMOP scheme which helped them to use more quantity of inputs. As a result the output obtained by beneficiaries (12.8 quintals) per hectare of pigeon pea cultivation was more than that of non-beneficiaries (10.63 quintals).

5.2.2.5 Costs and returns in cultivation of pigeon pea

A comparison of cost and returns structure of pigeon pea between beneficiaries and non-beneficiaries' farms are presented in Table 4.21.

The total variable cost incurred on pigeon pea was more on the beneficiaries farms compared to those on the non- beneficiaries farms as a result of increased application of vital inputs. The average cost on manures, fertilizer and plant protection chemicals were more on beneficiaries farms when compared with non- beneficiaries. This revealed better input utilization and their timely application as opined by beneficiaries during the survey. This was mainly because of availability of inputs in time whenever they required.

The gross return among beneficiary farms per hectare for pigeon pea (₹ 62555.9) was significantly more than non-beneficiary farms (₹ 51162.5). It was observed from the table that, the increase in total cost of beneficiary farms by ₹ 4384.83 over non-beneficiary farms. The reason identified were increased cost of seeds, FYM and PPC. The net additional returns were ₹ 7008.73.

The profit per rupees was more in beneficiary farms as compared to non-beneficiary farms. It was mainly due to the use of high yielding varieties, proper row spacing of 90 cm which helped in maintaining required moisture and also helped in reducing *Helicoverpa Armigera* (pod borer) infestation and even beneficiaries used recommended plant protection chemicals by the expertise whereas, majority of the non-beneficiaries used the same pesticides which built to resistance in the insect body and thus results in the reduced yield. All these knowledge was obtained by beneficiaries through training and demonstration conducted under TMOP scheme. The findings were in line with Balappa *et al.* (1998) who documented that the IPM farmers obtained higher yield in pigeon pea crop (12.4 q/ha) and net income (19.45%). The B: C in IPM farm was marginally higher than that of non-IPM farm.

5.2.2.6 General characteristics of chickpea growers in the study area

The general characteristics of the respondents growing chickpea are presented in Table 4.22. The beneficiaries were younger compared to non-beneficiaries. It could be further observed that the majority of the sample farmers both beneficiaries (83.33%) and non-beneficiaries (93.33%) were literate and in both the cases the main occupation of them was agriculture. The average size of the family was about five to six of both beneficiaries and non-beneficiaries and average land holding of beneficiaries was 6.13 ha and it was 5.96 ha in the case of non- beneficiaries. Both the group had no irrigation facility and operated under rainfed condition. Chickpea was the major pulse crop cultivated in the study area by beneficiaries and non- beneficiaries was 1.91 ha and 1.69 ha respectively. The chickpea varieties grown by the beneficiaries in the study area were A-I (50.0%), GBS-962 (23.33%) and ICCV-10 (26.67%) whereas the non- beneficiaries grown more of local (66.67%) varieties.

5.2.1.7 Cropping pattern of chickpea growers in the study area

The absolute area devoted to different crops by the beneficiaries and non-beneficiaries was ascertained for the agriculture year 2011-12. Table 4.23 indicated that in beneficiary and non-beneficiary farms the major crops grown during *Kharif* season were green gram, pigeon pea, cotton, chilli and bajra. During *Rabi* season chickpea,jowar and sunflower were grown. The area under chickpea was more in case of beneficiaries than non- beneficiaries. Similarly, both in *Kharif* and *Rabi* season the area under all crops was more in beneficiary farms than non-beneficiary.

These results showed the relevance of inputs availability under TMOP in determining area allocation under different crops to the beneficiaries because of which they chose to have more area under pulse crops when compared to non- beneficiaries. The cropping intensity was also found to be relatively high on beneficiary farms (160.33%) compared to non-beneficiary farms (154.66%).

5.2.2.8 Labour use pattern in chickpea cultivation

The quantities of labour utilized (Table 4.24) were more in case of beneficiaries in all the major operations like ploughing, harrowing, loading, transportation and spreading of FYM, sowing, fertilizer application, weeding, intercultivation, PPC application and harvesting. This was mainly because of the timely operations and use of more quantity of inputs by beneficiaries than non-beneficiaries.

5.2.2.9 Input use pattern and output obtained in chickpea cultivation

In the study area both beneficiaries and non-beneficiaries used different types of inputs in the cultivation of chickpea. About five types of inputs were used in the cultivation of chickpea (Table 4.25). They were seeds, labours, FYM, fertilizer and PPC. The results revealed that more quantity of inputs were used among the beneficiaries as against non-beneficiaries. This was mainly because of availability of adequate and timely availability of inputs through TMOP scheme.

As a result the output obtained by beneficiaries (10.9 quintals) for per hectare of chickpea cultivation was more than that of non-beneficiaries (8.92 quintals).

5.2.2.10 Costs and returns in cultivation of chickpea

It is evident from the results presented in the Table 4.26 that, the cost of chickpea cultivation on beneficiary farms (₹ 41525.68 per hectare) was more when compared to that on non-beneficiaries farms (₹ 40370.93 per hectare). The per hectare variable cost in cultivation of chickpea on beneficiary farms (₹ 33421.65) was higher as compared to that on non- beneficiary farms (₹ 32279.35). The average costs incurred on inputs were more on beneficiaries farms when compared with non-beneficiaries. This revealed better input utilization and their timely application, which was mainly because of availability of inputs in time whenever they required.

The gross return among beneficiary farms per hectare for chickpea (₹ 56963.08) was more than non-beneficiary farms (₹ 45292.4). It was observed from the table that, the increase in total cost of beneficiary farms by ₹ 1154.75 over non-beneficiary farms. The reason identified were increased cost of seeds, FYM, timely operations (labours) and PPC. The net additional returns were ₹ 10515.93. The profit per rupees was more in beneficiary farms as compared to non-beneficiary farms. It was mainly due to the use of high yielding varieties that is Annigeri-I which was better yielding variety in the region than any other, timely sowing of the crop, spraying of urea at the time of flowering and even the beneficiaries followed the timely nipping operation according to the suggestions made by the expertise in the chickpea cultivation were the possible reasons for getting higher yield in case of beneficiary farms than the non-beneficiary farms.

Overall we can conclude that the hypothesis made on the positive impact of TMOP on oilseeds and pulses economy was accepted. This was in line with the results of Deepak (2012) who showed positive impact of NFSM programme in raising various pulses since net returns from these crops are not only higher in NFSM district as against non- NFSM district but net returns have grown sharply in 2008-09 over that of 2007-08, especially in NFSM district of Amravati.

5.3 Instability in oilseeds and pulses production

Individual crop growth rates of area, yield and production help the planners and policy makers in formulating plans and strategies. But an understanding of how the time series variable of area, production and yield are interrelated and their inter-causative effects is also needed to proceed in the right direction while deciding plans and strategies.

5.3.1 Instability in oilseeds production

As a prelude to the analysis of instability in production of groundnut, sunflower and total oilseeds the sources of change in the average production were examined and presented in following headings.

5.3.1.1 Sources of change in average production of groundnut

The results of sources contributing to the change in average production of groundnut (Table 4.27) indicated that the change in mean area accounted for 57.25 per cent of the increased average production of groundnut between the two periods followed by change in mean yield (29.17 percent). This was in line with the findings of Addisu (2000) who observed that the change in mean yield and mean area contributed almost equally (47.43 and 41.94 per cent) to the increase in average production between the periods 1966-67 to 1980-81 and 1981-82 to 1997-98. The contribution equally by mean area and mean yield was due to the difference in study periods. Krishnadas (2010) found similar results in case of turmeric crop.

In the district of Belgaum, Bellary, Chitradurga, Raichur and Tumkur change in mean area was found to be the major component responsible for increased groundnut production whereas in the district of Bijapur, Dharwad and Gulbarga districts, the reverse was true. The interaction term between mean area and mean yield and covariance between area and yield were negligible in all the districts as compared to the major components in each district.

Most of the districts contributed positively to the state average production of groundnut between the two periods barring Belgaum, Bellary and Chitradurga. However, the major contribution came from the districts in the category ‘Others’ (101.09 per cent).

5.3.1.2 Sources of instability in groundnut production

The sources of change in the variance of groundnut production (Table 4.28) revealed that the change in area yield covariance contributed the major share (39.66 per cent) towards destabilizing the production of groundnut in the state. This was in sharp contrast to the findings of Addisu (2000) whose results indicated that the fluctuations in area constituted the major source of instability in the production of groundnut between the periods 1966-67 to 1980-81 and 1981-82 to 1997-98. This component had a similar effect on the instability of production in ‘Others’ districts (34.9 per cent). Change in area variance (23.71 per cent), was the second largest component showing destabilizing effect in the groundnut production in the state. It was also observed that all the components of change showed destabilizing effect towards production of groundnut but change in mean yield showed stabilizing effect.

Further, the results indicated that the production of groundnut was relatively stable in the districts of Bellary and Raichur. The stabilization in former was due to decline in area variance and later was due to decline in interaction between changes in mean area and yield covariance in the Period-II. Gulbarga district contributed to increased instability in the groundnut production. The change in mean area was the main source for increased instability showing that rapid expansion of area led to increased area variance in this district.

5.3.1.3 Sources contributing to the changes in average production of sunflower

Sunflower is a prominent oilseed crop introduced very recently. Within a short span of time it has become very popular among the farming community, attracting many agro-industries to take up its seed production on a commercial scale. Its wide acceptability was because of its manifold advantages over other crops. This crop can be raised all through the year. It is a unique short duration crop having both improved and hybrid varieties and not requiring much cost for its cultivation. The most disheartening situation revealed by the findings was that the yield growth in the entire study area was negative (Table 4.29).

The change in mean area contributed as high as 151.94 per cent to the increased average production of sunflower between the two periods in the state. Whereas, covariance between yield and area contributed only 2.17 per cent. The production of this crop was mainly due to expansion of area. This findings was in line with Mundinamani (1993) and Addisu (2000).

The disaggregate level analysis indicated that Tumkur and the districts in the category of 'Others' were found to be responsible for contributing 8.79 and 70.05 per cent of the increase in average production of sunflower at the state level. All the study districts showed increase in mean area during Period-II and hence contributed positively to mean production. In Tumkur and Raichur districts the change in mean yield was the major component responsible for increased production of sunflower. In Bellary district, interaction between mean area and yield was the major component responsible for increased production of sunflower.

5.3.1.4 Sources of instability in sunflower production

The analysis of variance revealed that production of sunflower (Table 4.30) in the state was destabilized mainly due to interaction between changes in mean yield and area variance (91.28 per cent) on account of a multitude of factors, among which, its cultivation on marginal and sub-marginal lands with poor management practices and its susceptibility to pests and diseases are the most important ones. This component showed a similar effect on instability of sunflower production in the districts in the category of 'Others' (95.23 per cent). Change in mean area constituted the second largest component (78.34 per cent). Similarly, Interaction between changes in mean area and yield covariance, Interaction between changes in mean yield and mean area and Change in area yield covariance registered 31.18, 3.12 and 2.13 per cent of instability in sunflower production respectively. Hence, it can be said that the sources of instability in sunflower production between the two periods were the synchronized movements in yield and area.

Among the major components of change, change in mean yield, change in area variance, change in yield variance and Interaction between changes in mean area and yield variance contributed to stability of sunflower production in the state. Further, the results revealed that production of sunflower was stabilized in the districts of Belgaum, Bellary,Dharwad, Raichur and Tumkur.

5.3.1.5 Sources contributing to the changes in average production of total oilseeds

The analysis of components of change in the average production of total oilseeds from the Table 4.31 indicated that change in mean area (62.21 per cent) was responsible for the increased average production between the two periods. This significant change in output due to expansion of the area are in conformity with the earlier study in the study area (Mundinamani, 1993). The change in mean yield was the second largest contributor (23.85 per cent) to the increase in average production. This was due to the research efforts of the different oilseed projects conducted in the state during last two and half decade for developing improved varieties with the inception of TMO (1986).

The results at the district level indicated that in majority of the districts the change in mean area was found to be major component towards contributing to the change in average production. The change in mean yield was the major contributor to the change in average total oilseeds production in the districts of Bellary, Chitradurga and Raichur..

Further, the results revealed that the change in covariance between yield and area contributed negligibly to the change in average production whereas the interaction term contributed positively in all districts to the change in average production of total oilseeds.

5.3.1.6 Sources of instability in total oilseeds production

The results of the instability analysis revealed that the production of total oilseeds in the state was destabilized mainly due to the interaction between changes in mean area and yield variance (199.60 per cent) indicating that the increase in area was accompanied by larger variability in yield under the crop (Table 4.32). The second important source of instability in production of total oilseeds in the state was found to be the change in yield variance. This might be due to erratic rainfall, cultivation on marginal and sub-marginal lands and most of the oilseed crops are cultivated in rainfed situation. Similarly, interaction between changes in mean area and yield covariance and change in area yield covariance which accounted for 25.25 and 23.03 per cent of the total variation respectively. The change in mean area, change in mean yield, change in area variance, interaction between changes in mean yield and mean area and interaction between changes in mean yield and area variance showed stabilizing effect in total oilseeds production in the state.

Further, the results revealed that instability of total oilseeds production was found to be highest in Dharwad (52.57 per cent) and 'Others' districts (205.08 per cent). In Dharwad the instability was mainly contributed by change in area variance and interaction between changes in mean yield and area variance. The change in mean area which played the main role in stabilizing production in total oilseeds was not strong enough to offset the combined effect of the above mentioned destabilizing sources in this district. In Bellary and Gulbarga districts production of total oilseeds was destabilized mainly due to interaction between changes in mean yield and area variance and change in mean area respectively. Production of total oilseeds was stabilized in Belgaum, Chitradurga, Raichur and Tumkur which are major producers of total oilseeds in the state. This stabilization phenomenon was mainly due to the reduction in interaction between changes in mean area and yield covariance, change in area yield covariance, interaction between changes in mean yield and area variance and change in mean yield respectively.

The hypothesis 3 was accepted as the main sources of instability in production of oilseeds are the fluctuations in area and yield.

5.3.2 Instability in pulses production

As a prelude to the instability in production of pigeon pea, chickpea and total pulses, the sources of change in the average production were examined and presented under following

5.3.2.1 Sources contributing to the changes in average production of pigeon pea

The results of sources contributing to the change in average production of pigeon pea (Table 4.33) indicated that the change in mean area accounted for 72.37 per cent of the increased average production of pigeon pea between the two periods followed by change in mean yield (14.67 percent). This was in sharp contrast with the findings of Sharanesh (1998) reported that pigeon pea production was contributed by more of yield increments in Gulbarga district and Karnataka state as a whole between the periods of 1976-77 to 1995-96.

In most of the district change in mean area was found to be the major component responsible for increased pigeon pea production barring the district of Mysore, the reverse was true. The interaction term between mean area and mean yield and covariance between area and yield were negligible in all the districts as compared to the major components in each district.

Most of the districts contributed positively to the state average production of pigeon pea between the two periods except Belgaum, Bellary, Mysore and Raichur. However, the major contribution came from the districts in the category 'Others' (111.48 per cent).

5.3.2.2 Sources of instability in pigeon pea production

The sources of change in the variance of pigeon pea production (Table 4.34) revealed that the change in area yield covariance contributed the major share (46.92 per cent) towards destabilizing the production of pigeon pea in the state. This component had a similar effect on the instability of production in 'Others' districts ((47.75 per cent) and Bijapur district (2.58 per cent). Change in yield variance (15.63 per cent), was the second largest component showing destabilizing effect in the pigeon pea production in the state. It was also observed that most of the components of change showed destabilizing effect towards production of pigeon pea but change in mean yield, change in mean area and Interaction between changes in mean yield and mean area showed stabilizing effect.

Further, the results indicated that the production of pigeon pea was relatively stable in the districts of Dharwad, Gulbarga and 'Others'. The stabilization in Dharwad was due to the interaction between changes in mean area and yield covariance whereas, Gulbarga and 'Others' districts the stabilization was due to the mean yield in the Period-II. Bidar district was the major source of increased instability in the pigeon pea production. The change in mean yield was the main source for increased instability.

5.3.2.3 Sources contributing to the changes in average production of chickpea

Chickpea is a prominent *Rabi* pulse crop raised both as an entire crop as well as a mixed crop. The change in mean area contributed as high as 151.94 per cent to the increased average production of chickpea between the two periods in the state (Table 4.35). Whereas, change in mean yield contributed only 3.17 per cent. The production of this crop was mainly due to expansion of area. This findings were in line with Sharanesh (1998) who documented that the area expansion made a significant contribution than that of yield and their interaction in Dharwad, Gulbarga and Karnataka state as a whole.

The disaggregate level analysis indicated that Belgaum and the districts in the category of 'Others' were found to be responsible for contributing 4.94 and 81.53 per cent of the increase in average production of chickpea at the state level. All the study districts showed increase in mean area except Bidar and Raichur during Period-II and hence contributed positive to mean production. In Belgaum and Raichur districts the covariance between area and yield was the major component responsible for increased production of chickpea. In Bellary, Dharwad and Mysore districts, interaction between mean area and yield was the major component responsible for increased production of chickpea.

5.3.2.4 Sources of instability in chickpea production

The analysis of variance revealed that production of chickpea (Table 4.36) in the state was destabilized mainly due to change in area variance accounted for 38.50 per cent on account of a multitude of factors, among which, its cultivation on marginal and sub-marginal lands with poor management practices and its susceptibility to pests and diseases are the most important ones. Interaction between changes in mean area and yield covariance constituted the second largest component (29.39 per cent). Similarly, interaction between changes in mean yield and area variance, change in area yield covariance, interaction between changes in mean area and yield variance, change in mean area and change in yield variance registered 20.71, 4.14, 2.40, 2.0 5 and 0.07 per cent of instability in chickpea production respectively. Hence, it can be said that the sources of instability in chickpea production between the two periods were the synchronized movements in area and yield.

Among the major components of change, change in mean yield and interaction between changes in mean yield and mean area contributed to stability of chickpea production in the state. Further, the results revealed that production of chickpea was stabilized in the districts of Bellary, Bijapur and Gulbarga.

5.3.2.5 Sources contributing to the changes in average production of total pulses

The analysis of components of change in the average production of total pulses from the Table 4.37 indicated that change in mean area (66.09 per cent) was responsible for the increased average production between the two periods. This significant change in output due to expansion of the area are in conformity with the earlier study of Rao (2010) who recorded that change in mean area has more effect on average production differential than by other components of change. The change in mean yield was the second largest contributor (25.05 per cent) to the increase in average production. This was due to the research efforts of the different pulse projects conducted in the state during last two decades for developing improved varieties with the inception of TMOP (1990).

The results at the district level indicated that in majority of the districts, the change in mean area was found to be major component towards contributing to the change in average production. The change in mean yield was the major contributor to the change in average total pulses production in the districts of Dharwad and Raichur.

Further, the results revealed that the change in covariance between yield and area and the interaction term contributed negligibly to the change in average production in all districts to the change in average production compared to other two important components.

5.3.2.6 Sources of instability in total pulses production

The results of the instability analysis revealed that the production of total pulses in the state was destabilized mainly due to the Change in area yield covariance (35.77 per cent) indicating that the increase in area was accompanied by larger variability in yield under the crop (Table 4.38). The second important source of instability in production of total pulses in the state was found to be the change in area variance. This might be due to erratic rainfall, cultivation on marginal and sub-marginal lands and shift of area to other food crops. Similarly, interaction between changes in mean area and yield and change in area-yield covariance, change in mean yield, change in the yield variance, interaction between changes in mean yield and area variance, interaction between changes in mean area and yield variance, interaction between changes in mean yield and area variance, change in mean area and interaction between changes in mean yield and mean area which accounted for 15.54, 13.78,7.39, 5.82,4.90, 3.89 and 0.24 per cent of the total variation respectively. Change in residuals (-12.38 per cent) is the only component which absorbed most of the source of stability in total pulses production in the state though it is an unimportant source from the view of stabilization policy measures.

Further, the results revealed that instability of total pulses production was found to be highest in Dharwad (95.81 per cent) and 'Others' districts (158.35 per cent). The major source was change in mean area for these districts. In Gulbarga and Bidar districts production of total pulses was destabilized mainly due to change in mean yield respectively. Production of total pulses was stabilized in Bijapur, Dharwad and Raichur which are major producers of total pulses in the state. This stabilization phenomenon was mainly due to the reduction in change in mean yield, change in yield variance and change in mean area respectively.

The hypothesis 3 was accepted as the main sources of instability in production of pulses are the fluctuations in area and yield.

5.4 Returns to investment on Technology Mission on Oilseeds and Pulses

5.4.1 TFP Growth by Crops at selected districts and at state Level

It can be observed from the Table 4.39 that the growth in output and TFP of groundnut was positive in all periods under study both in Tumkur and the state as a whole. TFP has contributed about 71 per cent and 84 per cent in Tumkur district and state as a whole respectively indicating that technology has played a greater role in augmenting the production of groundnut. Similar results were obtained by Elumalai (2011) and Ramesh *et al.* (2011).

The results of sunflower production in Bijapur district indicates that technology has not played much role. With respect to sunflower production in Karnataka use of inputs seems to be relatively high. The growth in inputs was the main driver of output growth in all periods. As for pigeon pea, except during Period-I in Gulbarga district output growth was mainly driven by technology both in Gulbarga and Karnataka. The results obtained were on par with the results of Elumalai (2011).

In case of chickpea output growth was mainly contributed by inputs during Period-I in both Gulbarga district and state as a whole. Overall if we consider TFP has contributed about 38 per cent in Karnataka state as a whole indicating that technology has not played much important role in the production of chickpea. This coincided with the findings of Ramesh *et al.* (2012) at All India level.

5.4.2 Returns to investment on Technology Mission on Oilseeds and Pulses

It was evident from the Table 4.40 that the investments in oilseeds need to be increased by 20.66 per cent for groundnut and 33.78 per cent for sunflower to achieve one per cent growth in TFP. For pulses investments need to be increased by 22.83 per cent for pigeon pea and 36.10 per cent for chickpea. These results suggest a substantial raise in investments on oilseeds and pulses schemes is needed to maintain a steady growth in TFP. These findings were in line with the results of Ramesh *et al.* (2011).

5.4.3 Value of Marginal Product

From the Table 4.41 it can be revealed that groundnut and pigeon pea generated more than Rs. 1 for the additional investment of one rupee whereas the sunflower and chickpea the value of marginal product is less than one indicating that investment on these commodities has not been generating enough output. There is a need to change the focus of investment in such crops to get higher returns. The results obtained were on par with the results of Ramesh *et al.* (2011).

5.4.4 Internal Rate of Return

It was apparent from the Table 4.42 that the overall internal rate of return was 31 per cent for groundnut, 22 per cent for sunflower crop, 28 per cent for tur and 18 per cent for chickpea crop showing that investment on oilseeds and pulses during the past 23 years and 19 years respectively has provided attractive returns. These results suggest that further investments on these crops will generate significant returns and will lead to development of oilseeds and pulses production in Karnataka. This is in conformity with the findings of Ramesh *et al.* (2012).

The hypothesis 4 was accepted as investment on the oilseeds and pulses was found to be profitable.

SUMMARY AND POLICY IMPLICATIONS

This chapter summarises the findings of the investigation and suggest appropriate policies to achieve growth and stability in oilseed and pulses production in the state.

6.1 Introduction

Although, India has the largest cultivated area under oilseeds and pulses in the world, the growth performance of these crops in the last five decades is quite disappointing. As a result the consumption levels of crucial nutrients like oils and fats and proteins are much below the minimum nutritional requirement prescribed by the Indian Council of Medical Research. Oilseeds and pulses are generally grown in energy starved conditions with hardly about 25 per cent of the area under irrigation. This has subjected oilseeds and pulses to the vagaries of monsoons resulting in lower yield levels. Added to this are lack of varietal breakthrough in domestic oilseeds and pulses, relatively higher fluctuation in the price realized by the producers in the markets and cultivation of oilseeds and pulses in relatively poor marginal lands are some of the major factors contributing to low level of productivity in Indian oilseeds and pulses.

Karnataka is one of the major oilseeds and pulses producing states and it is one of the project areas covered under the oilseeds and pulses development programmes (TMOP). Nine districts of the state namely Belgaum, Bellary, Bidar, Bijapur, Chitradurga, Dharwad, Gulbarga, Raichur and Tumkur for oilseeds and eight districts for pulses namely Belgaum, Bellary, Bidar, Bijapur, Dharwad, Gulbarga, Raichur and Mysore are selected as lead areas for concentrating research and development activities. With the introduction of Technology Mission on Oilseeds and Pulses in the state, the total area under oilseeds and pulses has increased, but the productivity of oilseeds and pulses is not improved so far and the level of instability also increased over the period. Therefore, the efforts to induce stability in oilseeds and pulses sector of the state require proper understanding and analysis of factors responsible for output instability. Hence, the present study attempts to analyse the performance of the major oilseeds and pulses of Karnataka both at disaggregate and aggregate levels.

6.2 Objectives of the study

The specific objectives of study are:

1. To study the growth in area, production and yield of oilseeds and pulses in Karnataka during pre and post Technology Mission on Oilseeds and Pulses;
2. To analyse the impact of Technology Mission on Oilseeds and Pulses on oilseeds and pulses economy of the state;
3. To analyse factors influencing production of oilseeds and pulses in the state; and
4. To study the returns to investment on Technology Mission on Oilseeds and Pulses in the state.

6.3 Sampling Frame and Sources of Data

On the basis of area covered by oilseed and pulse crops in the state, two major oilseed and two major pulse crops namely, groundnut, sunflower, redgram and bengal gram were selected. These crops have been covered under Technology Mission on Oilseeds and Pulses. For detailed study of growth and instability in selected oilseeds and pulses, eight districts having maximum area under these oilseeds and pulses were selected. These eight districts together accounted for 87.69 per cent and 84.92 per cent of the total area under oilseeds and pulses respectively in the state. The primary data was collected from Tumkur district for groundnut crop, Bijapur district for sunflower crop and Gulbarga district for pigeon pea and chickpea as these districts have major area in respective crops and these districts are covered under Technology Mission on Oilseeds and Pulses. From each district one taluk having highest area was selected. From each selected taluk, three villages were selected and in each village ten beneficiaries and ten non-beneficiaries were selected which makes a total sample size of 240 sample farmers.

Time series data on area, production and productivity of oilseeds and pulses were obtained from the records of Directorate of Economics and Statistics, government of Karnataka, Bangalore. The present study is confined to the period from 1972-73 to 2009-10 for oilseeds, 1980-81 to 2009-10 for pulses but for sunflower it was from the period 1978-79 to 2009-10. This period was further divided into two sub-periods, as Period –I (1972-73 to 1985-86), Period –II (1986-87 to 2009-10) and overall (1972-73 to 2009-10) for groundnut and total oilseeds. In case of sunflower crop, Period –I (1978-79 to 1985-86), Period-II (1986-87 to 2009-10) and overall period (1978-79 to 2009-10). For pigeon pea, chickpea and total pulses it is divided into Period –I (1980-81 to 1989-90), Period –II (1990-91 to 2009-10) and overall (1980-81 to 2009-10). Period-I represents the Pre-TMOP and Period-II represents the Post TMOP period. Cost of cultivation data on sunflower for northern dry zone (Bijapur), groundnut for central dry zone (Tumkur), pigeon pea for northern eastern dry zone (Gulbarga) and chickpea for northern eastern dry zone (Gulbarga)and Karnataka as a whole for all crops were collected from Karnataka state Department of Agriculture, Bangalore. The data was collected from the period 1980 to 2008 for oilseed and pulse crops. Primary data were obtained for the year 2011-12 from the selected sample famers through personal interview method with the help of pre –tested and structured schedule.

6.4 Analytical Tools and Techniques Employed

Keeping in view the objectives of the study, the following analytical techniques were employed.

In order to analyse the growth rates in area, production and productivity of major oilseed and pulse crops, total oilseeds and total pulses in each selected district and the state as a whole, the exponential growth function was used. Tabular analysis was done to analyze the impact of Technology Mission on oilseeds and pulses economy. Primary data from farmers were used to obtain meaningful results on impact of Technology Mission on their crop yield, change in cropping pattern and difference in input usage of beneficiaries and non-beneficiaries. Cost and returns of beneficiaries and non-beneficiaries were analysed by using budgeting technique. In order to analyze the sources of instability in respective crop production, a method developed by Hazell (1982) was adopted. This method uses statistical identities to provide an exact decomposition of the components of change in the variance of oilseeds and pulses production.

The returns to investment was analyzed using Total factor productivity (TFP) approach. Using the elasticity of TFP with respect to investment, the value of marginal product of mission investment was estimated.

6.5 Findings

6.5.1 Growth performance of oilseeds

6.5.1.1 Groundnut

The area of groundnut during the entire period showed positive growth of 0.16 per cent per annum and even the Period-I experienced a positive growth of 0.38 per cent per annum. The Period-II showed decelerating growth of 1.76 per cent per annum. Similar results were observed in most of the districts. In the Overall period, the districts of Bellary, Chitradurga, Dharwad and Tumkur registered positive growth rates, while Belgaum, Bijapur, Gulbarga and Raichur showed just the opposite. During the Period-I, most of the districts experienced positive growth except Belgaum, Bellary, Bijapur and Gulbarga. However, during the Period-II, area under groundnut in all districts showed negative growth.

Groundnut production growth trend was almost similar to that of the area. At the aggregate level, production increased at the rate of 0.17 per cent per annum during the Overall period as against 2.24 per cent per annum during the Period-I. During Period-II, however, production decelerated at 3.63 per cent. The districts of Bijapur, Chitradurga, Dharwad, Gulbarga and Tumkur recorded a positive growth in the Overall period, whereas in remaining districts it was found opposite. During Period-I, the production of groundnut was positive in most of the districts with the exception of Bijapur. However, during Period-II, all the districts experienced negative growth in production of groundnut.

The state recorded negative growth of 0.04 per cent and 1.84 per cent growth in yield levels during Overall period and Period-II respectively. Positive growth rate was recorded during Period-I. The district-wise analysis confirmed that most of the growth rates in Period-I were positive except Tumkur. The positive growth rates observed in most of the districts were transformed to negative growth rates in Period-II barring Bijapur and Gulbarga. During the Overall period, majority of the districts witnessed stagnation in yield levels.

6.5.1.2 Sunflower

The area under sunflower rapidly expanded since its introduction in the early seventies. The expansion was more pronounced during the Period-I (49.38 per cent) as compared to the Period-II (1.42 per cent) at the state level. All the districts experienced highly significant growth varying between 49.72 per cent (Gulbarga district) and 102.01 per cent (Dharwad district) except Tumkur which experienced negative growth. However, the growth rate during Period-II declined drastically in most of the districts.

The growth performance of sunflower production followed a trend similar to that of its area at aggregate and disaggregate levels in all the study periods. During Period-I, the state registered a growth of 38.18 per cent per annum but declined to 1.46 per cent during Period-II. Inspite of the decline in yield levels over time, the overall production performance of sunflower across the districts was encouraging. However, the rapid rise in production during Period-I was not continued in Period-II mainly due to deceleration in yield growth.

The results of growth analysis of sunflower yield highlighted that there was a significant decrease in yield levels during the two periods and the Overall period at the state as well as at the districts. The deceleration was more pronounced in Period-I as compared to Period-II as in Period-II marginal positive growth rate was seen. An exception to this was Belgaum, Gulbarga and Tumkur districts, which recorded significant positive growth during Period-II.

6.5.1.3 Total oilseeds

The area under total oilseeds showed positive growth during the Overall period in the state though it was negative in Period-II. All the districts witnessed significant increase in total oilseeds area during the Overall period. The period-wise analysis revealed that Bellary, Bijapur, Chitradurga and Raichur districts experienced a significant increase in area of total oilseeds during Period-I although the main oilseeds producing districts of Gulbarga and Tumkur had stagnated area unlike that of Belgaum and Dharwad which recorded a significant decrease in its area. During Period-II, most of the districts showed declining growth.

The state registered a positive growth in total oilseeds production during the Overall and the Period-I though there was a negative growth in the second period. Similar results were observed in all the districts except Belgaum and Bijapur which had negative and positive growth rates respectively during Period-II. The state as well as most of the districts recorded increase in yield during Period –I. However Period-II and Overall period were characterized by deterioration in yield levels.

6.5.2 Growth performance of pulses

6.5.2.1 Redgram

The results of growth analysis of pigeon pea area revealed that there was a significant increase in area in the state as well as in most of the districts in all the periods. Production of pigeon pea expanded at aggregate level in all the three periods mainly due to expansion in area and partly due to increase in yield levels. Belgaum, Bijapur, Dharwad and Raichur recorded declined growth during Period-I, whereas Bellary showed positive significant growth during same period. The trend reversed during Period-II and Overall period where in Bellary experienced negative growth in production.

The growth analysis of pigeon pea yield revealed that during the entire period the state and the districts of Bijapur, Dharwad, Gulbarga and Mysore recorded positive growth rates. During Period-I, both at the aggregate level and disaggregate level growth rates were found to be negative except Gulbarga. In the second period however, the state as well as well as all districts exhibited positive growth except Belgaum which showed negative growth.

6.5.2.2 Chickpea

The area of chickpea growth during the entire period showed positive growth of 6.00 per cent per annum and even the Period-I and Period –II experienced a positive growth of 6.33 per cent and 6.62 per cent, respectively. Similar results were observed in all the districts. Chickpea production growth trend was almost similar to that of the area. At the aggregate level, production increased at the rate of 7.15 per cent per annum during the Overall period as against 2.77 and 8.75 per cent per annum during the Period-I and Period-II respectively. The districts of Belgaum, Bellary and Mysore recorded negative growth during the Period-I. During Period-II and Overall period all the districts showed positive growth in production.

The state recorded positive growth of 1.39 per cent and 2.08 per cent growth in yield levels during Overall period and Period-II respectively. Negative growth rate was recorded during Period-I. The district-wise analysis confirmed that in all districts the growth rates in Period-I were negative. The negative growth rates observed in all the districts were transformed to positive growth rates in Period-II. During the Overall period, majority of the districts witnessed positive yield levels except Raichur.

6.5.2.3 Total pulses

The area under total pulses showed positive growth during the Overall period in the state. All the districts witnessed significant increase in total pulses area during the Overall period. The period-wise analysis revealed that Bellary, Bidar, Bijapur, Gulbarga, Dharwad and Raichur districts experienced a significant increase in area of total pulses during Period-I except districts of Belgaum and Mysore. During Period-II, all the districts showed positive growth.

The state registered a positive growth in total pulses production in all the three periods. The state as well as all most of the districts recorded increase in yield during Period –I. District wise analysis showed that the districts of Belgaum, Mysore and Raichur showed negative growth during Period-I and Overall period whereas during Period-II all districts showed positive growth. The state as well as most of the districts recorded increase in yield during Period –II and Overall period. However, during Period-I was characterized by deterioration in yield levels.

6.5.3 Impact of Technology Mission on Oilseeds and Pulses economy

6.5.3.1 Impact of Technology Mission on Oilseeds on oilseeds economy

6.5.3.1.1 Groundnut growers

The average age of beneficiaries was 46.45 years and that of non-beneficiaries was 47.88 years. It was observed that majority of the sample farmers both beneficiaries (80.00 per cent) and non-beneficiaries (63.33 per cent) were literate and in both the cases the main occupation was agriculture. The average size of the family of both beneficiaries and non- beneficiaries was about five members. The average size of the land holding was 2.97 ha, for beneficiaries and 7.85 ha for non-beneficiaries respectively. Average area under groundnut cultivation by beneficiaries and non-beneficiaries was 1.53 ha and 1.12 ha respectively. All beneficiaries used hybrid seeds for cultivation of groundnut whereas more than 70 per cent non-beneficiaries used local seeds. Hence, there exists yield difference between them.

In *Kharif* season, groundnut occupied 44.44 per cent and 38.62 per cent of the gross cropped area of beneficiary farms and non-beneficiary farms respectively. Cereals occupied major share in area among non-beneficiaries (21.70 per cent) whereas the total area covered under pulses was more with 27.00 per cent on beneficiaries farms as against 25.10 per cent in case of non-beneficiaries. Similarly, the area covered under oilseeds was more with 44.40 per cent on beneficiaries farms as against only 38.60 per cent in case of non- beneficiaries. The area covered under horticultural and plantation crops were also relatively more and accounted 11.04 per cent and 14.40 per cent in case of of non- beneficiaries and of beneficiaries, respectively. The cropping intensity was also found to be relatively high on beneficiary farms (147.47 per cent) compared to non-beneficiary farms (146.0 per cent).

The quantities of inputs utilized were more in case of beneficiaries in all the major inputs like seeds, labour, organic manure, chemical fertilizers and PPC in case of groundnut crop. As a result the output obtained by beneficiaries (27.2 quintals) per hectare of groundnut cultivation was more than that of non-beneficiaries (21.8 quintals).

The total variable costs incurred on groundnut was more on the beneficiaries farms compared to those on the non- beneficiaries farms. The gross return among beneficiary farms per hectare for ground nut (₹ 98958.6) was significantly more than non-beneficiary farms (₹ 78333.85), with higher net income and profit per rupee of cost on beneficiary farms when compared to non-beneficiary farms.

6.5.3.1.2 Sunflower growers

The beneficiaries were younger compared to non-beneficiaries. It could be observed that non-beneficiaries had less number of years of schooling than beneficiaries and in both the cases the main occupation of them was agriculture. The average size of the family was about six of both beneficiaries and non-beneficiaries and average land holding of beneficiaries was 3.39 ha and it was 3.42 ha in the case of non- beneficiaries. Both the group had no irrigation facility and operated under rainfed condition. Sunflower was the major oilseed crop cultivated in the study area by beneficiaries and non-beneficiaries was 1.51 ha and 1.21 ha respectively. The sunflower hybrids grown by the beneficiaries were ITC (30.0%), DSH-1 (20.0%), Mahyco (36.67%) and KBSH-22(13.33%), whereas the non-beneficiaries had grown more of Local (60.0%) hybrids.

In beneficiary and non- beneficiary farms the major crops grown during *Kharif* season were sunflower followed by onion, green gram, bajra and pigeon pea. During *Rabi* season jowar followed by chickpea and wheat. The area under sunflower was more in case of beneficiaries than non-beneficiaries. Similarly, both in *Kharif* and *Rabi* season the area under all crops was more in beneficiary farms than non-beneficiary. The cropping intensity was also found to be relatively high on beneficiary farms (152.50%) compared to non-beneficiary farms (145.91%).

More quantity of inputs and labours were used among the beneficiaries as against non-beneficiaries. The output obtained by beneficiaries (21.45 quintals) for per hectare of sunflower cultivation was more than that of non-beneficiaries (17.07 quintals). The cost of sunflower cultivation on beneficiary farms (₹ 55114.3 per hectare) was more when compared to that on non-beneficiaries farms (₹ 49381.03per hectare). The per hectare variable cost in cultivation of sunflower on beneficiary farms (₹ 46313.08) was higher as compared to that on non- beneficiary farms (₹ 40663.13). The gross return among beneficiary farms per hectare for sunflower (₹ 91166.35) was more than non-beneficiary farms (₹ 71685.45), with higher net income and profit per rupee of cost on beneficiary farms when compared to non-beneficiary farms.

6.5.3.2 Impact of Technology Mission on Oilseeds and Pulses on pulses economy

6.5.3.2.1 Pigeon pea growers

The average age of beneficiaries was 41.9 years and that of non-beneficiaries was 45.9 years. About 96.66 per cent of the beneficiaries were illiterates and remaining were found literate. While, around 10 per cent of non- beneficiaries were in the illiterate group. The average size of the family of both beneficiaries and non- beneficiaries was about five members. The average size of the land holding was 6.21 ha, for beneficiaries and 5.69 ha for non-beneficiaries respectively. Pigeon pea was the major pulse crop grown in the study area as average area allocated for the pigeon pea was 1.80 ha in case of beneficiaries and 1.45 ha for non- beneficiaries. All beneficiaries used hybrid seeds for cultivation of pigeon pea whereas more than 60 per cent non-beneficiaries used local seeds.

In *Kharif* season, pigeon pea occupied 19.40 per cent and 17.75 per cent of the gross cropped area of beneficiary farms and non-beneficiary farms respectively. The total area covered under pulses was more with 47.56 per cent on beneficiaries farms as against 44.67 per cent in case of non- beneficiaries. The cropping intensity was also found to be relatively high on beneficiary farms (149.44 per cent) compared to non-beneficiary farms (143.59 per cent). More quantities of inputs and labours are utilized among the beneficiaries as against non-beneficiaries. The output obtained by beneficiaries (12.8 quintals) for per hectare of pigeon pea cultivation was more than that of non-beneficiaries (10.63 quintals).

The total variable cost incurred on pigeon pea was more on the beneficiaries farms compared to those on the non- beneficiaries farms. The gross return among beneficiary farms per hectare for pigeon pea (₹ 62555.9) was significantly more than non-beneficiary farms (₹ 51162.5), with higher net income and profit per rupee of cost on beneficiary farms when compared to non-beneficiary farms.

6.5.3.2.2 Chickpea growers

The beneficiaries were younger compared to non-beneficiaries. Majority of the sample farmers both beneficiaries (83.33%) and non-beneficiaries (93.33%) were literate and in both the cases the main occupation of them was agriculture. The average size of the family was about five to six of both beneficiaries and non-beneficiaries and average land holding of beneficiaries was 6.13 ha and it was 5.96 ha in the case of non- beneficiaries. Chickpea was the major pulse crop cultivated in the study area by beneficiaries and non- beneficiaries was 1.91 ha and 1.69 ha respectively. The chickpea varieties grown by the beneficiaries in the study area were A-I (50.0%), GBS-962 (23.33%) and ICCV-10 (26.67%) whereas the non- beneficiaries grown more of Local (66.67%) varieties.

Major crops grown during *Kharif* season were green gram, redgram, cotton, chilli and bajra in beneficiary and non- beneficiary farms whereas during *Rabi* season chickpea, jowar and sunflower were grown. The area under chickpea was more in case of beneficiaries than non- beneficiaries. Similarly, both in *Kharif* and *Rabi* season the area under all crops was more in beneficiary farms than non-beneficiary.

More quantities of inputs and labours are utilized among the beneficiaries as against non-beneficiaries. The output obtained by beneficiaries (10.9 quintals) for per hectare of chickpea cultivation was more than that of non-beneficiaries (8.92 quintals). The cost of chickpea cultivation on beneficiary farms (₹ 41525.68 per hectare) was more when compared to that on non-beneficiaries farms (₹ 40370.93 per hectare). The per hectare variable cost in cultivation of chickpea on beneficiary farms (₹ 33421.65) was higher as compared to that on non- beneficiary farms (₹ 32279.35). The gross return among beneficiary farms per hectare for chickpea (₹ 56963.08) was more than non-beneficiary farms (₹ 45292.4), with higher net income and profit per rupee of cost on beneficiary farms when compared to non-beneficiary farms.

6.5.4 Instability in oilseeds and pulses production

6.5.4.1 Instability in oilseeds production

6.5.4.1.1 Groundnut

The change in mean area accounted for 57.25 per cent of the increased average production of groundnut between the two periods followed by change in mean yield (29.17 percent). In the district of Belgaum, Bellary, Chitradurga, Raichur and Tumkur change in mean area was found to be the major component responsible for increased groundnut production whereas in the district of Bijapur, Dharwad and Gulbarga districts, the reverse was true. Most of the districts contributed positively to the state average production of groundnut barring Belgaum, Bellary and Chitradurga. However, the major contribution came from the districts in the category 'Others' (101.09 per cent).

The change in area yield covariance contributed the major share (39.66 per cent) towards destabilizing the production of groundnut in the state. Change in area variance (23.71 per cent), was the second largest component showing destabilizing effect in the groundnut production in the state. It was observed that all the components of change showed destabilizing effect towards production of groundnut but change in mean yield showed stabilizing effect. The production of groundnut was relatively stable in the districts of Bellary and Raichur.

6.5.4.1.2 Sunflower

The change in mean area contributed as high as 151.94 per cent to the increased average production of sunflower, whereas, covariance between yield and area contributed only 2.17 per cent. The disaggregate level analysis indicated that Tumkur and the districts in the category of 'Others' were found to be responsible for contributing 8.79 and 70.05 per cent of the increase in average production of sunflower at the state level. In Tumkur and Raichur districts the change in mean yield was the major component responsible for increased production of sunflower. In Bellary district, interaction between mean area and yield was the major component responsible for increased production of sunflower.

Sunflower in the state was destabilized mainly due to interaction between changes in mean yield and area variance (91.28 per cent). Change in mean area constituted the second largest component (78.34 per cent). Similarly, Interaction between changes in mean area and yield covariance, Interaction between changes in mean yield and mean area and Change in area yield covariance registered 31.18, 3.12 and 2.13 per cent of instability in sunflower production respectively. Production of sunflower was stabilized in the districts of Belgaum, Bellary,Dharwad, Raichur and Tumkur.

6.5.4.1.3 Total oilseeds

Change in mean area (62.21 per cent) was responsible for the increased average production of total oilseeds between the two periods in the state. The change in mean yield was the second largest contributor (23.85 per cent) to the increase in average production. The change in mean yield was the major contributor to the change in average total oilseeds production in the districts of Bellary, Chitradurga and Raichur. The change in covariance between yield and area contributed negligibly to the change in average production whereas the interaction term contributed positively in all districts to the change in average production.

The production of total oilseeds in the state was destabilized mainly due to the interaction between changes in mean area and yield variance (199.60 per cent). The second important source of instability was found to be the change in yield variance. The change in mean area, change in mean yield, change in area variance, interaction between changes in mean yield and mean area and interaction between changes in mean yield and area variance showed stabilizing effect.

The instability of total oilseeds production was found to be highest in Dharwad (52.57 per cent) and 'Others' districts (205.08 per cent). Production of total oilseeds was stabilized in Belgaum, Chitradurga, Raichur and Tumkur. This stabilization phenomenon was mainly due to the reduction in change in mean area, change in mean yield, change in area variance, interaction between changes in mean yield and mean area and interaction between changes in mean yield and area variance.

6.5.4.2 Instability in pulses production

6.5.4.2.1 Pigeon pea

The change in mean area accounted for 72.37 per cent of the increased average production of pigeon pea followed by change in mean yield (14.67 percent). In most of the district change in mean area was found to be the major component responsible for increased pigeon pea production. The interaction term between mean area and mean yield and covariance between area and yield were negligible in all the districts as compared to the major components in each district. Most of the districts contributed positively to the state average production of pigeon pea between the two periods except Belgaum, Bellary, Mysore and Raichur. However, the major contribution came from the districts in the category 'Others' (111.48 per cent).

Change in area yield covariance contributed the major share (46.92 per cent) towards destabilizing the production of pigeon pea in the state. Change in yield variance (15.63 per cent), was the second largest component showing destabilizing effect. The production of pigeon pea was relatively stable in the districts of Dharwad, Gulbarga and 'Others'. The stabilization in Dharwad was due to the interaction between changes in mean area and yield covariance whereas, Gulbarga and 'Others' districts. Bidar district was the major source of increased instability in the pigeon pea production.

6.5.4.2.2 Chickpea

The change in mean area contributed as high as 151.94 per cent to the increased average production of chickpea, whereas, change in mean yield contributed only 3.17 per cent. Belgaum and the districts in the category of 'Others' were found to be responsible for contributing 4.94 and 81.53 per cent of the increase in average production of chickpea at the state level. All the study districts showed increase in mean area except Bidar and Raichur during Period-II and hence contributed positive to mean production. In Belgaum and Raichur districts the covariance between area and yield was the major component responsible for increased production of chickpea.

Production of chickpea in the state was destabilized mainly due to change in area variance accounted for 38.50 per cent. Interaction between changes in mean area and yield covariance constituted the second largest component (29.39 per cent). Among the major components of change, change in mean yield and interaction between changes in mean yield and mean area contributed to stability of chickpea production in the state. Chickpea production was stabilized in the districts of Bellary, Bijapur and Gulbarga.

6.5.4.2.3 Total pulses

Change in mean area (66.09 per cent) was responsible for the increased average production of total pulses. The change in mean yield was the second largest contributor (25.05 per cent) to the increase in average production. The change in mean yield was the major contributor to the change in average total pulses production in the districts of Bellary, Dharwad and Raichur. The change in covariance between yield and area and the interaction term contributed negligibly to the change in average production in all districts to the change in average production compared to other two important components.

The production of total pulses in the state was destabilized mainly due to the change in area yield covariance (35.77 per cent). The second important source of instability in production of total pulses in the state was found to be the change in area variance. Change in residuals (-12.38 per cent) is the only component which absorbed most of the source of stability in total pulses production in the state though it is an unimportant source from the view of stabilization policy measures. Further, the results revealed that instability of total pulses production was found to be highest in Dharwad (95.81 per cent) and 'Others' districts (158.35 per cent). The major source was change in mean area for these districts. In Gulbarga and Bidar districts production of total pulses was destabilized mainly due to change in mean yield respectively. Production of total pulses was stabilized in Bijapur, Dharwad and Raichur.

6.5.5 Returns to investment on Technology Mission on Oilseeds and Pulses

6.5.5.1 TFP Growth by crops at selected districts and at state level

The growth in output and TFP of groundnut was positive in all periods under study both in Tumkur and Karnataka except in Period-II in Karnataka. TFP has contributed about 71 per cent and 84 per cent in Tumkur district and state as a whole respectively. The results of sunflower production in Bijapur district indicates that technology has not played much role. With respect to sunflower production in Karnataka use of inputs seems to be relatively high. As for pigeon pea, except during Period-I in Gulbarga district output growth was mainly driven by technology both in Gulbarga and Karnataka. In case of chickpea output growth was mainly contributed by inputs during Period-I in both Gulbarga district and state as a whole. Overall TFP has contributed 38 per cent in Karnataka state as a whole.

6.5.5.2 Returns to Investment on Technology Mission on Oilseeds and Pulses

The investments in oilseeds need to be increased by 20.66 per cent for groundnut and 33.78 per cent for sunflower to achieve 1 per cent growth in TFP. For pulses investments need to be increased by 22.83 per cent for pigeon pea and 36.10 per cent for chickpea.

6.5.5.3 Value of Marginal Product

Groundnut and pigeon pea generated more than ₹ 1 for the additional investment of one rupee whereas the sunflower and chickpea the value of marginal product is less than one indicating that investment on these commodities has not been generating enough output.

6.5.5.4 Internal Rate of Return

The overall internal rate of return was 31 per cent for groundnut, 22 per cent for sunflower crop, 28 per cent for pigeon pea and 18 per cent for chickpea crop.

6.6 Policy implications

Based on the findings of the investigation, the following policies are suggested for improving the oilseeds and pulses economy of Karnataka.

1. It was observed that the area, production and yield of groundnut and total oilseeds showed negative growth during Period-II in all the study districts and the state as a whole and that of sunflower too was not encouraging. Hence, efforts should be made to increase area and yield in oilseeds for sustainable production of oilseeds in the state. This can be achieved by arranging timely supply of location specific varieties released by Agricultural Universities like, GPBD-4 during *Kharif* for zone-8 which is resistant to tikka, leaf spot and leaf rust diseases and TAG-24 under irrigated conditions during summer and sunflower hybrids like, KBSH-44 for Southern, Central, Eastern Dry and Southern Transitional Zones and RSFH-1 for Zone-1 and similar technologies developed by various other research institutions and organisations through the concerned extension agencies and Agriculture Department.
2. A substantial growth in production of pigeon pea, chickpea and total pulses was observed both in the study districts as well as at the state level during the entire study period, which was mainly due to area expansion rather than increase in yield. The major factors contributed for reduction in yield was adoption of local varieties by the majority of the farmers, which are prone to high pest and disease incidence. Hence, extension agency should make concerted efforts to educate the farmers regarding use of suitable improved varieties like BRG-1, BRG-2, ICP-7035, ICP-87119, WRP-1 in pigeon pea and JG-11, ICCV-2 ,ICCV-10 ,ICCV-2 (kabuli), BGD-103 for chickpea and also for adoption of improved technologies like proper mix of NPK and use of sulphur and IPM technologies.
3. Another factor that hindered oilseeds and pulses production in the study area was cultivation of these crops mainly under rainfed situation. Due to erratic behaviour of rainfall in general and during recent decade in particular in the study area, the crops suffered for want of required moisture during their critical growth stages. Efforts should be made to educate the farmers to provide protective irrigation during critical growth stages of these crops wherever possible and also to grow drought tolerant varieties for sustainable production of these crops.
4. The additional cost incurred by the TMOP beneficiary farmers was relatively higher than their non-beneficiary counterparts in cultivation of groundnut, sunflower, pigeon pea and chickpea,

which was mainly due to timely supply of crucial inputs under the scheme and also use of recommended quantity of these inputs and taking up all operations timely (labour cost) as per the knowledge gained by the beneficiary farmers during field demonstrations and capacity building activities taken up under the scheme. Hence efforts should be made to create awareness among the non-beneficiary farmers about the benefits of use of critical inputs and adoption of appropriate technologies in cultivation of oilseeds and pulses to attain sustainable growth over the years in the study districts as well as in the state.

5. It was observed that in the production of major oilseeds and pulses selected for the study showed that the sources of instability between the two periods were the synchronized movements in area and yield. Hence, measures such as support prices, irrigation facilities and yield risk minimizing practices have to be taken up in order to narrow down the fluctuations in area and yield in these crops.

6. The analysis of Returns on Investment (ROI) in the scheme under study revealed that a high Marginal Internal Rate of Return (MIRR) in groundnut, pigeon pea, sunflower and chickpea in that order showed that the investment in the scheme like Technology Mission on Oilseeds and Pulses was found to be profitable. Hence, investments should be encouraged in such schemes in the state for achieving sustainable production growth in oilseeds and pulses,

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Appendix I: Interview schedule

Beneficiary / non-beneficiary

Impact Assessment of Technology Mission on Oilseeds and Pulses in Karnataka

I. General Information:

1. Name of the respondent:

   Village:

   Taluk :

   District:

Main occupation:

Subsidiary occupation:

a. Dairy B. Poultry c. Business D. Others if any, (Specify) _________

2 .Family composition:

Sl. No.	Name	Sex	Age	Education	Whether engaged in farming
1.					
2.					
3.					
4.					
5.					
6.					

2. Land holdings (Acre):

Sl. No.	Types of land	owned	Leased in	Leased out	Total
1.	Dry				
2.	Irrigated				
3.	Total				

3. Source of irrigation

Sl. No.	Source	Area irrigated (acre)
1.	Open well	
2.	Bore well	
3.	Canal	
4.	Tank	
5.	Others if any	

5. Cropping pattern (2011-2012)

Season	Crops / variety	Area(Acres)		Yield/acre(qtls)		Total quantity produced(qtls)		
		Dry	Irrigated	Dry	Irrigated	Dry	Irrigated	Total
Kharif								
1								
2								
3								
4								
5								
Rabi								
1								
2								
3								
4								
5								
Summer								
1								
2								
3								
4								
5								

7. Asset position

Types of assets	Nos	Year of purchase/ Construction	Purchase/ Construction Value(Rs)	Junk value	Expected life span
Building					
Bullock cart					
Livestock					
Tractor					
Implements					
1. Pumpset					
2. irrigation equipments					
3. Others					
(i)					
(ii)					

II. 1. Mass media exposure

Sl.No.	Mass media use	Frequency of use (Mark √)		
		Regular	Occasionally	Never
1	News paper reading			
2	Listen to radio programme			
3	Reading farm magazines/extension leaflets/any other literatures relating to agriculture			
4	Watching TV programmes relating to agriculture			

4. Contact with extension agencies

Sl.No.	Agencies	Frequency of use (Mark √)		
		Regular	Occasionally	Never
1	ADA			
2	AO/AAO			
3	AHO			
4	Village assistant			
5	Bank assistant			
6	RSK			

5. Exposures to extension education methods

Sl. No.	Name of the extension method	Frequency (Mark √)			Availed information was specific to crop? (Yes/No)	Participation was part of TMOP programme? (Yes/No) (This column is for beneficiary)
		Regularly	Occasionally	Never		
1	Krishimela					
2	Demonstration					
3	Training programme					
4	Group meetings					
5	Field days					
6	Field visits					
7	Exhibitions					
8	Film shows					
9	Farmers interaction					
10	SHG meetings					
11	Tours					
12	Others (if any)					

III. Details of cost of cultivation of crop

Crop: _______________ Variety:_______________ Area(acres):_________

Season:___________ Dry:____________ if irrigated, Source of irrigation:_

A. Farm operations and labour applied(per acre)									
Sl. No.	Particulars of the operations	No. of times	Family			Hired			Machine labour(hired)
			M	W	BP	M	W	BP	
1	Ploughing								
2	Transportation of FYM								
3	Spreading of FYM								
4	Harrowing								
5	Application of fertilizers								
6	Seed treatment								
7	Sowing								
8	Irrigation								
9	Inter cultivation								
10	Weeding								
11	Plant protection chemicals								
12	Watch and ward								
13	Harvesting								
14	Transportation and marketing								
15	Miscellaneous								
	Total (A)								
Wages rate per day: Men: ______;Women: ________;BP:______ ;Machine Labour:________									

B. Inputs used in production:

Sl. No.	Inputs	Quantity	Rate (Rs.)	Amount (Rs.)
1	Seeds			
2	Manures /FYM			
3	Chemical fertilizers			
i				
ii				
iii				
iv				
4	Bio fertilizers			
i				
ii				
iii				
5	Plant protection chemicals			
i				
ii				
iii				
6	Bio pesticides			
i				
ii				
7	Weedicides			
i				
ii				

C .Others

Sl .No	Inputs	Quantity	Rate (Rs.)	Amount (Rs.)
1	Irrigation			
2	Electricity charges			
3	Land revenue/ rent			
4	Maintenance of machinery			
5	Interest on borrowed funds			

D. Gross returns from crops: __________

Sl .No	Crop	Area (acre)	Production	Price	Total returns(Rs.)
1	Main product				
2	By product				

E. Marketing / Disposal pattern

Month of sale	Quantity retained for			Place of sale	To whom sold	Quantity sold(qtls)	Price (Rs)	Total amount (Rs)
	Consumption	Seed	Kind of payment					

II. Adoption of recommended practices in the cultivation of selected crop:_________

Sl. No.	Practices / Technology	Adopted	Partially adopted	Not adopted
1	Summer ploughing			
2	Seed used: Local/ HYV/IV/C/UC			
3	Sources of seed: trader/Own/ KSSC/ Agril. Dept./ others (Specify)			
4	Seed treatment			
5	Time of Sowing			
6	Method of Sowing: Drill sowing/ others			
7	Spacing			
8	Group approach to get seeds from government Department			
9	Purchasesd seeds in subsidy			
10	Irrigation management			
11	Timely weeding			
12	Plant protection			
13	Right time of harvesting			

IV= Improved variety C=Certified UC=Uncertified

Technological gap of interventions

Sl. No.	Name of the practice	Recommended	Adopted	Discrepancies	Reasons
1	Variety for planting				
2	Seed rate				
3	FYM /Compost rate				
4	Rate of application fertilizers				
a	N				
b	P_2O_5				
c	K_2O				
5	Type and rate of application biofertlizers				
6	Irrigation schedule				
7	Intercultivation				
8	PPC				
9	Weedicides				

General opinion of the farmers about TMOP

Sl. No.	Aspects	Yes/ No	Reasons
1	Do you know the TMOP programme fully?		
2	Do you know how much each person is entitled to?		
3	Do you get assistance for seeds/machines/micronutrients in time?		
4	Is there increase in the knowledge level about the farming?		
5	Have you obtained subsidies on fertilizers?		
6	Is there any improvement in the technology pertaining to farming?		
7	Have you adopted POP's completely?		
8	Is there increase in the knowledge level regarding pests, diseases and nutrient management?		
9	Is there increase in the knowledge level about farm machinery?		
10	Is there any distribution of sprinkler sets/pipes?		

IMPACT ASSESSMENT OF TECHNOLOGY MISSION ON OILSEEDS AND PULSES IN KARNATAKA

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ABSTRACT

The present study was conducted to examine the impact of Technology Mission on Oilseeds and Pulses in Karnataka. Karnataka state was selected as it is one of the major oilseeds and pulses growing state in the country and covered under Technology Mission on Oilseeds and Pulses scheme. Secondary data was collected from DES, Bangalore and Department of Agriculture, Bangalore. Multistage sampling technique was adopted for selection of the sample farmers. Primary data were obtained for the year 2011-12 from the selected sample farmers with the help of pre–tested and well structured schedule. The analytical tools employed were compound growth rate, tabular analysis, budgetting technique, Hazell's Decomposition analysis and Total Factor Productivity analysis.

The growth in area, production and yield was positive during Pre TMO in oilseeds whereas negative growth was observed during Post TMO period. The growth in area, production and yield was positive both during Pre TMOP and Post TMOP in pulses. In selected oilseeds and pulses costs, net returns and gross returns were more in beneficiaries as compared to non-beneficiaries. The change in mean area was the major contributor for increased average production in both oilseeds and pulses. Synchronized movements in area and yield contributed for instability in oilseeds and pulses. Technology has played an important role in groundnut and pigeon pea production whereas in sunflower and chickpea input was the major contributor for output growth. Overall internal rate of return was 31 per cent for groundnut, 22 per cent for sunflower crop, 28 per cent for pigeon pea and 18 per cent for chickpea crop showing that investment on oilseeds and pulses during the past 23 years and 19 years respectively has provided attractive returns.