

PRODUCTION, TRADE COMPETITIVENESS AND VARIETAL
TRAIT PREFERENCES IN CHICKPEA IN KARNATAKA-AN
ECONOMIC ANALYSIS

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INTRODUCTION

Chickpea is known in India since ancient times. It is said to be one of the oldest pulses known and cultivated in Asia and Europe. According to Aykroid and Doughty (1964), the centre of origin of chickpea is stated to be eastern Mediterranean region, but its probable place of origin lies in South Western Asia, *i.e.* countries lying to North-West of India such as Afghanistan. According to De Candolle, the fact that gram has a Sanskrit name “Chanaka” which indicates that the crop was under cultivation in India longer than any other country in the world.

Chickpea is an important pulse crop in India belongs to *Leguminosae* family. It is also known as Garbanzo beans. Chickpea is a rich source of high quality protein. There are two commercial types of Chickpea, namely, *Desi and Kabuli*, which are divided according to seed colour, size and geographic origin. The *Kabuli* types have bigger seed; are of Mediterranean and Middle Eastern origin. The type chickpea is mainly cultivated in India; has a smaller seed and is of Indian origin. *Desi* chickpea accounts for about 85 per cent of world production while, *Kabuli* chickpea accounts for about 15 per cent of the production.

Chickpea is an important legume that plays a significant role in the food and nutritional security of people in the developing countries contributing to protein intake, particularly for the vegetarian population. Chickpea can be consumed in various forms – raw, roasted boiled and further processed as flour and decorticated splits (dhal). It has been well recognized as a valuable source of protein particularly in India, where a majority of the population is vegetarian and depends on the low priced food for meeting its dietary requirements. It is consumed as a dry pulse, after cooking, germination, soaking or fermentation or as a green vegetable. It is also used for the preparation of various sweets and spicy dishes where the split halves or flour is used.

Sprouted seeds are recommended for curing scurvy. Malic and Oxalic acids collected from green leaves are prescribed for intestinal disorders. Gram seeds contain a higher percentage of oil (4-5%) than other pulses. It is consumed in different forms all over the country and thus, forms an important component of Indian diet.

Further, being a leguminous crop it contributes towards improving soil fertility by fixing atmospheric nitrogen into the soil. This property has an added benefit to farmers by saving external applications of nitrogenous fertilizers and in turn reduces cost of production and thus is an environment friendly crop.

South and Southeast Asia region contributes about 81 per cent to the global chickpea production, with India as the principal chickpea producing country (84% share in the region). The chickpea area marginally increased from 6.4 million ha to 9.19 million ha during the period 2000-01 to 2010-11. However, the production increased substantially from 5.47 to 8.22 million tonne due to the increase in grain yields from 853 kg/ha to 895 kg/ha.

India occupies the first position in the world in terms of chickpea area (9.18 m.ha.) and production (8.22 m.t.) during 2010-11 accounting for nearly 30.9 per cent and 39.9 per cent of total pulses area and production, respectively. The largest chickpea producing state in the country is Madhya Pradesh followed by Uttar Pradesh, Maharastra, Andhra Pradesh, Karnataka, Rajasthan and Haryana.

Chickpea is well adapted to the drier parts of the brown and dark brown soil zones. Chickpea do not tolerate poorly drained or saline soils. Crop is widely grown in Indian sub-continent which accounts for almost 90percent of the world's crop. Trade in chickpea is relatively robust and has been growing over time. The growth in chickpea exports for eleven years period from 2000-01 to 2010-11 was 4.31 per cent annually. Both the *desi* and *Kabuli* types of chickpea are traded in the international market. The *desi* type accounts for approximately 80 per cent of the total trade in chickpea. The *Kabuli* type commands a higher price owing to larger seed size compared to the *desi* type. Australia, Myanmar, Tanzania Republic, Iran and Turkey are the largest exporters of chickpea. India is by far the largest importer accounting for over a quarter of global imports and 40 per cent of Asia's imports.

Myanmar and Tanzania Republic are major suppliers of both the types of chickpea to Indian market, each supplying about one-third of India's pea imports. Most *Kabuli* chickpeas come from Mexico, Australia, Canada, Turkey and Iran. Import of pulses generally increased over the period between 1991 and 2007. Volume of import has increased from 3.13 lakh tonne to 27.91 lakh tonne during the above said period. There have some sudden hike in the quantum of imports that appeared

during the years of 1997, 2001, 2005 and 2006. However, in value terms the import of pulses increased continuously in most of the years.

Chickpea is the major pulse crop in Karnataka state and occupies a prominent place in the economy of the farmers in recent years, particularly in the rain-fed eco-system. However its area and production are fluctuating year after year due to high incidence of pest and diseases, rain fed condition and fluctuating market prices. Farmers do not get remunerative price for their produce commensurate with high cost of cultivation. Annigeri-1 being the old/ruling variety spread on a large area across districts in the state and for long the farmers are cultivating this variety in the absence of alternative improved cultivars. The lower productivity of chickpea is due to non-availability of suitable improved cultivars particularly drought tolerant one as chickpea production is largely confined to rain fed areas, non-adoption of proper production technologies, severe incidence of pests and diseases, non-remunerative market prices, lack of area under irrigation and its cultivation mainly as a mixed crop and prominently under rain fed conditions. Marketing facilities available to this crop are reportedly not efficient. Thus, both production and marketing of chickpea are associated with the various technological and economic constraints, thus hindering the adoption of chickpea production technologies. In the case of *Kabuli* variety, low yield, high pest and high disease incidence and long duration were the major constraints for large scale adoption of these varieties by farmers. Therefore, the present study was taken up to understand the importance of chickpea in the prevailing cropping systems and various other issues related to technology uptake, production by farmers including constraints hindering the adoption of improved chickpea cultivars in the selected districts of Karnataka state. The specific objectives of the study are;

Objectives

1. To study the growth and instability in area, production and productivity of chickpea in India.
2. To analyze India's import and export performance of chickpea
3. To study the impact of varietal interventions on area allocation, productivity and income of chickpea growers in the study area.
4. To assess the costs, returns and resource use efficiency in chickpea production in the study area.
5. To identify farmers' preferred traits in chickpea varieties and constraints in its production and marketing.

Hypotheses

1. There is a significant growth in area, production and productivity of chickpea in major chickpea producing states and in the selected study districts.
2. There is a significant growth in import and export trade of chickpea in India
3. Intervention of new chickpea varieties lead to increased adoption by farmers and results in increased productivity and income among the farmers.
4. The resource use in chickpea production is inefficient.
5. Farmers' have varied trait preferences in the new chickpea varieties and have many constraints in the production and marketing of the crop.

Limitation of the study

The analysis of direction of trade with respect to Indian chickpea export to other countries was not attempted as there was no consistency in the countries having import trade relationship with India over time. This could be due to the fact that India is a net importer of chickpea and its exports are limited and possibly during surplus production conditions.

REVIEW OF LITERATURE

A review of past research helps in identifying the conceptual and methodological issues relevant to the study. This will enable the researcher to collect relevant data and subject them to sound reasoning and meaningful interpretation. This chapter attempts a brief review of the relevant research literature related to the present study. Keeping in view, the objectives of the study the reviews are presented under the following headings.

- 2.1 Growth and instability in area, production and productivity
- 2.2 Import and export performance
- 2.3 Impact of varietal interventions on area allocation, productivity and income
- 2.4 Cost and returns in the cultivation
- 2.5 Resource use efficiency
- 2.6 Constraints in production and marketing
- 2.7 preferred traits production and marketing

2.1 Growth and instability in area, production and productivity

Gangawar and Pandey (1982) have analyzed the area, production and yield trends of pulses during the last decade (1970-71 to 1980-81) in India. They argued that to improve pulses production in India. Effort must be made to develop drought and disease resistance varieties with high yield potential. They showed that per capita consumption of pulses has been decreasing over the years in India largely because of ever increasing population.

Rajpurohit (1983) compared the growth rates of agricultural production in Karnataka for the period 1956 – 82. Author observed that there had been a major set back in the productivity of rice in the in the period 1976 – 77 and 1981 - 82 and expressed fears of the new varieties not being stable and their vulnerability to pest was high. In contrast to this, Ragi and pulses were observed to have made major break through. Ragi recorded high growth with stability. Pulses showed a moderate growth in productivity as compared to stagnation prior to 1975.

Chatham and Singh (1986) found that growth rate of area under pulses was significantly negative and that of oilseeds though positive but not significant in Punjab. They opined that risk in productivity and price did not significantly affect the area under pulses. While in the case of oilseeds the variance in productivity had a significant effect on area.

George and Mukharjee (1986) analyzed the changes in the growth pattern of rice in Kerala over and across time period (prior to the mid 1970's and since) seasons (autumn, winter and summer) and space (major rice growing districts). The growth rates of area, yield and production indicated considerable variations across districts, over season and over time. The fall in growth rate of production was the maximum during summer.

Bisaliah and Patil (1987) studied the trends of major crops in Karnataka. They found that ragi (finger millet), bajra (pearl millet) and pulses experienced higher output growth rate whereas, rice and sorghum had recorded lower growth during the period 1966-67 to 1977-78. Area-cum-productivity led output growth during pre-green revolution period in the case of sorghum, ragi, rice and bajra had shifted to productivity led growth during the green revolution period. They concluded that productivity increase had contributed substantially to the growth of agriculture performance of Karnataka, which was higher than the all India performance.

Acharya (1993) studied the compound growth rates of pulses in India for different periods namely pre-green revolution period (1950-51 to 1964-65), Green revolution period (1966-67 to 1980-81) and post-green revolution period (1981-82 to 1990-91). During 1950-51 to 64-65, the area, production and productivity of total pulses have registered a growth rate of 1.77, 0.40 and 2.19 per cent per annum respectively while during 1966-67 to 1980-81, pulses were pushed to marginal lands as irrigated and fertile lands got diverted to wheat and paddy where the increased prices made these crops more profitable as a result area and yield of pulses declined considerably. The per cent per annum during 1981-82 to 1990-91. This happened due to improvement in the yield per hectare.

Choudhari *et al.* (1993) in their study on growth rate in area, production, productivity of grains in Bihar indicating that the growth in area (-4.62%) and production (-3.32%) were negative, while in productivity it was positive (1.67) and significant.

Singh *et al.* (1993) studied the growth trend of area, production and productivity of cotton in India. They found that cotton area in India increased by about 49 per cent during the last four decades. Similarly, production increased by 315 per cent in the year 1989-90, indicating that the increase in the cotton production was more on account of increased productivity rather than increase in cotton acreage alone.

Tripathy (1993) examined the temporal and spatial variations in the growth rates of area, yield and production of major crops in Orissa state and overall for India during two periods *i.e.*, 1970-71 to 1979-80 and 1980-81 to 1989-90. Semi-logarithmic trend equations were fitted to the annual time series data to obtain compound growth rates. It was found that food grain production in the State increased at the rate of 2.21 per cent per year during the period and the major contribution was from maize (6.8) followed by pulses (6.81%), jowar and bajra (5.06%) and ragi (3.63%).

Hiremath *et al.* (1994) studied the growth rates in area, production and productivity of important pulse crops in Karnataka for the period 1984-85 to 1993-94 for important pulse crops. The annual growth rate in area under red gram decreased steadily (0.067%) over the period from 1984 to 1994 where as in other pulse crops it increased. The area under black gram (5.4%) and Bengal gram (1.12%), with respect to production, black gram registered a higher growth rate (5.50%) followed by green gram (4.9%) 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.

Shankaran (1994) worked out the compound growth rate of area, yield and production of sorghum at all-India level by classifying the study period into pre-green revolution (1950-51 to 1964-65) and post-green revolution (1967-68 to 1992-93) periods. In the first sub-period both area and yield of sorghum have increased at the rate of 0.91 per cent and 2.2 per cent per annum, respectively which led to a 2.9 per cent per annum increase in the production of the crop. The result further revealed that the area of sorghum declined by 0.94 per cent per annum during the post-green revolution period, whereas productivity grew to the tune of 1.84 per cent, which offset the decline in area and ultimately the rate of growth in production of sorghum was 1.2 per cent per annum. Considering the entire period (1950-51 to 1992-93), the author reported that although the area under sorghum declined by 0.47 per cent per annum the yield and production increased at the rate of 1.51 per cent and 1.27 per cent per annum, respectively.

Goswami *et al.* (1995) made an attempt to analyze the compound growth rates of area, yield and production of total pulses, gram and tur. The compound growth rate of area of total pulses and 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 of area of tur to the extent 2.28 per cent was noticed in Phase-III. The growth rate of total pulses and gram was found to be 1.04 and 1.03 per cent in Phase-III. While growth rate of yield of tur was negative both in Phase-I and Phase-III. Higher compound growth rate of production to the extent of 2.19 and 2.66 per cent in the case of total compound growth rate in production of tur was noticed in Phase-III. Increase in area contributed for higher growth rate in production of total pulses and gram for Phase-I while increase in yield was responsible in growth in production in Phase-III.

Hiremath *et al.* (1996) studied the growth rates in area, production and productivity of important pulse crops in Karnataka for the period 1984-85 to 1993-94 for important pulse crops. The 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.

Rajang (1996) studied the compound growth rates of 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 were examined for 24 years in two periods *i.e.*, early period of green revolution (1974-84) and later period of green revolution (1984-1994). 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 gram also witnessed negative growth rate (-3.3%), but the rate of decline showed down during early 1990s. It was finally concluded that in spite of negative growth rates in area under major pulse crops the area under total pulses showed positive growth rate

in both the zones, indicating an increase in area under minor pulse like green gram and black gram which have been adopted as *kharif* and *summer* crops in the project area.

Singh (1996) studied the growth trend for four major pulse crops in four regions of Uttar Pradesh. The growth rates were calculated with the help of simple regression equation with the time of trend as the sole explanatory variable of the four regions. 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 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%/annual) for green gram.

Vani and Vasulu (1996) studied the growth rates for three important cereal crops in Karnataka, namely rice, Jowar and Ragi in the three sub-periods 1955-56 to 1964-65, 1965-66 to 1979-80 and 1980-81 to 1989-90. The results indicated that, in the case of rice there was a positive growth rate in the production and yield over the entire period and a negative growth rate in area. In the case of ragi, the growth rate of production was higher than that of rice. A positive growth rate in area and production over the entire period with the highest growth in the second sub period was reported. In the case of jowar, there was a high growth rate in area and production in most of the districts. Productivity in most of the districts was high in the second period compared to the first and third sub periods.

Dhindsa and Anjusharma (1997) made an attempt to study the compound growth rates of area, production and productivity of pulses in Punjab for the period 1996-97 to 1991-92. The negative growth of production of pulses can be mainly attributed to a decline in area and stagnancy in the yield of various pulse crops. Gram has shown decline in its area and production in most of the regions. The area under moong crop has shown a very high growth rate of 13.79 per cent per annum during 1966-92 in Punjab state as a whole. The yield has also shown significant positive rates of growth in two regions of the state.

Kandarapa Kumar Barman (1997) studied the compound growth rates of area, production and productivity of pulses in Assam for them period 1967-68 to 1989-90. It was found that the compound growth rates of production of gram, Tur, 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 production of pigeon pea was found to be the highest but its yield growth rate was negative being -0.51 per cent per annum. The growth rates of area under different pulses turn out to be positive in the case of Assam and these are much higher than the corresponding growth rates in the case of India. He concluded that on production front, special efforts should be made to generate and transfer appropriate technology for dry farming and limited irrigated agriculture.

Savant (1997) studied the growth performance of India's agriculture sector during different periods. Compound annual growth rates were estimated by fitting a log-liner trend function, for two periods *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 (1.00% during period – II). The former was the outcome of low pace of expansion in area accompanied by decline in the yield per hectare of pulses, while, in the post 1981 period expansion in pulses output was totally induced by growth in their yield per hectare (growth rate of 1.00%). The dismal performance of the two major pulses, namely, gram and Tur, was largely responsible for low level of productivity growth for all pulses after 1981. By and large, however pulses represented a group of growing crops throughout green revolution period.

Raghuwanshi *et al.* (2001) conducted a study to evaluate the growth performance of chickpea production in Bundelkhand region of Madhya Pradesh during 1970–71 to 1994–95. The findings of the study revealed that all the districts of the region experienced positive growth rates of area, production and productivity of chickpea during the reference period. Tikamgarh district showed higher growth rate under area of chickpea while Datia district ranked first in growth of yield. Coefficient of variation analysis indicated that variability was highest in production and it was due to increased yield variability associated with nominal acreage variability of chickpea crop. Efforts should be made for both increasing and stabilizing yield. Results of the component analysis showed that yield was the major contributor in production than the area in Datia and Tikamgarh district.

Karan Singh *et al.* (2004) revealed that rice and wheat have come to contribute around three-fourth of India's food grains production in 2000, up from just one- half in 1950; with the food grains production itself having increased by four times from 50 million tonne in 1950 to 200 million tones

2000. Punjab has been known for wheat production since long. Its productivity increased by more than 5 times in five decades (1950-2000), area by 3 times and production by more than 15 times. Its productivity continues to increase at the growth rate of more than 2 per cent. Its yield variability across districts has declined over time.

Kalankar (2004) conducted the study on growth of value of crop output in Maharashtra. The study revealed that maize crop recorded significant and highest growth rate of 6.31 per cent per annum followed by sugar cane, gram, paddy and cotton.

Naik (2007) studied growth performance of underutilized millets in Karnataka. The growth in savi area was negative and significant for Dharwad district (-1.934%) and the state (-5.620%) as a whole. Accordingly, the production of savi also showed declining trend for both sample district and state. For state as well as district, the growth rate of foxtail millets area (-8.922%) and production (-8.462%) showed significant declining trend, while growth rate of foxtail millet productivity (0.396%) was found to be positive and statistically significant.

Dhakre and Sharma (2009) conducted a study on growth and instability of Ginger production in North-eastern region. The study revealed that north-eastern region had showed significant growth in production (26.72%) and productivity (6.77%) under crops. In the case of area growth, it was positive (11.91%) but not significant. During the period 1992-93 to 2004-05, coefficient of variation of North-Eastern region as a whole recorded instability in area, production and productivity as 204.20, 10.46 and 29.43 per cent respectively, thus area variation has more influence on production fluctuation in the states.

Preema Borkar *et al.* (2010) examined the growth rates and extent of variability in area, production and productivity of cotton in Vidarbha region of Maharashtra state. The Vidarbha region of Maharashtra state constituting of two divisions *i.e.*, Amravathi and Nagpur region, were purposefully selected. The study was based on secondary data collected from various government publications and pertained to a period of 26 years from 1980-81 to 2005-06. To estimate the growth rate of area, production and productivity of cotton, the period was grouped into, *i.e.*, Period-I (1980-81 to 1992-93) and Period-II (1993-94 to 2005-06). From this study it is concluded that, the Vidarbha agriculture has observed definite change in the cropping pattern. Soyabean attained important position in the cropping in both divisions. The magnitude of variability in area and production is observed to be small in Nagpur division whereas, productivity has been comparatively small in Amravathi division. The proportion of area under cotton in *Kharif* in total cropped area has reduced in both divisions. The growth rate of area and yield has decreased in period II in both the divisions.

Sunit Kumar *et al.* (2010) conducted a study on pulses on account of their vital role in nutritional security and soil ameliorative properties and that have been an integral part of sustainable agriculture since ages. However the production of pulses in Uttarakhand had drastically come down in the period, 1990-91 to 2007-08. The pulses data of Government of Uttarakhand, directorate of Agriculture, 2008, showed that the winter pulses (lentil and chickpea) area declined in this period by 5 thousand hectare. The Production has declined up to 5.78 and 1.41 thousand metric tonne in lentil and chickpea, respectively. The productivity has declined (-2.19 qt/ha) in chickpea and (-2.15 qt/ha) in lentil. In rainy legumes, the area, production and productivity of pigeon pea has remained almost static while, in black gram the production and productivity showed positive trend due to increase in area during the period 1990-91 to 2007-08.

2.2 Import and export performance

Gemtessa (1991) analyzed the direction of trade using the Markov chain model. The share of Ethiopian coffee exports to USA had drastically declined during the period from 1979 to 1989. The loss in the export shares of Ethiopian coffee to USA, France, USSR and other countries were directed to erstwhile West Germany. The study revealed that the Ethiopian coffee exports to Japan, France and Italy had moderately increased. But the share of Saudi Arabia remained stagnant. It was predicted that the market share of Ethiopian coffee exports to West Germany increase to 32 per cent by 2000 AD mainly because of their preference for Ethiopian mild coffee.

Jeromi and Ramanathan (1993) reported that there were significant changes in the direction of pepper exports from India during the period from 1975 to 1990. It was observed that nearly 44 per cent of India's pepper exports were directed to former USSR which constituted about 82 per cent of the total pepper import of that country. On the other hand, India not only failed to increase its exports to USA in tandem with increased consumption in that country, but also could not sustain the quantity

exported in the past years. Instability of exports was lower in the case of former USSR, Italy and Canada and higher for Poland, USA and Czechoslovakia.

Veena *et al.* (1994) examined the changing directions of Indian coffee exports in terms of importing country shares over the period from 1965 to 1990 using Markov chain analysis. It was observed that India could not retain her previous market share to USA, Netherlands, Yugoslavia and other importers. However, the actual quantities exported to all these countries have increased which was due to increased quantity of Indian coffee exports. India retained her market share to former West Germany, erstwhile USSR and Italy. The increased market share of the USSR in the seventies and eighties was then threatened by the economic and political upheaval in the region.

Murthy and Subrahmanyam (1999) measured the dynamics of changes in the exports of onion from India to different countries with the help of a Markov chain model. From one step transitional probabilities, the model was extended to n-step for future forecasting. The results have shown that Malaysia, United Arab Emirates (UAE) and Singapore were having high probability of retention and would continue to be the major importers in future also. As revealed by the low values of probability of retention, Saudi Arabia and others were unstable importers of Indian onion. In the next decade, Sri Lanka and Bangladesh would increase their imports from India though it may come at the cost of UAE. The exports of onion from India would increase to 5.06 lakh tones by 2004-05 AD.

Ananthi (2000) analyzed the direction of trade of basmati and non-basmati rice in India using Markov chain analysis. The study period was 1987-88 to 1998-99. The results indicated that countries such as Saudi Arabia, UAE and UK showed the probability of getting more share of import at the cost of countries such as Bahrain, Kuwait and USA. In the case of non-basmati rice all the major countries which import Indian rice would lose their share and the probability of the minor countries importing at present may be dominant over the other countries.

Shivaraya (2000) studied the changes in trade directions of export of selected vegetables using Markov chain analysis. The results revealed that UAE and Malaysia were the loyal markets for Indian onion. In the case of potato, Sri Lanka and Nepal were found to be the most loyal markets, whereas, Bangladesh and Nepal were the most stable importers of Indian fresh tomatoes.

Hugar (2002) studied the changes in the share of exports of onion from India to different countries. He used the Markov model with first order finite Markov chain property to analyze the export shares by countries and forecast the export of onion, which follows stochastic process. The share of export of onion to a particular country at time t was considered as a random variable. Minimum absolute deviations estimation procedure was used to estimate the transition probabilities P_{ij} i.e. probability of share of export to j^{th} country from i^{th} country. Using this one step transition probability, shares of major importers of onion from India were compared with observed export shares. One step and five step transition probabilities were also found to predict the export shares of countries for one year and five years after the base year. The results indicated that Malaysia and UAE were loyal markets of onion export from India.

Rajesh *et al.* (2002) studied the direction of trade of major spices from India during pre liberalization period (1981-82 to 1990-91) and post-liberalization period (1991-92 to 2000-01). The results showed that USA had a high retention power (i.e. 0.8083) in pre liberalization period for pepper compared to post liberalization period (0.3188). Japan and Saudi Arabia had high transition probability values of 0.5500 and 0.4921 respectively in retaining cardamom export from India during pre liberalization period. Pakistan, Bangladesh and Saudi Arabia had a retention power in ginger trade during post liberalization period with transition probability values of 0.6387, 0.5032 and 0.5488, respectively.

Nisha (2004) studied the export potential and direction of exports of Indian groundnut. The results of Markov chain indicated that exports were likely to be concentrated in Indonesia and Malaysia. She also studied the size, composition and direction of exports in addition to sanitary and phytosanitary measures stipulated by different countries.

Mahadevaiah *et al.* (2005) studied the changing pattern of raw cotton exports from India during pre-reforms period (1981-82 to 1990-91) and post-reforms period (1991-92 to 1998-99) using Markov Chain model. The transition probability matrix estimated for both the periods showed that China was the only stable importer of Indian cotton with retention probability values of 0.0832 and 0.3155 during pre and post reforms periods, respectively. The other traditional importing countries such as Bangladesh, Germany, Indonesia, UK, Japan and Korea.

Savadatti (2006) studied the export behaviour of basmati rice using annual time series data covering the period from 1980-81 to 2000-01. The direction of trade and the changes in exports were analyzed using Markov Chain Model. She reported that Indian basmati rice exports would be concentrated in Saudi Arabia and Kuwait in future. Saudi Arabia was one of the stable importers as it reflected high probability of retention at 0.90.

Pramod *et al.* (2007) analyzed the changing direction of Indian mango exports using Markov chain. It revealed that the USA, UAE and Bangladesh were stable markets for Indian mango while, UK and Saudi Arabia were unstable markets. The increasing share of other countries showed the need to explore and exploit the market potential of other countries.

Yeladhalli and Vilas (2009) studied on direction of trade and export competitiveness of onion. Markov chain analysis has been employed to ascertain the direction of trade through transitional probability matrix. The study revealed that Malaysia had shown the increasing trend while, UAE had shown a declining trend. UAE and Sri Lanka have been very loyal markets for Indian onion.

2.3 Impact of varietal interventions on area allocation, productivity and income

Nanjareddy *et al.* (1990) studied the economics of producing hybrid and local tomato varieties for 1988-89, in Bangalore district. They found that most of the inputs used in the cultivation of hybrid tomatoes were higher than those of local varieties except seeds and bullock labour. Their average total variable cost per acre in the case of hybrid tomato (Rs. 14,006.55) was about 250 per cent higher than that of local varieties (Rs. 4,109.63). The average labour required per acre in the case of hybrid tomato (313.21 man days) was about 180 per cent higher than that of local variety (112.55 man days). The total cost of production of hybrid tomatoes (Rs. 23,364) per acre was about 290 per cent higher than that of local tomato (Rs. 7,894.42). Yield and gross income per acre of hybrid tomatoes was (259.92 qtl and Rs. 45,778.22) about 225 per cent and 400 per cent higher than that of local variety (79.40 qtl. and Rs. 9,131). The net gain per acre from the production of hybrid tomatoes over local tomatoes was Rs. 21,181.64.

Umesh and Bisaliah (1991) compared the relative efficiency of different varieties of groundnut over the seasons and regions in Karnataka using frontier profit function. Both TMV- 2 and SP-I varieties recorded a higher level of efficiency. Sample farmers of Chitradurga district showed higher efficiency during both *kharif* and summer when compared to their counterparts in Dharwad district. Among different production inputs, labour was used more efficiently. However, between the seasons its efficiency was higher during *kharif* season.

Amarendar (2010) conducted a study on pulses production technology: status and a forward study revealed that India is the largest producer and consumer of pulses in the world. However, pulses production has been stagnant at between 11 and 14 million tonne over the last two decades. Per capita pulses consumption over the years had come down from 61 gm/day in 1951 to 30 gm/day in 2008. This paper analyses the status of pulses production technology, constraints in cultivation of pulses and the possibilities of increasing production. It emphasizes the expansion of area under short duration varieties, development of multiple disease/pest resistance varieties, use of micro-nutrients like zinc and sulphur and increase in area under *rabi* pulse crops to increase pulses production.

Birthal *et al.* (2011) conducted a study on an economic assessment of the potential benefits of breeding for drought tolerant in crops: a case of groundnut in India. This report provides estimates of the potential benefits from the adoption of an improved drought-tolerant groundnut variety ICGV - 91114 in Anantapur district of Andhra Pradesh. A new drought-tolerant groundnut variety ICGV-91114, developed by ICRISAT Hyderabad, was found a suitable alternative to TMV 2 through farmer-participatory varietal selection trials. At the farm level, adoption of ICGV-91114 has a pod yield advantage of 23%, reduces yield variability by 30% and generates 36% higher net income compared to TMV 2. Its adoption in 35% of the 0.8 million ha under groundnut in Anantapur by 2020-21 was likely to generate a surplus of Rs. 694 million a year; of which 65% would accrue due to higher yield and 35% due to reduction in yield variability. Despite a reduction in yield advantage (30%) and variance, the benefits remain huge. Small farmers being more risk averse than other farmers could benefit more from the adoption of improved drought-tolerant varieties.

Macharia *et al.* (2012) assessed the potential economic and poverty impact of 11 improved chickpea varieties released by the national agricultural research organization of Ethiopia in collaboration with the International Crops Research Institute for the Semi-Arid Tropics. The economic

surplus model applied quantified a total benefit of US\$ 111 million for 30 years. Of this, consumers were to get 39% of the benefit and producers 61%. The benefit-cost ratio was estimated at 5:1 and an internal rate of return of 55%, indicating that the investment was profitable. The generated benefit was expected to lift more than 0.7 million people (both producers and consumers) out of poverty. Thus, further investments in the chickpea and other legume research in Ethiopia is justified as a means of poverty alleviation.

2.4 Cost and returns in the cultivation of chickpea

Singh *et al.* (1987) conducted a study in Sultanpur district of Uttar Pradesh in order to compute the cost of production and profitability in paddy on different farm sizes. The cost of cultivation per ha of paddy was Rs. 2657.50 which varied from Rs. 2407.14 on marginal farms to Rs. 3116.50 on large farms. The use of higher quantities of resources by large farms resulted in higher yield and higher value of output per hectare of paddy. The average net income was Rs. 544.11 per hectare which increased with an increase in the size of holdings. They opined that higher expenditure incurred by large farmers by way of using modern farm inputs such as fertilizers, irrigation, plant protection chemicals and hired human labour resulted in higher production, productivity and income on these farms as compared to small and marginal farms.

Chahal and Chahal (1989) studied the economics of irrigated crops in Punjab and concluded that the variable costs per hectare were highest for paddy followed by maize, sugarcane, wheat, cotton and groundnut. While, the gross returns to fixed resources were maximum for sugarcane followed by wheat, paddy, cotton, groundnut and maize. Among the crop combinations, the annual returns to fixed farm resources were highest for sugarcane followed by paddy-wheat, cotton-wheat, groundnut-wheat and maize-wheat. The returns to fixed farm resources per unit of irrigation were the lowest for paddy-wheat combination followed by cotton-wheat, sugarcane and maize-wheat. They concluded that cotton and groundnut should be encouraged in their respective farming areas, as their returns per unit of irrigation were higher than sugarcane.

Mohandas and Thomas (1997) studied the economics of rice production in Kuttanad area of Kerala. They reported that cost of cultivation of paddy for state was Rs. 13, 108.05 for marginal farmers (Class I), Rs. 13, 309.72 for small farmers (Class II) and Rs. 13, 858.13 for large farmers (Class III). Rental value of own land recorded the highest expenditure in Class I and Class II which accounted for 24.19 per cent (Rs. 3, 171.30) and 22.38 per cent (Rs. 3, 112) respectively. However, the item of highest expenditure was fertilizer in Class III which came to 22.39 per cent (Rs. 3,100.75) of the total cost. Gross return was highest for marginal farmers (Rs. 15,857.45) followed by small farmers (Rs. 15,560) and large farmers (Rs. 15,387.50). The net return and input-output ratio was also found to be highest in marginal farmers (Rs. 2748.95 and Rs. 1.21) followed by small farmers (Rs. 2250.28 and 1.17) and large farmers (Rs. 1529.37 Rs. 1.11).

Yerriswamy (1999) studied the economics of selected agricultural system in Tungabhadra project area, Karnataka. He reported that cost of cultivation for *Kharif* paddy was Rs. 20,475 for Ancient Irrigated Agricultural System (AIAS), Rs. 24,242.04 for Highly Intensive Agricultural System (HIAS) and Rs. 21,381.17 for Semi Intensive Agricultural System (SIAS). Whereas in *rabi/summer* the cost of cultivation was Rs. 18, 222.97 for AIAS and Rs. 23,143. 35 for HIAS which were lower compared to *kharif* paddy. The gross returns were found to be higher in HIAS for *rabi/summer* (Rs. 44,845.54) and it was Rs. 41,063.75 for AIAS which were higher than *kharif* crop. The benefit-cost ratio in HIAS *rabi/summer* paddy was 2.25 and it was 1.81 for HIAS.

Mundinamani and Kunnal (2000) found that the average total cost of cultivation per hectare of cotton was Rs. 9,460.23 of which the variable cost was Rs. 7,674.89, accounting for 81.12 per cent of the total cost of cultivation. The share of the fixed cost in total cost of cultivation was Rs. 1,176.64 accounting for 18.88 per cent. The gross returns per hectare of cotton cultivation were Rs. 12,844.30 and gross returns per quintal of cotton were Rs. 1,597.55. The net returns obtained over total costs were Rs. 2,442.45 per hectare and Rs. 303.78 per quintal of cotton.

Singh and Singh (2000) estimated the cost and returns of rice in different ecosystems *viz.*, rain-fed upland (RU), rain-fed lowland (RL), irrigated with high yielding varieties (IHVV), Deepwater rice (DR) and boro-rice (BR) in India. The cost of cultivation (Cost C) per hectare was highest on IHVV farms (Rs. 12111.04), which was slightly higher than BR farms (Rs. 12104.98) with lowest on DR farms (Rs. 5165.21). When total cost was divided into factors of production, it was found that hired human labour along with imputed value of land jointly contributed to more than 50 per cent of the factor cost under all the rice ecosystems. The study also revealed that net profit was much higher on

BR farms (Rs. 3615 per ha.) than IHVY farms (Rs. 3329 per ha.) owing mainly to significantly higher yields on BR farms (6.43 t/ha) compared to IHVY (3.9 t/ha). In conclusion, the study reported that future food needs of the eastern India could be successfully met by extending the area under boro rice wherever possible.

Krishna (2001) worked out the costs and returns of paddy cultivation in Kerala through a sample of 100 farmers for the year 2000-2001. Major portion of the total cost of cultivation was attributed to human labour, which amounted for 61.46 per cent of total cost. Net return per hectare was Rs. 5955.68. The findings further confirmed the trend in changes in cropping pattern. Area under cereals dropped by 34 per cent during 1982-83 to 2001-02 periods mainly due to the reduction in paddy area, which was converted for other profitable crops.

Rajendraprasad *et al.* (2001) conducted a study on costs and returns in cotton production vis-à-vis its competing crops in Guntur district and reported that the per hectare expenditure on PPCs in cotton was Rs. 11,331.37. This was very high compared to Rs. 4,217.92 in soybean-bengal gram cropping system, Rs. 4,379.81 in soybean-red gram and Rs. 1,334.00 in soybean-Jowar cropping systems. The proportion of expenditure on PPCS in total operational cost was the highest in cotton (41.33%) when compared to soybean-bengal gram (22.3%), soybean-red gram (27.04%) and soybean-Jowar (9.83%). The gross return was also the highest in cotton *i.e.*, Rs. 29884.77 compared to soybean-bengal gram (Rs. 27802.84), soybean-red gram (Rs. 29171.42) and soybean-Jowar (Rs. 2,954.78) whereas net returns were very low in cotton compared to other cropping systems.

Suresh (2001) examined the performance of organic farming in Shindgi district of Karnataka. He reported that the cost of paddy cultivation on organic farm was slightly less (Rs. 8,509.52 per acre) when compared to that on inorganic farms (Rs. 8784 per acre). The gross returns were highest in organic farms (Rs. 17,601.00), while it was Rs. 14,226 per acre for inorganic farming. The net return and B: C ratio was found to be higher in organic farming (Rs. 9,091 per acre and 2.06) than those for inorganic farming 5,441 and 1.61).

Shetty (2002) studied the technical and allocative efficiency of paddy production in Tungabhadra project area. The per hectare cost of paddy cultivation was Rs. 26,192 and Rs. 25,938 in Bellary and Raichur districts, respectively. The variable costs (85%) constituted the major portion of the total cost of cultivation. The expenditure on human labour was found to be the major item of variable cost. The fixed cost per hectare was estimated to be Rs. 33,896 and Rs. 33,746 respectively, for Bellary and Raichur district farmers. Rental value of land formed the major component of fixed cost. The average gross returns realized by farmer in Bellary and Raichur districts for paddy was Rs. 42,842 and Rs. 40,735 per hectare respectively.

Damte *et al.* (2003) conducted the study on costs and returns of wheat, paddy and cotton in Punjab state has increased by 94.13 per cent of Rs. 1,700.34 in 1972-73 to Rs. 3,300.95 in 1982-83. The total cost at current price increased further by 333.71 per cent in 1993-94 over 1982-83 and fixed and variable costs by 439.02 per cent and 267.69 per cent, respectively. Gross returns per hectare at current price from cotton crop increased by 68.40 per cent in 1981-82 over 1971-72 and returns over variable cost by 28.28 per cent. But net returns from cotton have declined by 34.98 per cent over the 1972-73, which was due to drastic decline in the yield of cotton crop in the early eighties.

Radha and Choudhary (2005) conducted a study on costs and returns in cotton seed production vis-à-vis commercial production of cotton in Andhra Pradesh and revealed that per acre total cost of production of cotton seed (Rs. 74,412) was higher than that of commercial cotton production (Rs. 26,461), of which human labour accounted for major share in both cotton seed production (53.86%) as well as commercial cotton production (19.03%). The operational costs of all the items were comparatively higher in seed production (Rs. 68,101/acre) over commercial production (Rs. 16,166/ acre). This was due to the additional operations like gap filling, rouging, emasculation, pollination, *etc.*, involved in cotton seed production. Thus, the operational costs took the major share of 91 per cent in seed production as compared to 61 per cent in commercial production. It revealed that seed production gives positive returns with the cost-benefit ratio of 0.29:1.00 when compared to commercial production (1.00:0.35).

Ramasundaram *et al.* (2005) carried out research on cost of cultivation of hybrid cotton under rain fed and irrigated conditions of central India and hybrid under rain fed conditions of south India and varieties under irrigated condition of north India. Study revealed that the per hectare total cost of cultivation of cotton varieties (Rs. 25,358) was relatively higher in irrigated north India followed by rain fed hybrid cotton of south India (Rs. 22,637), irrigated (Rs. 18,958) and rain fed (Rs. 15,640) hybrids of central India. The variable cost accounted for 83 per cent of the total cost of cultivation of the hybrids

cultivated in rain fed central zone followed by 81 per cent in the South, irrespective of the ecosystem, while it was only 65 per cent for irrigated cotton variety cultivation under northern conditions. The fixed costs for central and south zones varied between 17-22 per cent, while for north it was 35 per cent. The main reason for higher fixed cost was the exorbitant land rent values in the fertile Indo-Gangetic Plains. Plant protection accounted for the major share (19% and 26%) followed by intercultural operation (15.45%) in southern rain fed farm samples and fertilizers and manures (14%) in the case of others. The cost of cultivation per quintal ranged from Rs. 1,541 in irrigated cotton of north to Rs. 2,148 in rain fed central. Though the cost of cultivation increased with irrigation availability, the associated high yields reduced the cost of production. Returns over total cost were the highest in irrigated hybrid (Rs. 10,810) of central India followed by varieties (Rs. 9,025) irrigated of north, rain fed hybrid (Rs. 8,873) of south India and rain fed hybrid (Rs. 4,448) of central India.

Sita Devi and Piñatas (2009) studied on modern rice technologies and its adoption behaviour in Tamil Nadu. The study revealed that the per hectare cost of cultivation was about 10 per cent lower in SRI than the conventional method. Partial budgeting technique was used to work out the cost and returns incurred in paddy farms. The increment in the profit realized in paddy cultivated through SRI method was Rs. 16968 /ha. It was concluded from the partial budgeting analysis that the adoption of SRI technique would provide additional profit to farmers.

Karunakaran (2009) studied socio-economic assessment of groundnut production, farmers technology choice and adoption process. In Tamil Nadu Baseline study report revealed that 90 per cent of ruling varieties were Co2, VRI2, TMV7 and POL2 which were released 1984, 1989, 1967 and 1968, respectively.

2.5 Resource use efficiency

The use of Cobb-Douglas production function in agriculture is well known. This function was used for crops and is popular among agricultural economists. Here, the results of past work on related crops are given which are comparable with the present study.

Srikanthamurthy (1986) studied the productivity of resource use in two major food crops (Ragi and Paddy) in Bangalore district. Cobb-Douglas production function was fitted and the results indicated that marginal farmers used nutrients in excess.

Muralidharan (1987) studied the resource use efficiency in rice production in Kerala, employed the Cobb-Douglas production function. The R^2 was 0.84 indicating that 84 per cent of the variation in yield of paddy is explained by the estimated production function. The coefficient of land and human labour were positive and significant at one per cent probability level.

Naik *et al.* (1998) analyzed the resource use efficiency and productivity of various factors involved in onion production in Dharwad district of Karnataka using Cobb-Douglas production function. They observed that regression coefficients for land and farmyard manure were positive and highly significant.

Veerapur (1999) analyzed resource use efficiency in cotton production in Raichur district by using Cobb-Douglas production function. The regression coefficient of three factors *viz.*, fertilizer, and organic manure and IPM component significantly (at 5%) influenced cotton yield in Raichur district of Karnataka.

Dyamannavar (2000) in his study on economics of gherkin production employed Cobb-Douglas production function. The regression co-efficient of bullock labour (0.2338) and FYM (0.4805) were found to be statistically significant indicating their crucial role in gherkin production. The MVP to MFC ratio was positive in the case of bullock labour, FYM, staking material and seeds. This indicated that there is an opportunity to maximize returns by using more of these resources.

Chulaki (2001) studied the resource use efficiency of different inputs in hybrid seed production using Cobb-Douglas production function. Out of six selected variables in DCH-32, land, fertilizer, irrigation charges and human labour inputs were significant at one per cent level, while, FYM was significant at 5 per cent level of probability in the pooled category of KSSC seed growers and Mahyco seed growers.

Verma (2002) employed Cobb-Douglas production function for evaluating resource use efficiency in onion. The marginal value product of seed, manures and fertilizers, human labour and machine power were (Rs. 0.15, Rs. 1.51, Rs. 0.69 and Rs. 0.28) found to be positive on small farms while, it had negative value on bullock labour, plant protection and irrigation (Rs. -0.13, Rs. -0.49 and

Rs. -0.47), respectively. This implies that in the case of the small farms, seed, manures and fertilizers, human labour and machine power were underutilized and bullock labour, plant protection and irrigation were excessively used on the farms. In the case of large farms, marginal value product of seed, manures and fertilizers, human labour, bullock labour and plant protection were (Rs. 0.80, Rs. 0.34, Rs. 0.18, Rs. 0.01 and Rs. 0.15) positive while, it was negative for machine power and irrigation respectively arrived at Rs. -0.16 and Rs. -0.01 implied that on the large farms seed, manures and fertilizers, human labour, bullock labour and plant protection chemicals were underutilized, while machine power and irrigation were excessively used, indicating the scope for increasing their use up to the optimum level and where the efficiency of the machine power and irrigation use was maximum.

Sunanda and Narendra (2003) studied the resource productivity of Mesta farms in Srikakulam district of Andhra Pradesh, observed that Mesta fiber accounts for 70 per cent of raw jute. The cultivation involves intensive human labour in addition to manures and fertilizers, seed and cattle labour. The Cobb-Douglas production function analysis for these variables indicated constant returns-to-scale on all farm size groups. The marginal value product to opportunity cost ratios for all farm size groups indicated resource use efficiency and revealed the scope of adjustments and reorganization of resources, so as to obtain higher returns in mesta cultivation.

Saikumar (2005) studied the resource use efficiency in different farming systems of three districts of north eastern Karnataka employing the Cobb-Douglas production function. The adjusted R^2 was 0.76, 0.58 and 0.54 for Bidar, Bellary and Raichur districts, respectively, indicating that 76, 58 and 54 per cent of variation in yield was explained by the estimated production functions. The coefficient of cost of seeds and feeds plus concentrates in Bidar, fertilizer plus FYM cost in Bellary and fertilizer plus FYM cost and labour cost in Raichur district were positive and significant at 5 per cent probability level.

Suresh and Reddy (2006) studied the resource use efficiency of paddy cultivation in Peechi command area of Thrissur district of Kerala by using primary data of 71 rice farmers collected through the stratified random sampling method. The cost of cultivation of paddy in the command area was Rs. 21, 603 per ha, resulting in a B: C ratio of 1.34. The elasticity co-efficients were significant and positive for chemical fertilizers, farmyard manure and human labour. The allocative efficiency indicated that the marginal return per rupee increased under these heads would be Rs. 2.83, Rs. 1.57, Rs. 1.17, respectively. The average technical efficiency of the paddy farmer in the command area was found to be 66.8 per cent. Education of the farmer and supplementary irrigation provided during the water-stress days have been identified as the major factors, which could enhance the technical efficiency. The study has called for an equitable distribution of canal water and enhanced extension services for resource management in the area.

Biradar (2007) Studied the resource use efficiency economics of redgram based cropping systems in bidar district study revealed that CS-II (red gram and Bengal gram) are presented in the ratio of MVP to MFC were greater than unity for the human labour (7.218), seeds (25.410), FYM (1.038), phosphorus (5.549), potash (6.748) and PPCs (2.092). The MVP to MFC ratio was less than unity for the resources like bullock labour (0.002) and nitrogen (0.108), whereas, machine labour (-0.348) showed negative MVP: MFC ratio.

Dodamani *et al.* (2009) conducted study on resource use efficiency in organically produced naturally colored cotton under contract farming. The data from 80 farmers contracted for organically cultivating naturally coloured cotton variety DDCC-1 from Upinabetagiri village of Dharwad taluk were collected. The study pertained to the agricultural year 2005-06. The resource use efficiency, estimated using the Cobb Douglas production function, revealed that the inputs land (area under colored cotton) seed, farm yard manure and human labour would improve gross returns if their use was further augmented. Similarly bullock labour, bio pesticides and trichocards would also improve returns but their estimation was not statistically significant. Overall, there was increasing returns to scale but the MVP to MFC ratios indicated that except for bullock labour, all other inputs could be profitably increased.

Mohan (2009) indicated that output elasticities of seed (0.138), human labour (0.148) and IPM component (0.279) had significant influence on the cotton yield in IPM farms. Whereas in non-IPM farmers chemical fertilizer (0.087) and plant protection chemicals (-0.047) found to have significant influence positively and negatively on cotton production in non-IPM farms.

Nethrayini (2010) examined that the Marginal Value Product (MVP) to Marginal Factor Cost (MFC) ratio was greater than unity for human labour (1.79), plant protection chemicals (3.18) and staking materials (2.66) indicating the greater scope for using additional units of these resources to increase gross income from gherkin cultivation. The MVP to MFC ratio was positive but less than unity

for bullock and tractor labour and was negative for seeds and FYM and fertilizers indicating that these inputs were overused.

2.6 Constraints in production and marketing

Anonymous (1986) studied the problems of increasing production of gram in Sriganganagar district of Rajasthan during the year 1984. The constraints noticed were small size of holdings, lack of technological support, very less area under irrigation (only 2.2 per cent of total cropped area of selected holdings) due to better prospects for other crops like wheat, cotton and mustard, lack of fertilizer and pesticide use, certain natural factors like emergence of blight diseases, occurrence of frost, attack of pests like termites and pod borer. The producers suffered more in the case of gram as compared to wheat because of the higher gram price escalations during the successive intervals of its transactions.

Satyanarayana (1988) made an attempt to study the constraints in pulse production in Andhra Pradesh for black gram and green gram. The major constraints noticed were lack of location specific variety, grown varieties were photosensitive and susceptible to diseases, weed menace, cuscuta problem, moisture stress at the terminal phase, severe diseases like powdery mildew, leaf spot and heliothis. These problems have been sought to be met through a variety of measures including development of improved variety and suitable agronomic practices. Andhra Pradesh Agricultural University has identified and developed a number of improved varieties of black gram and green gram suitable for rice fallows. These are LEG-17 (Krishnayya) a powdery mildew disease resistant variety, LEG-402 (Prabhava) / a weed resistant variety in the case of black gram and Lam M-2 in the case of green gram.

Singh *et al.* (1988) listed the major constraints faced in the production of major *rabi* crops (wheat, gram and sugarcane) in Parua-Nala watershed of Madhya Pradesh. It was found that lack of capital at the time of major farm operations was the main constraint and high prices of fertilizers, lack of irrigation facilities, lack of high yielding seed, unavailability of fertilizers, *etc.* were the other constraints for low productivity of major *rabi* crops.

Srivastava *et al.* (1989) conducted a study to identify the constraints in pulse production in Tal area of Bihar. The study indicated lack and inadequate supply of improved seeds as the major problems in the study area. Therefore four distinct components of technological improvements were identified in the study area i.e adoption of improved seeds, ii. seed treatment practices, iii. use of plant protection measures, iv. intensive use of machine labour for different farm operations."

Bhatia (1991) noticed some of the economic constraints which retard the growth of pulses production in India. Some of the important constraints were production under rain fed situation, low yield and value, productivity, higher risk associated with pulse cultivation, low level of technology adoption and susceptibility to pests and diseases. From the point of marketing, the most important problem was the large price spread. To increase the yield per hectare, appropriate measures may have to be taken up for reducing/shifting the risk of adopting new technology through expansion of crop insurance scheme to cover pulse crops. Efforts should also be made to improve the efficiency of marketing so that producers could get their due share in the prices paid by the ultimate consumer.

Gajanana and Subramanyam (1999) studied the main constraints in the production and marketing of anthurium in Karnataka and Kerala. The non-availability of required quantity and quality of planting materials, high cost of seedling, incidence of pest and diseases were the major constraints in the production of the flowers. As regards to marketing, absence of organized market was the major problems followed by non-availability and high cost of transportation. Besides, exploitation by the flower traders in the form of delayed payment and purchases of only quality flowers were the other constraints faced by the growers in marketing of anthurium.

Gowda (2002) in his study on sustainable grape cultivation reported the important constraints in grape marketing as, no fixed price, low price, lack of regulated markets, exploitation by middle men, lack of cold storage facility, no guidance on marketing aspects and lack of transportation facilities. Further, constraints perceived by them in availing credit were non-availability of credit in time and inadequate quantity of credit.

Velavan (2004) observed the major production constraints were poor yield of cashew nuts, because of the old plantation, necessity of financial support. Lack of irrigation facilities and farmers were not able to adopt proper pest control measures due to the high cost of pesticides. Further, he reported that cashew nut in India face severe competition from other surrogate nuts like almonds,

pistachios, hazelnuts, Brazil nuts and macadamia *etc.* In addition to this, India was facing severe competition from the exporting countries like Brazil and Vietnam in exports of cashew nuts, because of devaluation of their currencies, non availability of value added kernels in consumer packets for exports, non-availability of the packing materials in the international standards, inconsistency and the non-uniformity in the quality of kernels for individual brands and the markets. Value added products from the cashew were not available in the exports from India.

Basavaraj and Kunnal (2002) identified the constraints in production, marketing and processing of soybean in Belgaum district. It was observed that severe problems faced by growers were rust disease leading to heavy loss, high labour wages and non-availability of quality seeds in the production front. In marketing, farmers experienced problem of price fluctuation, low price for the produce, problem of transportation and delayed payment of sale when produce was sold to co-operative society. The other problems were inadequate power supply and non-availability of labour at critical times faced by the processor.

Suhasini *et al.* (2009) obtained Garrett scores of chickpea were revealed that high yield (66.2), short duration (55.6), drought resistance (52.8), early maturity (43.4), pest resistance (41.56), fitting into the cropping system (36.83), disease resistance (35.1), improvement of soil fertility (33.7), more recovery or shelling (31.8) to be important traits preferred by farmers in that order. Overall short duration, high yielding, pest and disease resistant and drought resistant varieties are important preferred by farmers, The traits preferred are less cooking time and high keeping quality from consumption view point, Traders considered bigger grain size as preferred trait in the case of Annigeri-1, JG-11 and KAK-2 cultivars, second trait preferred was better taste for *Kabuli* type KAK-2 and pest disease free material for Annigeri-1 variety and JG-11. Processors of chickpea specified that grain should be of bigger size, colour and pest disease free grain were preferred traits. Bigger grain size is preferred as dal obtained will be bold.

2.7 Preferred traits in production and marketing

Frank *et al.* (2000) conducted a study on factors influencing the demand for chickpea in India: implications for marketing and promotion in the Indian chickpea market. This paper described the Indian chickpea market based on the information collected from forty wholesalers, retailers, processors, brokers and commission agents in eight key Indian markets. The main conclusions were that the Indian chickpea market is segmented mainly by the end-use. Australian desi chickpea are perceived as not suitable for consuming as whole or for making roasted chickpea because of their bitter taste. *Desi* chickpeas from Tanzania and Myanmar were considered to have a sweet taste. Australian desi was suitable for making dhal and flour because the bitterness is masked in the cooking. Australian *desi* peas were preferred to local and other imported chickpeas because of their high recovery rate, uniform and large size and low contamination. The size of *kabuli* chickpea was considered very important. Australia's *kabuli* chickpea is smaller than the preferred size.

Wankhade and Deshmukh (2010) carried out the study to assess the preferred trait of pigeonpea production in India. The survey was conducted in district Akola of Maharashtra state. Three treatment villages were selected randomly *i.e.* one from Akola taluka and two from Murtizapur talukas. Thus, the sample sizes of 135 farmers were selected, of which, 90 farmers from adopted village and 45 farmers from control villages. The result of the present study was observed to identify the preferred trait of Maruti, Asha and Ganesh varieties of pigeonpea by using Garrett's ranking technique. Preferred trait observed in pigeonpea production was high yield, drought resistance and short duration. Pigeonpea had preferred trait in consumption also, like better taste, less cooking time and also quantity and durability of fodder in pigeonpea. Because of all these preferred traits pigeonpea is a most important pulse crop in India. Thus, it is suggested that, it is necessary to enhance the area under pigeonpea production.

Egbadzor *et al.* (2012) conducted survey in three southern districts of the Volta Region of Ghana and Agbogbloshie market in Accra to ascertain current production constraints faced by farmers and consumers' desired traits of cowpea. There were two focus group discussions, one in Akatsi and the other at Ketu North District. A total of 180 farmers, 45 food vendors, 30 seed dealers and 80 cowpea traders were interviewed. The interviewees were made up of 226 females and 109 males. Data were classified and analyzed with SAS 9.2. It was realized that most of the cowpea found in the markets at the time of this study were imported from different countries within the West Africa sub-region. Preference for cowpea with cream large seeds which is sweet and easy to cook among Ghanaian consumers has not changed. Constraints to cowpea farming identified were similar to those

known elsewhere: Including insect pests, diseases, drought, *cyperus* spp. as weed and harvesting difficulty.

Peter Andersen (2012) conducted study on challenges for under-utilized crops illustrated by rice bean (*Vigna umbellata*) in India and Nepal. The study concluded that farmers' desired traits were uniform seeds, good yield, resistance to pests and diseases, as well as able to fetch good market prices through attractive appearance, cooking qualities and organoleptic qualities.

Singh *et al.* (2013) conducted study in Uttar Pradesh in order to compute Development and Promotion of an Informal and Formal Seed System Through Farmer Participatory Seed Production of Pigeon pea (*Cajanus cajan* L.). Study revealed that pigeon pea is a major pulse crop in India. However, its productivity, which hovers around 700 kg ha⁻¹, has remained stagnant over the past several decades. Local landraces dominate the cultivation of pigeon pea in the country. A major reason for low productivity in pigeon pea is the non-availability of quality seed of improved varieties to farmers. In this article, we share experiences of farmer-participatory pigeon pea seed production in Fatehpur and Kanpur Dehat districts in Uttar Pradesh in India. Through farmer-participatory varietal selection trials, farmers identified NA-1, long-duration pigeon pea variety and UPAS-120, short-duration variety as their preferred choices. Long-duration variety NA-1 was preferred because of its disease resistance, higher yield, attractive seed size and color. The B:C ratio of seed production of NA-1 variety was 1: 5.19 as compared to 1: 2.53 of the local variety. Village-level seed production not only addressed the issue of shortage of quality seeds but also brought higher incomes to farmers leading to improved livelihood.

METHODOLOGY

The nature and sources of data for the study and the analytical tools employed in the study are presented in this chapter in the following heads.

- 3.1 Description of the study area
- 3.2 Database and sampling procedure
- 3.3 Analytical tools used
 - 3.3.1 Tabular analysis
 - 3.3.2 Compound growth rate
 - 3.3.3 Coefficient of variation
 - 3.3.4 Markov chain analysis
 - 3.3.5 Production function analysis
 - 3.3.6 Output decomposition model
 - 3.3.7 Garrett's score technique
- 3.4 Definition of terms and concepts used in the study

3.1 Description of the study area

Peninsular India has a land mass of 32,00,483 sq km with 15,200 km land frontier. India lies to the north of equator between 8.5^o to 37.6^o north latitude and 68.7^o to 97.25^o east longitudes. India has a varied temperature ranging between 15.7^o C and 35.5^o C. India gets rainfall from both southwest and northeast monsoon ranging from 20 to 80 inches. India's huge agricultural potential is embodied in its size and abundant and diverse natural resources, unlike most parts of the world which have a cold and hostile winter and a relatively small proportion of arable land. Indian cereal and horticultural crops provide another demonstration of her abundance, diversity and opportunity. India's production basket includes variety of cereals, pulses, oil seeds commercial crops, horticulture and other crops.

India occupies the first position in the world in terms of chickpea area (7.1 million hectare) and production (5.75 metric tonne.) during 2004-05 accounting for nearly 30.90 per cent and 39.9 per cent of total pulses area and production, respectively. The largest chickpea producing state in the country is Madhya Pradesh followed by Uttar Pradesh, Maharashtra, Andhra Pradesh and Karnataka. Madhya Pradesh, Rajasthan and Haryana are the main surplus producing states wherein, nearly 37 per cent chickpea production is brought to the wholesale markets for trading.

The geographical area of Karnataka is 190.50 lakh ha, of which, an area of 126.02 lakh ha, comes under the cultivable area constituting 66.15 per cent of the geographical area for the year 2009-10. Out of the total cultivable area, 970 thousand hectares are covered under chickpea cultivation.

In India, Karnataka is fourth largest chickpea growing state next to Madhya Pradesh, Maharashtra. Total area under chickpea in Karnataka was 970 thousand hectare with a production of 570 thousand tonne. The medium rainfall, dry and healthy weather are considered to be the ideal condition for chickpea cultivation. Dharwad and Gulbarga districts of Northern Karnataka have these ideal conditions for successful chickpea cultivation, which are the major Chickpea growing districts, accounting for 71 per cent of total Karnataka's production. In Karnataka, Gulbarga occupies the first position in chickpea area (1.81 lakh ha), production (1.13 lakh tonne), followed by Bijapur, Bidar, Gadag and Dharwad. Hence these districts were selected to collect primary information required for the study.

The study was conducted in Karnataka state, which was one of the important chickpea growing states in the country. Two of the six major chickpea growing districts and representing different agro-ecological situations, namely, Gulbarga and Dharwad districts were selected for the study. These two districts respectively account for 29.67 per cent and 9.35 per cent of the total chickpea area cropped in the state. From either of the selected districts, two major chickpea growing taluks, namely, Navalgund and Dharwad taluks from Dharwad district and Chittapur and Gulbarga taluks from Gulbarga district were chosen for the study. Three villages that were selected at random

from each district are Harobelwadi from Dharwad taluk and Kumargoppa, Shirkol from Navalagunda taluk in Dharwad District and Farhatabad, Kurikota from Gulbarga and Gotur from Chitapur taluk in Gulbarga district. "treatment or adopted villages" by the ICRISAT under the project.

The climate of these districts is generally dry, large variation in the rainfall, from year to year both in amount and in its distribution throughout the season has made this district prone to drought and famine. The average rainfall of these districts is 668.2 mm and minimum and maximum temperature ranges from 14.8^o C to 43^o C. There are two main types of soils namely black and red soil. The average water holding capacity is medium to high. A major portion of these districts is covered by deep black soils which has a greater moisture retention capacity. These soils are slightly alkaline and are poor in organic matter contents.

Gulbarga district is situated in northern part of Karnataka state, it belongs to northern dry zone of Karnataka state. The soils of the district are deep to very deep black, medium black, sandy loam and are light textured soils. The average annual rainfall ranges from 623.1 to 789.6 mm. The total population is 31, 30,982 with literacy percentage of 39.84. The total geographical area of the district is 16, 10,208 ha out of which 11, 57,564 ha is under cultivation.

Among the five taluks, Kalghatagi and Dharwad taluks fall under malnad and semi malnad regions, respectively. While other three taluks namely Hubli, Kundagol and Navalgund fall under dry regions. Average annual rainfall distribution in the district is 772.0 mm. February to May is the summer season. Monsoon prevails between June to September. It gets rain from north-east monsoon in the months of October to November, while winter season prevails between the months of December to February. The district has maximum temperature of 38°C in the months of April to May, whereas minimum temperature of 16°C in the months of December to January.

3.2 Sampling procedure and Database

The primary data generated under Tropical Legumes-II (TL-II) project, entitled "Enhancing Grain Legumes Productivity, Production and Incomes of Poor Farmers in Drought-Prone Areas of Sub-Saharan Africa and South Asia" for chickpea crop in Gulbarga and Dharwad districts of Northern Karnataka were used for evaluating the specific objectives of the present research. The database created through baseline survey before varietal interventions during 2007-08 on the existing cultivation pattern of chickpea crop in the study districts was compared with the information generated after identification of preferred chickpea cultivars through FPVS process. These preferred varieties were intervened through field demonstrations in identified villages of the two districts from 2008-09 onwards. Thus, baseline variables specific to objectives were compared with early adoption data collected during 2009-10. A multistage sampling technique was used to choose the respondents.

3.2.1 Selection of the sample districts

Gulbarga and Dharwad districts were selected in Northern Karnataka for the study under the Tropical Legumes-II research project which was funded by Melinda and Bill Gates foundation. The project was implemented by University of Agricultural Sciences, Dharwad in collaboration with International Crops Research Institute for Semi Arid Tropics (ICRISAT), Hyderabad. The TL-II project focussed mainly to enhance productivity and incomes of farmers producing legumes. Chickpea crop was identified for the state for the purpose of enhancing its productivity through varietal interventions using improved chickpea cultivars as a substitute for Annigeri-1 variety. Annigeri-1 being an old *Desi* cultivar and a ruling variety in the districts and was popularly cultivated by farmers on a large area predominantly as a rain fed crop. This variety also suffers due to low productivity as a result of its susceptibility to wilt and pod borer incidence. In addition to *Desi* types, the districts also have a considerable potential for producing bold and white seeded *Kabuli* type and therefore, the project aimed to popularise the *Kabuli* varieties in these selected districts. In the context of chickpea crop, the TL-II project set the short term objectives in the Phase-I of its three years implementation period (2008-09 to 2010-11) was increase the legume productivity to five per cent, improved varieties to the extent of 10 per cent of cropped area and to bring a gain of more than \$ 75 million.

Hence, these two districts in the state were identified under the project. Of these, Gulbarga district was selected as it occupied a largest area under chickpea in the state. While, Dharwad district was selected as it had a considerable area under chickpea and also has a potential opportunity for area expansion and enhancing its productivity and production both with respect to *Desi* and *Kabuli* types. The details of chickpea area in the selected districts for study are furnished in Table 3.1.

Table 3.1: Chickpea area in the major districts of Karnataka (2004-05 to 2006-07)

District	Gulbarga	Dharwad	State
Year	Area (Ha)	Area (Ha)	Area (Ha)
2004-05	1,24,029	39,111	4,18,000
2005-06	1,12,801	36,568	4,18,000
2006-07	1,47,503	45,060	651000
Average	1,28,111	40,246.33	4,95,666.66
Percentage (%)	24.84	8.11	100

3.2.2 Farmers' Participatory Variety Selection (FPVS) Process

The Tropical Legumes project with an objective to enhance the legumes productivity in the targeted areas, the improved germplasms/cultivars has been introduced through FPVS process. The TL-II project has two components during its implementation stage; the first stage was mainly to identify the best performing varieties to the local conditions through Farmers' Participatory Variety Selection (FPVS) Process by way of conducting mother-baby trials in order to up-scale and prioritize the breeding work in chickpea. Accordingly, mother-baby trials were conducted in the villages of selected districts namely, Dharwad and Gulbarga during *rabi* 2007-08. About 10 improved cultivars were identified (both *Desi* and *Kabuli*) which are suitable to the agro-ecological conditions. While, five mother trials in five selected villages and twelve baby trials in each five selected villages in each district were conducted during *rabi* 2007. The mother trials comprised of eight trial varieties and two check varieties. Of these eight varieties, four improved varieties of *Desi* type with Annigeri-1 (ruling variety) as check and four improved varieties of *kabuli* type with KAK-2 as check in each location. Whereas, each baby trial consisted of two trial varieties and one check variety for comparison. Thus, a total of five mother and 60 baby trials (12 baby trials in each village) in five selected villages were conducted in each of the selected district. The farmers were involved in the selection of varieties based on collective decisions together with scientists considering the performance of varieties in terms of yield, income, resistance to pests and diseases and adoptability to the local production conditions, consumer and traders preferences. This provided an opportunity for the farmers to compare and evaluate selected varieties for later multiplication and adoption on large-scale. The preferred traits in the cultivars by farmers were scored between 1-10 scale and most preferred varieties were identified through this process.

The improved cultivars like JG-11, BGD-103, JAKI-9218 among *Desi* type and BG-1105, MNK-1, KAK-2 among *Kabuli* type were identified by farmers as preferred cultivars in the mother-baby (FPVS) trials in districts which were resistant to biotic and abiotic stresses, fusarium wilt and terminal drought conditions. The varieties included in the mother-baby trials are presented in Table 3.2. The list of villages selected for FPVS trials in the selected districts is furnished in Table 3.3.

Further, these preferred varieties were demonstrated on a large number of farmers' fields from 2008-09 *Rabi* season onwards in the selected villages in the two districts. From among these cultivars, one or two best varieties from the second year demonstrations were further selected based on the preferences of farmers as well as traders for the third year. Breeders took special initiatives for the large-scale multiplication of varieties selected through FPVS to pump them into the seed chain of the chickpea production system in the districts.

These preferred varieties were demonstrated in the farmers' fields by the breeders in the villages of both the districts. A total of 12 villages were identified based on the largest chickpea area in both the districts by the University in collaboration with ICRISAT. Of these villages, six were treated

as adopted villages (three villages in each district) and the remaining six as control villages (three villages in each district). This was mainly to track later on the short-term and long-term impact of the projects' technological interventions in the study districts in the two sets of villages identified as adopted and control villages.

"Adopted Villages" are considered to be those villages where the project activities on varietal interventions are carried out during the project implementation period through varietal demonstrations on preferred chickpea cultivars in the farmers' fields to create awareness among the farmers about improved varieties.

"Control Villages" are considered to be those villages where the project activities on varietal interventions on preferred chickpea cultivars are not carried out during the project implementation but these villages are located nearby the adopted villages and having almost similar agro-ecological situations.

The classification of villages as adopted and control was only for the impact analysis through mid-term/long-term evaluation approaches later-on to estimate the extent of project impact on the spread of technology in those villages where the project intervened (adopted) with improved varieties. Similarly, its impact outside the intervention domain of the control villages by other dissemination processes-formal/informal so as to know the mode of impact and extent of technological spread or otherwise without the project activity in these villages.

3.2.3 Selection of the sample taluks, villages and farmers

Two taluks based on the largest chickpea area under cultivation in each district were identified. In Dharwad district, Dharwad and Navalgund taluks were selected while, in Gulbarga district, Gulbarga and Chittapur taluks were selected for the study. From among the selected taluks in Dharwad district, six villages namely, Harobelawadi and Kabbenu in Dharwad taluk and Kumargoppa, Shirakol, Hansi and Yemanur in Navalgund taluk were selected based on largest chickpea area. Similar criteria was adopted for selecting equal number of villages in the selected taluks of Gulbarga district, From among the taluks selected in Gulbarga district, villages namely, Farhatabad, Kurikota, Bhushangi and Honnakirangi in Gulbarga taluk and Gotur and Bennur in Chittapur taluk were selected. From among these six villages in each district, three villages were identified as adopted for the purpose of initiating technological interventions under the project and another three villages located nearby to the adopted ones having almost similar agro-ecological situations served as control villages. The distribution of sample villages selected and number of sample farmers chosen is furnished in Table 3.4. The same sample farmers were considered for early adoption survey to track varietal adoption and their impact.

In all, 270 farmers spread across two districts belonging to four taluks and 12 villages were chosen based on stratified random sampling technique. Of the 270 sample farmers, 90 farmers from each district at the rate of 30 samples in each of the three adopted villages were selected as "adopted farmers" thereby, total adopted sample constituted 180 farmers for both the districts together. Another 45 farmers in each district at the rate of 15 samples in each of the three control villages were selected as "control farmers" making them together 90 farmers for both districts.

3.2.4 Nature and sources of data

The primary data were collected and documented from farmers on various indicators of chickpea production in the selected two districts of the state during baseline in 2007-08 and on early adoption in 2009-10 was used for the study as a secondary data for this study. The data pertained to socio-economic characteristics of farmers such as on land holdings, resource endowments etc, status of chickpea crop in the study districts before varietal interventions with respect to cropping pattern, chickpea varieties cultivated, extent of area cropped under chickpea, productivity levels, input utilization and cost and returns structure *etc*. An early adoption survey was undertaken during the year 2009-10 which covered the same sample farmers to document the impact of varietal interventions on the extent of adoption of new and improved chickpea cultivars evolved through FPVS process, yields obtained, cost and returns on chickpea cultivation, varietal trait preferences, constraints in production and marketing of chickpea. The primary data were collected using the well designed pre-tested questionnaire from the farmers through recall method as the farmers did not maintain the farm records. However, they were able to provide necessary information which was cross checked for its accuracy.

Table 3.2: List of chickpea cultivars identified for each focal location for FPVS trials in Karnataka

District	No. of cultivars	Cultivars	
		<i>Desi</i> type	<i>Kabuli</i> type
Dharwad	8+2	JG-11, BGD-103, JG-130, JAKI-9218, Annigeri-1 (Check)	Vihar, BG-1105, MNK-1, ICCV-95334, KAK-2 (Check)
Gulbarga	8+2	JG-11, BGD-103, JG-130, JAKI-9218, Annigeri-1 (Check)	Vihar, BG-1105, MNK-1, ICCV-95334, KAK-2 (Check)

Table 3.3: List of villages selected for FPVS trials in the selected districts

District	Village	No. of Mother trials	No. of Baby trials
Dharwad	Shirkol	1	12
	Kumaragoppa	1	12
	Arekurahatti	1	12
	Amminbhavi	1	12
	Harobelawadi	1	12
	Sub-Total	5	60
Gulbarga	Gundagurthi	1	12
	Kurikota	1	12
	Gotur	1	12
	Farhatabad	1	12
	Pattan	1	12
	Sub-Total	5	60
Overall	Total	10	120

Table 3.4: Distribution of sampling villages for both baseline (2007-08) and early adoption (2009-10) under TL-II project

District	Taluk	Adopted Village	No. of farmers	Control Village	No. of farmers	Total
Dharwad	Dharwad	Harobelwadi	30	Kabbenur	15	
	Navalgund	Kumaragoppa	30	Hansi	15	
		Shirkol	30	Yemnur	15	
		Sub-Total	90		45	135
Gulbarga	Gulbarga	Farhatabad	30	Bhushangi	15	
		Kurikota	30	Honnakirangi	15	
	Chittapur	Gotur	30	Bennur	15	
		Sub-Total	90		45	135
	Grand Total		180		90	270

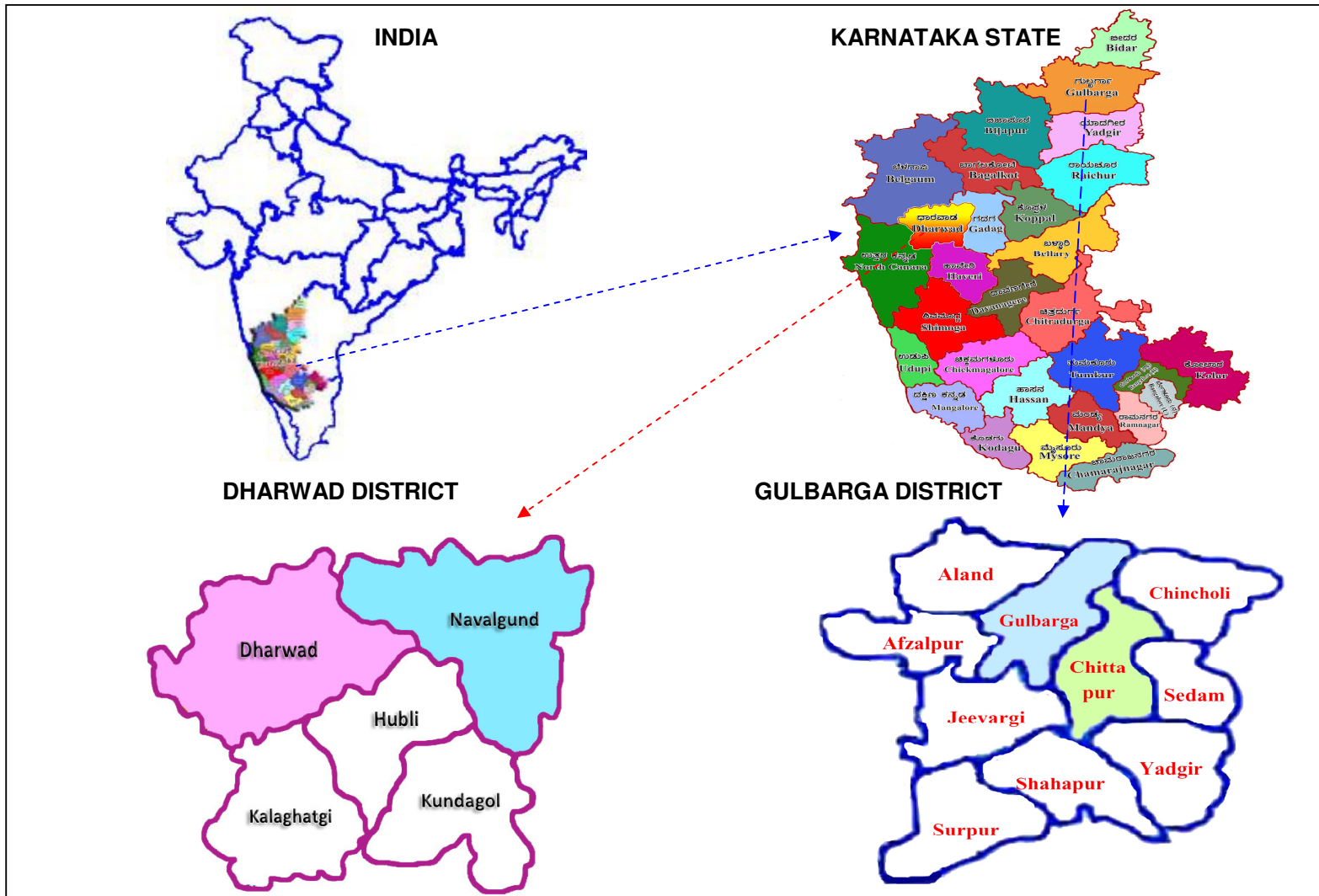


Fig. 1: Maps showing the study area

Secondary data for the study were collected from various published sources. Time series secondary data on area, productivity, production, export and import quantity and value of chickpea for the period of 11 years from 2000-01 to 2010-11 were obtained from the publications of Ministry of Agriculture, Government of India. FAO, APEDA. Further, chickpea import data for India from different countries was collected for the available period from 1997-09 to 2007-08 from Monthly Statistics of Foreign Trade of India, Ministry of Commerce and Industry, Directorate General of Commercial Intelligence and Statistics.

3.3 Analytical tools and techniques

The analytical tools employed in the present study were elaborated under the following headings.

3.3.1 Descriptive statistics

Descriptive statistics were estimated for general and demographic characteristics of the sample farmers, cropping pattern, exports and imports, input utilization, cost and returns, opinion of the farmers on the preferred traits and problems and constraints in the production and marketing.

The data were summarized with the help of statistical tools like averages percentages etc, in order to draw meaningful conclusions.

3.3.2 Exponential Growth Model

Growth rate on area, production, productivity of chickpea were computed for the period of 11 years from 2001-02 to 2010-11. The linear, log-linear, exponential and power functions were some of the important functional forms employed to study the growth rates for the said variables. Different functional forms were tried in the past for working out growth rates in area, yield and production. Some of the important forms tried were the linear growth model ($Y=a+ bt$), exponential function ($Y=ab^t$) and quadratic function ($Y=a+bt+ct^2$). However, it was found that the exponential form of the function $Y_t = ab^t$ was the better and most frequently used one.

Growth rates in area, production and productivity of chickpea as well as quantity and value of export and imports of chickpea were computed for the 11 years period from 2000-01 to 2010-11. The growth rates were computed using the exponential growth function of the form (Angles, 2001).

$$Y = a b^t \quad \dots\dots\dots (1)$$

Where,

Y = Dependent variable for which the growth rate is estimated *i.e.*, Area, Production, Productivity.

A = Intercept

b = Regression coefficient

t = Time variable

e = Error term

The compound growth rate was obtained from the logarithmic form of the equation (1) as below

$$\ln y = \ln a + t \ln b$$

The per cent compound growth rate (g) was derived using the relationship

$$g = (\text{Anti log of } b - 1) \times 100$$

3.3.3 Instability Analysis

The coefficient of variation was used as measure to study the variability in area, production, productivity and export and import of chickpea by India. The coefficient of variation (CV) or index of instability was computed by using the following formula.

$$CV = \frac{\text{Standard Deviation } (\sigma)}{\text{Mean } (X)} \times 100$$

Linear trend were fitted to the original data of area, production, productivity and exports and import of chickpea for the time series data of 11 years from 2000-01 to 2010-11. The trend coefficients

were tested for their significance. Whenever the trend of series found to significant; the variation around the trend rather than the variation around mean was used as an index of instability. The formula suggested by Cuddy and Della (1978) was used to compute the degree of variation around the trend. That is Coefficient of variation was multiplied by the square root of the difference between the unity and coefficient of multiple determinations (R^2) in the cases where R^2 was significant to obtain the Instability Index.

$$\text{Instability Index} = \frac{\text{Standard Deviation } (\sigma)}{\text{Mean } (X)} \times 100 \times \sqrt{1 - R^2}$$

Where,

- R^2 = RSS/TSS = Goodness of fit
- RSS = Regression Sum of Square
- TSS = Total Sum of Square

3.3.4 Markov Chain Analyses

The annual import data for the period from 2000-01 to 2008-09 were used to analyze the direction of trade and changing pattern of Indian chickpea import. The five major chickpea exporting countries to India considered were Australia, Myanmar, Tanzania Republic, Iran, and Turkey. Estimation of the imports was carried out for the study period using Markov chain analysis.

Markov chain analysis was employed to analyze the structural change in any system whose progress through time can be measured in terms of single outcome variable. In the present study, the dynamic nature of trade patterns *i.e.*, the gains and losses import of chickpea by major exporting countries to India was examined using the Markov chain model. Markov chain analysis involves developing a transitional probability matrix 'P', whose elements, P_{ij} indicated the probability of imports switching from country 'i' to country 'j' over time. The diagonal element P_{ij} where $i=j$, measures the probability of a country retaining its market share or in other words, the loyalty of an exporting country to a particular country's imports.

In the context of current application, structural change was treated as a random process with five exporting countries of chickpeas to India. The assumption was that the average import of chickpeas to India amongst exporting countries in any period depends only on the import in the previous period and this dependence was same among all the periods. This was algebraically expressed as

$$E_{jt} = \sum_{i=1}^n [E_{i,t-1}] P_{ij} + e_{jt}$$

Where,

- E_{jt} = imports of India from the j^{th} country in the year t
- $E_{i,t-1}$ = imports of i^{th} country during the year t-1
- P_{ij} = the probability that imports will shift from i^{th} country to j^{th} country
- e_{jt} = the error term which is statistically independent of $E_{i,t-1}$
- n = the number of exporting countries

The transitional probabilities P_{ij} , which can be arranged in a (c x n) matrix, have the following properties.

$$\sum_{i=1}^n P_{ij} = 1 \text{ and } 0 \leq P_{ij} \leq 1$$

Thus, the expected import share of each country during period 't' is obtained by multiplying the export to these countries in the previous period (t-1) with the transitional probability matrix. The probability matrix was estimated for the period 2000-01 to 2008-09.

Thus transitional probability matrix (T) was estimated using linear programming (LP) framework by a method referred to as minimization of Mean Absolute Deviation (MAD).

$$\text{Min, } OP^* + I e$$

Subject to

$$X P^* + V = Y$$

$$GP^* = 1$$

$$P^* \geq 0$$

Where,

P^* is a vector of the probabilities P_{ij}

O is the vector of zeros

I is an appropriately dimensional vectors of areas

e is the vector of absolute errors

Y is the proportion of imports each country.

X is a block diagonal matrix of lagged values of Y

V is the vector of errors

G is a grouping matrix to add the row elements of P arranged in P^* to unity.

Prediction of quantity of chickpea imports were made by using the Transitional Probability Matrix.

$$B_t = B_0 * T$$

$$B_{t+i} = B_{t+i-1} * T$$

Where,

B_0 = Quantity imports in base years

B_t = Quantity imported in next year (prediction)

T = Transitional probability matrix

3.3.5 Functional Analysis

The Cobb-Douglas type of production function was used to study the effect of various input costs on chickpea gross returns on account of its well known properties like its computational simplicity that justify its wide application in analyzing production relations (Handerson and Quandt, 1971) and it being a homogenous function provided a scale factor enabling one to measure the returns-to-scale. The Cobb-Douglas types of production function were fitted for ruling Annigeri-1 and JG-11, improved chickpea cultivar. The same was not attempted for other improved varieties like BG-103, MNK-1 and JAKI-9218 due to inadequate sample sizes. The estimated regression coefficients represented the production elasticities.

The form of Cobb-Douglas production function used in the present study is as follows.

$$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} X_7^{b_7} e^u \dots\dots\dots (1)$$

Where,

Y = Gross returns (Rs/acre)

a = Intercept

X_1 = Seed cost (Rs/acre)

X_2 = Organic manure cost (Rs/acre)

X_3 = Fertilizer cost (Rs/acre)

X_4 = Human labour cost (Rs/acre)

X_5 = Labour-BP cost (Rs/acre)

X_6 = Machine labour cost (Rs/acre)

X_7 = Plant protection chemicals cost (Rs/acre)

e^u = Random error term

b_i 's = Output elasticities of respective factor inputs, $i = 1, 2, 3, \dots, 7$

The Cobb-Douglas production function was converted into log linear form and parameters (coefficients) were estimated by employing Ordinary Least Square Technique (OLS) as given below.

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 + u \log e \dots \dots \dots (2)$$

Returns to Scale

The returns-to-scale for different chickpea cultivars were estimated directly by getting the sum of 'bi' coefficients. The returns will be increasing, constant or diminishing based on whether value of summation of 'bi' is greater, equal or less than unity, respectively.

Allocative Efficiency

The ratio of the MVP to MFC of individual resources was used to judge the allocative efficiencies of each input. The computed Marginal Value Product (MVP) was compared with the Marginal Factor Cost (MFC) or opportunity cost of the resource to draw the inference. A resource is said to be optimally allocated when it's MVP = MFC.

The marginal value products (MVP's) were calculated using the geometric mean levels of the variables using the formula.

Where, MVP i^{th} resource = $b_i \frac{\bar{Y}}{\bar{X}_i}$

\bar{Y} = geometric mean of gross returns.

\bar{X}_i = geometric mean of i^{th} independent variable /factor cost.

b_i = regression coefficient or elasticity of production of i^{th} independent Variable/factor

This analysis was carried out in order to identify the possibilities of increasing gross returns under a given farm situation.

3.3.6 Output decomposition model

3.3.6.1 Structural break in production relation

Before going to the decomposition analysis of the productivity difference between JG-11 and Annigeri-1, one must ensure whether there is structural break or not in the production relations between JG-11 and Annigeri-1 varieties. To identify the structural break, if any, in the production relations between the varieties, the output elasticities were estimated by ordinary least square method by fitting log linear regression separately for JG-11 and Annigeri-1. The pooled regression was run in combination with JG-11 and Annigeri-1 variety by including dummy variables for farmers. The dummy variable was quantified as one for JG-11 farmers and zero for farmers producing Annigeri-1 variety.

The following log linear estimable forms of equations were used for examining the structural break in the production relation.

$$\ln y_1 = \ln A_1 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + U_i \dots \dots \dots (1)$$

$$\ln y_2 = \ln A_2 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + U_i \dots \dots \dots (2)$$

$$\ln y_3 = \ln A_3 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + U_i \dots \dots \dots (3)$$

Where,

Y = Gross returns (Rs/acre)

a = Intercept

X_1 = Seed cost (Rs/acre)

X_2 = Organic manure cost (Rs/acre)

X_3 = Fertilizer cost (Rs/acre)

X_4 = Human labour cost (Rs/acre)

X_5 =Labour-BP cost (Rs/acre)

X_6 =Machine labour cost (Rs/acre)

X_7 =Plant protection chemicals cost (Rs/acre)

U_i = Random error term

b_i 's = Output elasticities of respective factor inputs, $i = 1, 2, 3, \dots, 7$

b_i = Elasticities coefficient of respective inputs and summation of these gives returns-to- scale

Equation 1, 2 and 3 represent Annigeri-1, JG-11 farmers and pooled regression function with dummy variables, respectively.

$$b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_1', b_2', b_3', b_4', b_5', b_6', b_7', b_1'', b_2'', b_3'', b_4'', b_5'', b_6'', b_7''$$

represents individual income elasticity of respective input variable in equation (1) (2) and (3), 'b' in equation (3) represent dummy variables.

3.3.6.2 Output decomposition model

For any production function, the total change in income is affected by the change in the factors of production and in the parameters that defined in the function. This total change in per acre income is decomposed to reflect on adoption of JG-11 and the change in input levels. The output decomposition model developed by Bisalialah (1977) is used in the study, which is depicted below.

The output decomposition equation used in this study can be written as

$$\begin{aligned} \ln Y_{JG-11} - \ln Y_{I JG-11} &= [\text{intercept } JG-11 - \text{intercept } I JG-11] + \\ &[(b_1' - b_1) \times \ln X_1 | JG-11 + \dots + (b_7' - b_7) \times \ln X_7 | JG-11] + \\ &[\{(b_1' (\ln X_1 | JG-11 - \ln X_1 | I JG-11) + \dots + (b_7' (\ln X_7 | JG-11 - \ln X_7 | I JG-11))\}] \end{aligned} \tag{4}$$

The decomposition equation (4) is approximately a measure of percentage change in income with the adoption of JG-11 variety. The first bracketed expression of the right hand side is the measure of percentage change in income due to shift in scale parameter (A) of the production function. The second bracketed expression is the difference between output elasticities each weighted by natural logarithms of the volume of that input used under non adopter category, a measure of change in income due to shift in slope parameters (output elasticities) of the production function. The third bracketed expression is the sum of the natural logarithms of the ratio of each input of adopters (JG-11) to Annigeri-1 variety each weighted by the output elasticity of that input. This expression is a measure of change in returns due to change in the per acre cost of seeds, organic manures, human labour, bullock labour, machine labour, chemical fertilizer, and plant protection chemicals.

3.3.7 Garrett's ranking technique

Garrett's ranking technique was used to identify the preferred traits and constraints in the production, marketing of chickpea varieties in study area. Garrett ranking is applied to rank a set of items or factors as perceived by the sample respondents based on certain criteria. The order of merit assigned by the respondents was converted into scores using the formula given by Garrett and Woodworth (1977).

$$\text{Per cent position of each rank} = 100 (R_{ij} - 0.5)/N_j$$

Where,

R_{ij} = the rank of the i^{th} item by j^{th} individual and

N_j = the number of items ranked by the j^{th} individual.

By referring the Garrett's table, per cent position estimated was converted into score. Then, for each factor the scores of various respondents were added and the mean score was calculated. The factor with the highest mean score was considered to be the most important constraint. Thus, mean score for each constraint was ranked by arranging them in the descending order.

3.4 Definition of terms and concepts used in the study

Concepts used in production

Following concepts were used in the execution of the present study. The understanding of these concepts would be of critical importance in the context of the specific objectives of the present investigation.

Tropical Legume-II (TL-II) Project

TL-II project is the project initiated by the University of Agricultural Sciences, Dharwad in collaboration with ICRISAT, Hyderabad to enhance productivity and income among farmers by intervention of improved chickpea cultivars identified through FPVS process in the selected chickpea growing districts of the state.

Farmers' Participatory Varietal Selection (FPVS)

It is relatively a new term and the process encompasses both old and new concepts and breeding procedures. Basically, participatory varietal research refers to approaches in the form of Mother-Baby trials that involve farmers who are not trained researchers, inactively undertaking and making collective decisions together with scientists considering the performance of varieties taken up on the farmers' fields itself in terms of yield, income, resistance to pests and diseases and adaptability to the local production conditions and resources. The focus was to achieve more appropriate technology design and faster adoption by ensuring the research based on farmers' knowledge of local environment, constraints conditions, plant genetic resources, their own capabilities, traders and consumers' preferences. Based on production conditions and desired traits by farmers.

Baseline survey

Is the survey undertaken during 2007-08 under the Tropical Legumes-II project to generate information on the existing adoption status of chickpea varieties and its cultivation before the technological interventions through improved cultivars among the farmers in the selected districts. This information would serve as benchmark for future studies on assessment of the impact of technological interventions.

Early adoption survey

Is the survey undertaken during 2009-10 under the Tropical Legumes-II project to generate information after the technological intervention using farmers preferred chickpea cultivars in order to assess an adoption process of varietal interventions of improved cultivars among the baseline farmers in the study districts and their early impact.

Adopted farmers

Adopted farmers are the farmers who were selected as sample chickpea cultivators under baseline and early adoption surveys from the adopted villages where the project activities on varietal interventions were implemented through trials/demonstrations on improved chickpea cultivars preferred by farmers.

Control farmers

Control farmers are the farmers who were selected as sample chickpea cultivators under the baseline and early adoption surveys from the identified control villages located nearby to the adopted villages having almost similar agro-ecological situations where the project activities on varietal interventions were not implemented through trials/demonstrations on improved chickpea cultivars preferred by farmers.

Human labour

Human labour was estimated in terms of eight hours of work per day. The women labour days were converted into man days on the criteria that one woman day is equal to 0.60 man days on the basis of wage rate equivalent, similar, methodology was adopted by Mundinamani (2000).

Bullock labour

It was measured in pair days where, one pair day means eight hours of work by a pair of bullock. Prevailing rate per day paid by farmers was used in the calculation.

Machine labour

The costs of machine labour both for hired and owned on per hour basis was calculated using differential rates for deferent type of operations that prevailed in study area.

Seed cost

The cost of own seeds was calculated at local market price and the actual expenditure incurred in the case of purchased seeds was considered.

Seed treatment

The cost of seeds treatment chemicals was calculated at local market price and the actual expenditure incurred in the case of purchased seed treatment chemical was considered.

Organic manure

The quantity of organic manure used in the cultivation was measured in terms of tonne and the cost was imputed at the market price prevailing in the village.

Fertilizers

Cost of fertilizer was computed considering the actual price paid by the farmers including the transportation cost and other identical charges if any.

Gross return

The total value of produce [seed and by-product (hay)] for both main and byproduct together is referred to as the gross return.

Net return

Return obtained by subtracting the total cost from gross return.

Interest on working capital

The paid out cost constitutes the working capital. The prevailing bank rate of interest @ 7 per cent per annum was used to work out the interest on working capital for the duration of the crop.

Interest on fixed capital

The present value of farm assets, equipments form the fixed capital. The prevailing bank rate of interest @ 12 per cent per annum was used to work out the interest on fixed capital per crop.

Rental value of own land

The actual land rent prevailing per unit of area for a similar land was used in the analysis.

Variable costs

The variable cash costs included were cost of seed, fertilizer, hired labour, bullock and machine labour *etc.* Actual price paid towards these inputs was included along with the payments made in kind were accounted only once.

Fixed costs

Land revenue to the paid to the government per acre, prevailing land rent paid and apportioned depreciation cost per acre on farm machineries, tools and equipments, and farm buildings were include as fixed costs.

RESULTS

Keeping in view the objectives of the study, the data collected from different sources were analyzed employing appropriate techniques. The results of the analysis are presented under the following headings:

- 4.1 Growth rate in chickpea area production and productivity and their instability
 - 4.1.1 Major chickpea growing states of India
 - 4.1.2 Selected districts in Karnataka
- 4.2 Growth rates, their instability and direction of chickpea trade
 - 4.2.1 Growth rates in export and import and their instability
 - 4.2.2 Direction of chickpea trade
- 4.3 Socio-economic characteristics of sample farmers
- 4.4 Composition of chickpea in the cropping pattern
 - 4.4.1 Cropping pattern and major crops grown by chickpea growers-Dharwad district
 - 4.4.2 Cropping pattern and major crops grown by chickpea growers Gulbarga district
- 4.5 Impact of improved chickpea varietal interventions on adoption process
 - 4.5.1 Adoption of improved varieties in Dharwad district
 - 4.5.2 Adoption of improved varieties in Gulbarga district
 - 4.5.3 Productivity changes-comparison between baseline and early adoption
- 4.6 Input utilization pattern in chickpea production
 - 4.6.1 Input utilization pattern in chickpea production between baseline and early adoption
- 4.7 Cost structures in chickpea production
 - 4.7.1 Cost structures in chickpea production-comparison between baseline and early adoption
- 4.8 Impact of varietal interventions on crop income
 - 4.8.1 Impact of varietal interventions on income of chickpea– between baseline and early adoption
- 4.9 Resource use efficiency in chickpea cultivation
 - 4.9.1 Chickpea production function estimates for Annigeri-1 baseline
 - 4.9.2 Allocative efficiency in chickpea production for Annigeri-1 baseline
 - 4.9.3 Production function estimates for Annigeri-1 and JG-11 in Dharwad district-Early adoption
 - 4.9.4 Production function estimates for Annigeri-1 and JG-11 in Gulbarga district-Early adoption
 - 4.9.5 Allocative efficiency in chickpea production in Dharwad district-Early Adoption
 - 4.9.6 Allocative efficiency in chickpea production-Anniger-1 and JG-11-Early adoption
- 4.10 Decomposition approach
 - 4.10.1 Structural break in the production relations between JG-11 and Annigeri- 1 Varieties in Dharwad district
 - 4.10.2 Geometric mean levels of cost and returns in chickpea production in Dharwad district
 - 4.10.3 Decomposition of total differences in chickpea yield between JG-11 and Annigeri-1 in Dharwad district

- 4.10.4 Structural break in the production relations between JG-11 and Annigeri-1 Varieties in Gulbarga district
- 4.10.5 Geometric mean levels of cost and returns in chickpea production in Dharwad district
- 4.10.6 Decomposition of total differences in chickpea yield between JG-11 and Annigeri-1 in Dharwad district
- 4.11 Preferred production and marketing traits in chickpea cultivars
 - 4.11.1 Preferred production traits in chickpea cultivars
 - 4.11.2 Preferred marketing traits in chickpea cultivars
- 4.12 Production and marketing constraints in chickpea cultivars

4.1 Growth rate in chickpea area production and productivity and their instability

Compound growth rates were computed to comprehend the annual growth in the area, production, and productivity of chickpea in the country for major chickpea growing states and for the selected districts for the period from 2000-01 to 2010-11. The instability indices were also worked out to know the extent of instability in respect of chickpea area, production, and productivity during the said period.

4.1.1 Major chickpea growing states of India

The estimated growth rates and instability indices with respect to chickpea area, production and productivity for the period from 2000-01 to 2010-11 are presented in Table 4.1. Among the states, Madhya Pradesh is the largest chickpea producing state in the country with mean annual area of 25,04,850 hectare under the crop for the eleven year period and showed positive (1.14%) but non-significant area growth under chickpea. Maharashtra state occupied second position with average annual area of 10,73,000 hectare under chickpea with a very high annual growth in area by 7.34 per cent and the same was found to be significant at one per cent level of probability. The other important states that contributed to the chickpea area were Rajasthan and Uttar Pradesh and contributed 9,50,500 hectares and 7,37,900 hectares, respectively and the area under chickpea witnessed an annual growth by 7.92 per cent and 0.08 per cent at five per cent level significance, respectively in that order. Karnataka occupied fifth place in respect of chickpea area (5,73,500 hectares) followed by Andhra Pradesh (4,55,700 hectares) and both states witnessed a significant annual growth in area at the one per cent level of significance and a growth rate of 6.96 per cent and a very high growth of 14.47 per cent, respectively.

The results on area instability for different states implied that it was lowest in the case of Madhya Pradesh (3.44%) followed by Uttar Pradesh (8.13%), Maharashtra (10.51%) implying a greater stable area under chickpea over the study period. While, the area instability was moderately high in the case of Andhra Pradesh, Karnataka and Rajasthan ranging between 17.00 to 20.00 per cent. This could be due variability in the production conditions in these states.

Among the major states, Andhra Pradesh ranked first in respect of productivity which registered highest yield of 1248.10 kg/ha and showed an annual increase in yield by 2.10 per cent. In addition to this the instability in productivity was moderate at 14.70 per cent in Andhra Pradesh. In the case of Madhya Pradesh the average productivity was 902.81 kg/ha with a growth rate in yield by 0.72 per cent and moderate instability of 11.14 per cent about its mean yield. The productivities in Madhya Pradesh and Andhra Pradesh were found to be significant at five per cent probability level. The average per hectare productivity of chickpea varied between 651 kg/ha to 675 kg/ha in the case of Uttar Pradesh, Maharashtra, Karnataka and Rajasthan. While, per hectare productivity of chickpea in Maharashtra and Karnataka states showed a positive and significant increase (at one per cent probability) by 5.25 per cent and 3.98 per cent, respectively. However, the states of Uttar Pradesh and Rajasthan which occupied a predominant position in respect of chickpea area in the country found to have a negative and significant (at one per cent probability) growth in productivity and were very high (-7.12%) in Uttar Pradesh followed by Rajasthan (-1.85%). In the case of Rajasthan there was a high instability in productivity compared to other states and were about 20.00 per cent. Interestingly, the yield instability for the states such as Karnataka, Maharashtra, and Uttar Pradesh was very low implying yield statistically in the states.

Table 4.1: Compound growth rate in area, production and productivity of chickpea and their instability in the major chickpea growing states (2000-01 to 2010-11)

Particulars	Area			Productivity			Production		
	Growth rate (%)	Mean ('000/ha)	Instability index (%)	Growth rate (%)	Mean (kg/ha)	Instability index (%)	Growth rate (%)	Mean (kg/ha)	Instability index (%)
Madhya Pradesh	1.14 (0.007)	2504.85	3.44	0.72** (0.013)	902.818	11.14	2.26** (0.018)	2535.1	3.69
Andhra Pradesh	14.47*** (0.021)	455.7	16.52	2.10** (0.017)	1248.1	14.7	21.18*** (0.19)	553.7	24.8
Karnataka	6.96*** (0.020)	573.5	19.47	3.98*** (0.013)	666	0.11	10.72***	298.1	0.24
Maharashtra	7.34*** (0.012)	1073	10.51	5.25*** (0.010)	653.1	0.094	10.64*** (0.026)	525	0.12
Rajasthan	7.92** (0.027)	950.5	19.73	-1.85*** (0.025)	674.7	19.74	1.61 (0.035)	667.4	25.56
Uttar Pradesh	0.08** (0.010)	737.9	8.13	-7.12*** (0.016)	650.8	0.13	-0.68 (0.014)	880.6	0.12
INDIA	1.60 (0.007)	7324.1	4.46	0.89** (0.006)	836.1	5.90	5.58*** (0.011)	6207.01	9.72

Note: *** - Significant at 1% level

** Significant at 5% level

Figures in parentheses indicate standard errors of coefficient

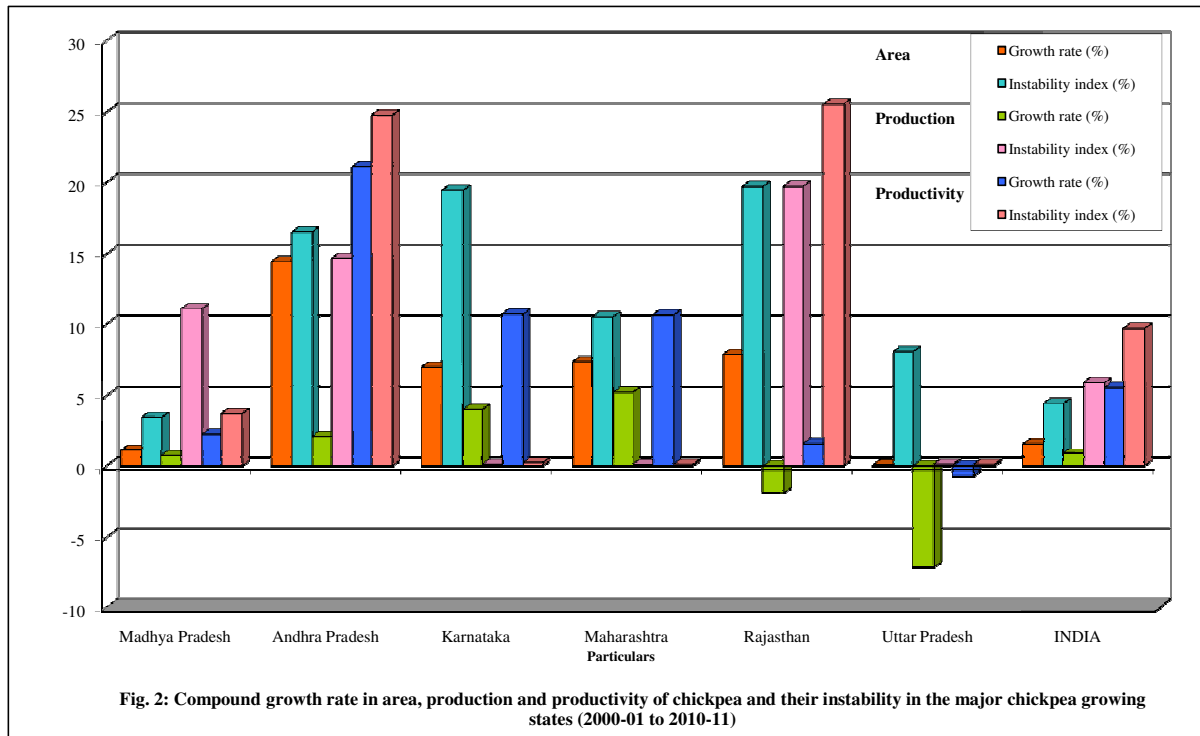


Fig 2: Compound growth rate in area production and productivity of chickpea and their instability in the major chickpea growing states (2000-01 to 2010-11)

Among the states, Madhya Pradesh being the largest chickpea producing state in the country substantially contributed to the total production with lower production instability (3.69%) and the increase in production was positive (2.26%) and significant at five per cent. This was followed by contribution of Uttar Pradesh, Rajasthan, Andhra Pradesh, Maharashtra and Karnataka states. The production instability was high in the case of Rajasthan and Andhra Pradesh to the tune of 25.56 per cent and 24.80 per cent, respectively. While, in the case of Uttar Pradesh, Maharashtra and Karnataka states, the production was more stable as indicated in the table with instability values ranged between 0.12 to 0.24 per cent.

The overall area growth in chickpea for the country as whole for the study period was positive (1.60%) but non-significant with an average area of 7.32 million hectares. The area instability was also found to be very low at 4.46 per cent about its mean during the period of study. Similarly, corresponding growth in productivity and production in chickpea for the country increased at the rate of 0.89 per cent and 5.58 per cent. The productivity increase was significant at five per cent while, for production it was significant at one per cent probability. The average productivity was 836.10 kg/ha with a low instability in productivity of 5.90 per cent and that of production instability was also relatively low at 9.72 per cent about its mean for the study period.

4.1.2 Study districts in Karnataka

The estimated growth rates for area, production and productivity and their instability indices for the period from 2001-02 to 2010-11 are presented in Table 4.2. Gulbarga district in Karnataka state had a largest area under chickpea cultivation and occupied an average area of 1.24 lakh hectare. The growth rate of chickpea area (-27.00%) and productivity (-4.5%) of chickpea for Gulbarga district were negative and significant at one and five per cent level, respectively. This was also accompanied by a significant reduction in the annual production (-30.35%) with a very high production instability index in the district at 32.66 per cent. This clearly indicated that decreased chickpea production in Gulbarga district was contributed both by area and productivity decline. However, area decline over the study period contributed more to the production decrease than productivity decline.

The results on chickpea area in Dharwad district showed a negative growth in area under the crop and observed to be decreasing annually by 14.56 per cent during the study period. This further was complicated by high area instability of 32.90 per cent. The annual growth rate of chickpea productivity in Dharwad was positive (13.43%) and was significant at five per cent significance level. This was associated with productivity instability of 43.68 per cent indicated a year to year high variability in per hectare yield. In respect of production in Dharwad, it could be seen from the results that there was a decline in the chickpea production at the rate of 2.89 per cent per annum in the district over the study period. In addition to decrease, there was also a high variability in the chickpea production (67.05%) and this variability was contributed by both area variability (32.90%) and variability in productivity (43.68%) in the district. The average annual area, production and productivity of chickpea in Dharwad district during the study period were 39,010 hectares, 17,64 tones and 467 kg/ha.

4.2 Growth rates, their instability and direction of chickpea trade

4.2.1 Growth rates in export and import and their instability

The results of growth and instability analysis of export and import of chickpea are have been shown under Table 4.3.

Looking at the results for the overall study period (2001-02 to 2011-12) the value of chickpea and the quantity of chickpea export registered a significant increase at one per cent probability over the study period. The growth in export value (81.18%) was significantly higher than growth in terms of export quantity (4.31%). There was a high variability in export value at 47.21 per cent and that for export quantity was only 0.43 per cent indicating more stability in terms of quantity exported than value terms. The annual average quantity of export and value realized during study period were 72,427 MT and US\$. 30,056, respectively.

Similarly, results on chickpea imports by India for the study period (2001-02 to 2011-12) showed that imports registered an annual growth of 5.16 per cent at one per cent level of significance and quantity of imports declined annually by 2.73 per cent and was significant at five per cent level. The instability in import value was quite high at 24.75 per cent as observed for exports (47.21%) this could be largely attributed to variability in international prices. The instability for the import quantity during the period was very high at 96.08 per cent. The average quantity of import and value imported

during study period were 1,52,858 MT and US \$ 56543 and its import quantity (96.08%) of chickpea could be as a result of year to year variability in production and there by imports varied between years.

4.2.2 Direction of chickpea trade

The transitional probability matrix presented in Table 4.4 provides a broad indication of changes in the direction of chickpea imports by India for the study period (2000-01 to 2007-08). The major chickpea exporting countries were Australia, Myanmar, Tanzania Republic, Iran, Turkey and all other exporting countries were grouped under the category of the 'other countries'. The transitional probability matrix was obtained for the study period by using the actual proportion of imports to different exporting countries. This matrix explained the changing direction of chickpea trade among exporting countries which was necessary for taking the proper decision in view of their expected changes.

The row elements in the transitional probability matrix provided the information on the extent of loss in trade, on account of competing countries for exports. The column elements indicated the probability of gains in volume of trade from other competing countries and the diagonal element indicated probability of retention of the previous year's trade volume by the respective country.

It is evident from Table 4.4 that Tanzania Republic was one of the most stable exporter among the major exporters of chickpea to India as reflected by high probability of retention at 0.84, *i.e.*, Chickpea import from Tanzania Republic was retained to the tune of 84 per cent of its previous year's share in the current period; of the remaining 16 per cent of Tanzania Republic market share in the previous year to India, 15 per cent was directed to Australia. Thus, Tanzania Republic was the most reliable and loyal exporter of chickpea to India. Thus, it could be also said that India was a most reliable market for Tanzania republic.

Myanmar had the probability retention of 0.47, which retained its previous years' export share of 47 per cent. This implied that it had lost more than half of its share to other countries of export from Myanmar; of the remaining 53 per cent of Myanmar market share in exports, 39.93 per cent was directed to Iran and another 12.97 per cent was directed to Tanzania republic.

Australia had moderate probability retention of only 24 per cent of its previous years' export share to India. This implied that it had lost most of its share to other exporting countries; Out of this, 12.64 per cent of its exports directed towards Myanmar (66%), and considerable share of export for Australia *i.e.*, 62.59 per cent were lost to other countries.

Only, 5.44 per cent of the previous years' exports to India were retained by Iran. The entire share of Iran chickpea market was directed to Australia to the extent of 32.59 per cent and 12.05 per cent share to Turkey. While, major share of 49.03 per cent directed towards other countries.

In the case of Turkey, it did not retain any share of its previous years' exports to India during the current year. The entire chickpea exports share to India by Turkey during the previous year was lost to other countries in the current year.

The major country gained among the exporters of chickpea over a period of time has been Tanzania Republic, which was having a transfer probability of 12.97 per cent from Myanmar and 1.44 per cent from other countries. The probability that Tanzania Republic gained in the export share of chickpea over the study period at the cost of Myanmar (12.97%) and other countries (1.14%). Myanmar could retain its original share of 47.10 per cent and gained 12.64 per cent from Australia.

Similarly, other countries retained 31.79 per cent of their original/previous years' share and gained 62.59 per cent from Australia and lost their export share of 30.36 per cent and 17.07 per cent to Australia and Iran, respectively.

4.3 Socio-economic characteristics of sample farmers

The demographic characteristics of the sample households of the study districts are depicted in the Table 4.5. The demographic characteristics of study area highlight the discussion on family size, farm labor availability by age, educational and occupational status, participation in local bodies and ownership of land holding among the sample farmers. These characteristics were considered as important influencing factors for adoption of new technology. The mean age of household head across districts was 48.94 years which in the case of Gulbarga farmers was 48 years and it was 50 years in the case of Dharwad district.

Table 4.2: Compound growth rate in area, production and productivity of chickpea and their instability in the study districts (2001-02 to 2010-11)

Particular	Area			Productivity			Production		
	Growth rate (%)	Mean (ha)	Instability index (%)	Growth rate (%)	Mean (kg/ha)	Instability index (%)	Growth rate (%)	Mean (tonne)	Instability index (%)
Gulbarga	-27.002*** (0.19)	124944.8	33.43	-4.5** (0.014)	669	11.00	-30.35*** (0.20)	86021.4	32.66
Dharwad	-14.56*** (0.1076)	39009	32.90	13.43** (0.10)	467	43.68	-2.89*** (0.149)	17643.1	67.05

Note: *** - Significant at 1% level

** Significant at 5% level

Figures in parentheses indicate standard errors of coefficient

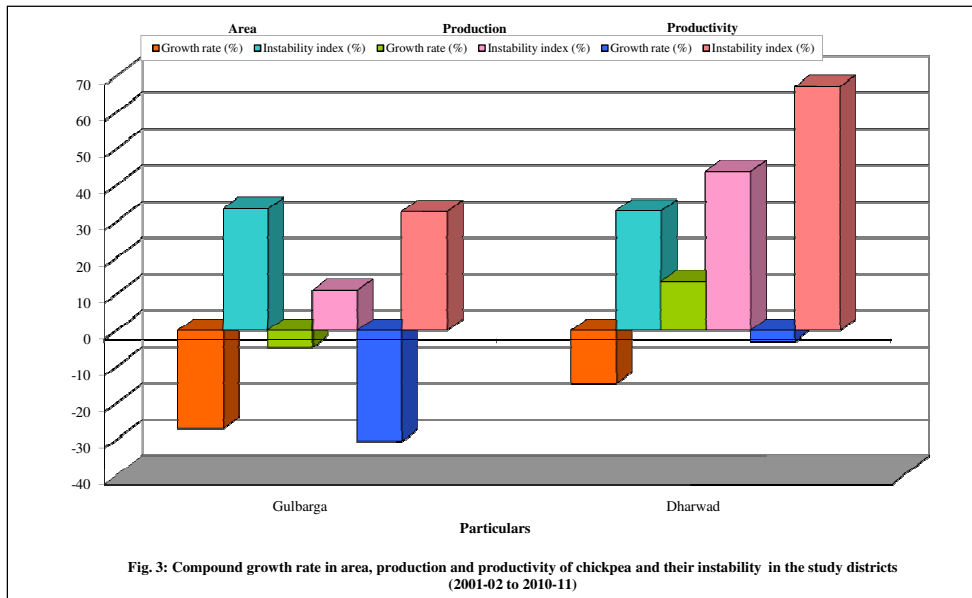


Fig 3: Compound growth rate in area production and productivity of chickpea and their instability in the study districts (2001-02 to 2010-11)

Table 4.3: Compound growth rates and instability of export and import of chickpea by India during 2001-02 to 2011-12

Description		Export	Import
Compound growth rate (%)	Quantity (MT)	4.31*** (0.28)	-2.72** (0.52)
	Value (US\$)	81.18*** (0.04)	5.16*** (0.03)
Instability index (%)	Quantity (MT)	0.43	96.08
	Value (US\$)	47.21	24.75
Average	Quantity (MT)	72426.82	152857.71
	Value (US\$)	30056.38	56542.98

Note: *** - Significant at 1% level

** Significant at 5% level

Figures in parentheses indicate standard errors of coefficient

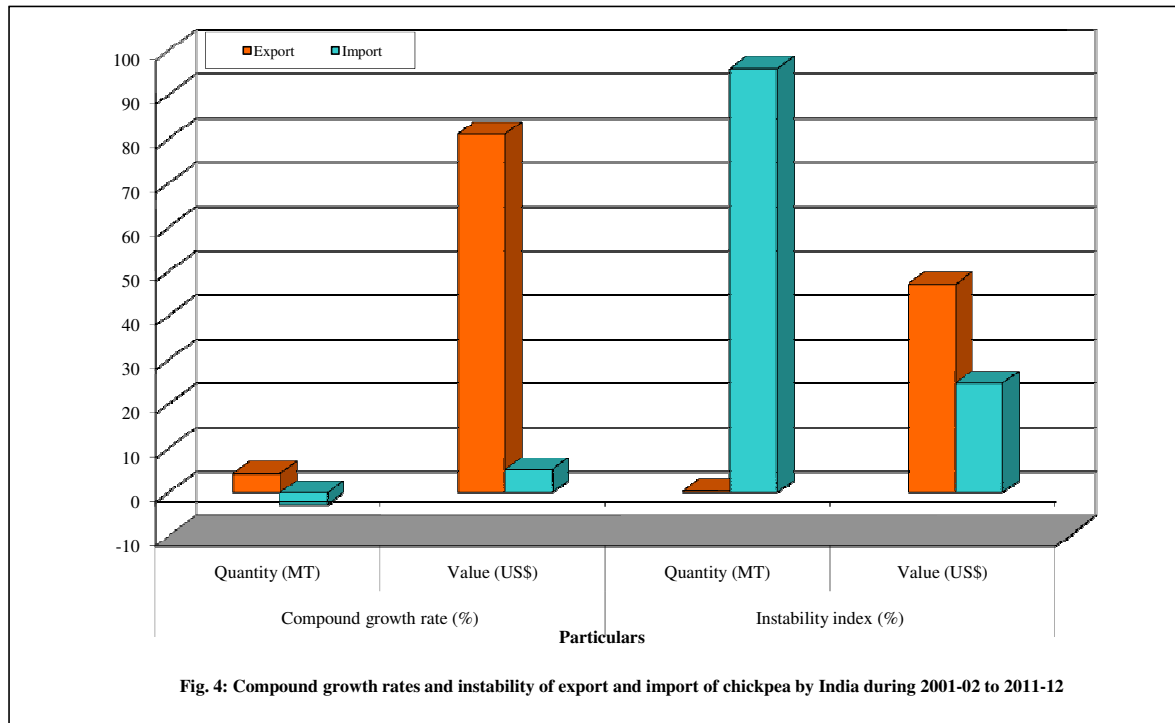


Fig 4: Compound growth rates and instability of India's chickpea export and import during 2001-02 to 2011-12

Table 4.4: Transitional Probability Matrix for chickpea import to India (2000-01 to 2007-08)

Destination	Australia	Myanmar	Tanzania Rep	Iran	Turkey	Others
Australia	0.2478	0.1264	0.0000	0.0000	0.0000	0.6259
Myanmar	0.0000	0.4710	0.1297	0.3993	0.0000	0.0000
Tanzania Rep	0.1513	0.0000	0.8487	0.0000	0.0000	0.0000
Iran	0.3259	0.0090	0.0000	0.0544	0.1205	0.4903
Turkey	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
Others	0.3036	0.0759	0.0144	0.1707	0.1176	0.3179

Table 4.5: Socio-economic characteristics of sample farmers in the study area

n=270

Sl. No.	Characteristics	Unit	Dharwad n=135	Gulbarga n=135	Overall n=270		
1	Family size						
	Female members	No.	2.95	2.86	2.91		
	Male members	No.	2.83	2.87	2.85		
	Children	No.	1.95	1.24	1.60		
	Total size	No.	7.72	6.97	7.35		
	Gender ratio (Male = 1)	Ratio	1.04	1.00	1.02		
2	Average age of the household head	Years	50.13	47.75	48.94		
	Less than 20 years	%	Nil	Nil	Nil		
	20-40 years	%	29.63	35.56	32.59		
	40-64 years	%	48.15	51.85	50.00		
	65 years and above	%	22.22	12.59	14.07		
3.	Educational level						
	No Formal education	%	9.63	32.59	21.11		
	Primary education	%	48.15	24.44	36.30		
	Higher secondary school	%	28.15	20.00	24.07		
	College level education	%	14.07	22.96	18.52		
	Average years of education		6.95	6.43	6.69		
4	Participation in local bodies	Yes	10.37	6.67	8.52		
		No	89.63	93.33	91.48		
5	Main occupation of the head						
	Agriculture/livestock	%	96.30	90.37	93.33		
	Service/employment	%	2.96	6.67	4.81		
	Business	%	0.94	2.22	1.48		
	Social work	%	0	0.74	0.37		
6	Secondary occupation						
	Agriculture/livestock	%	3.70	9.63	6.67		
	Service/employment	%	0.74	3.70	2.22		
	Business	%	2.96	6.67	4.81		
	Social work	%	0.00	0.74	6.37		
7	Caste composition						
	Forward caste	%	64.44	61.48	62.96		
	Other Backward castes	%	19.26	26.67	22.96		
	Scheduled Caste	%	8.15	8.15	8.15		
	Scheduled Tribes	%	8.15	3.70	5.93		
8	Land holding status						
Particular	Dharwad n=135		Gulbarga n=135		Overall n=270		
	% farm	Average area	% farm	Average area	% farm	Average area	
Type of land (acre)							
	Dry land	58.75	5.07	94.92	6.17	74.34	5.62
	Irrigated land	40.21	3.47	4.77	0.31	25	1.89
	Permanent fallow	1.04	0.09	0.15	0.01	0.66	0.05
	Total farm size	100	8.45	100	6.47	100	7.46

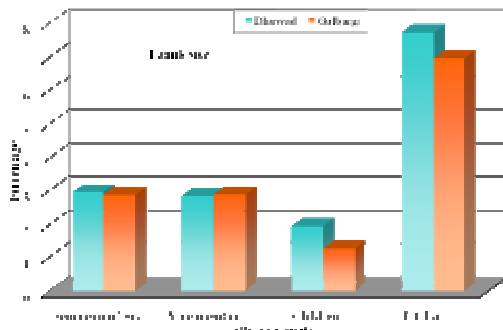


Fig 5: Socio-economic characteristics of sample farmers in

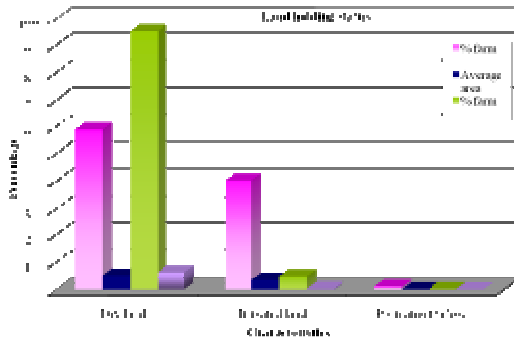
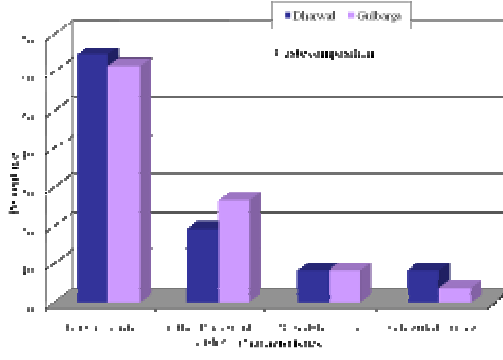
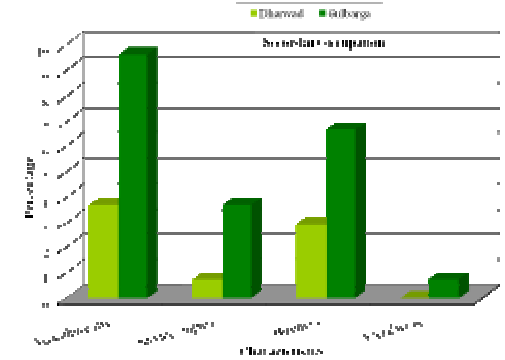
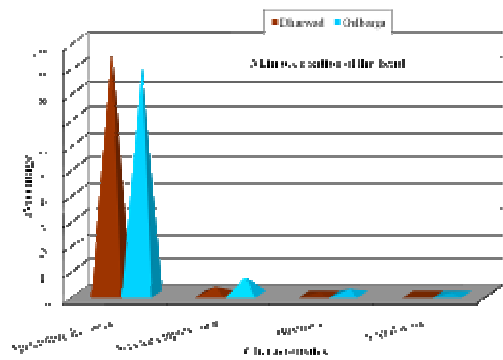
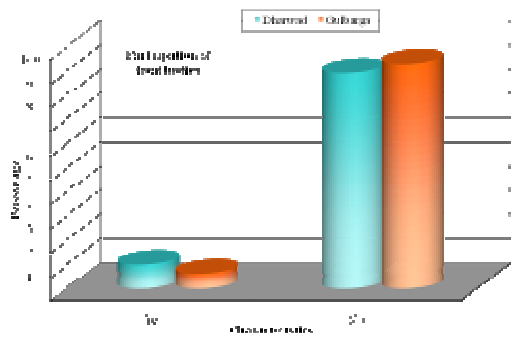
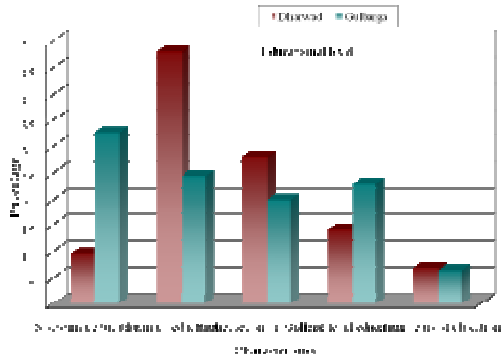
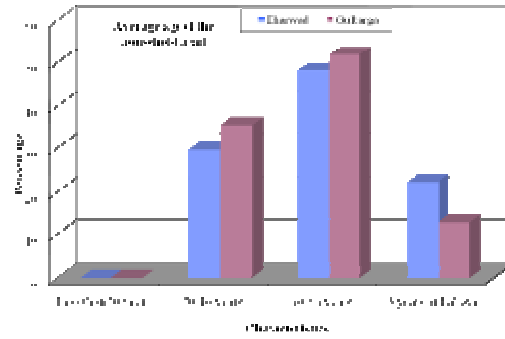


Fig 5: Socio-economic characteristics of sample farmers in the study area

Caste-wise distribution was almost on par in both the study districts and showed that majority (62.96%) of them belonged to forward caste followed by (22.96%) backward caste. About 8.15 and 5.93 per cent belonged to scheduled caste and scheduled tribes.

The gender ratio was observed to be 1.02 for both districts together and the same between districts was on par. The composition of the family both in Dharwad and Gulbarga districts was almost on par. While, the total family size was 7.35 per family in both districts together and for Gulbarga it was 6.97 members and 7.72 members in the case of farmers of Dharwad district. The distribution of family heads in different age groups showed that majority (50%) of them belonged to age group between 40-64 years followed by 32.59 per cent in the age group 20-40 years and the remaining 14.07 per cent of them were 65 years and above. There was variation in the age group classification between districts of family heads. About 36 per cent in Gulbarga belonged to age group 20-40 years as against 30 per cent in Dharwad district. Nearly 22 per cent farmers were more aged over 65 years and above in Dharwad as against 13 per cent in Gulbarga. In respect of educational accomplishments among the farmers of two districts, it was found that a large proportion (36.30%) had primary education and 24.07 and 18.52 per cent farmers' had higher secondary school and collegiate education, respectively. Among the two districts, 32.59 per cent farmers in Gulbarga had no formal education while, it was only about 10 per cent in Dharwad.

The mean years of education ranged between 6 and 7 years in both districts as against all India average years of schooling was 3 years in 1990 and increased to 4.4 years in 2010 (Jean Druze and Marty Sen., 2012). The level of participation in local bodies among the farmers was found to be poor as revealed by 91.48 per cent farmers.

4.4 Composition of chickpea in the cropping pattern

The cropping pattern of chickpea sample farmers is presented in Table 4.6

4.4.1 Cropping pattern and major crops grown by chickpea growers in Dharwad district

The area under different crops grown on the chickpea growing sample farms in Dharwad is presented in Table 4.6. Of the total gross cropped area (1682.95 acres) during the cropping year 2007-08, the area under *kharif* crops was 910.40 acres and it accounted to 54.13 per cent of the gross cropped area during 2007-08. While, during 2009-10 there was a reduction in the *kharif* cropped area at 51.19 per cent of the gross cropped area. The major crops in the *kharif* season in the district were maize, green gram, onion, sorghum. Among the *rabi* crops, chickpea occupied substantial area of about 36 per cent of the gross cropped area both during 2007-08 and 2009-10. The cropping intensity in 2007-08 was 148 per cent and in 2009-10 it was 154 per cent.

4.4.2 Cropping pattern and major crops grown by chickpea growers in Gulbarga district

The area under different crops grown on the chickpea growing sample farms in Gulbarga district is presented in Table 4.6. Of the total gross cropped area (1183.72 acres) during the cropping year 2007-08, the area under *kharif* crops was 703.33 acres and it accounted to 59.42 per cent of the gross cropped area. The same during 2009-10 accounted 57.84 per cent to the gross cropped area. While, during 2009-10 there was a reduction in the *kharif* cropped area to 57.84 per cent of the gross cropped area. The major crops in the *kharif* season in the district were pigeon pea, sorghum, and green gram. Other crops were black gram, sesame, and sunflower. Among the *rabi* crops, chickpea occupied substantial area of about 39 to 40 per cent of the gross cropped area both during 2007-08 and 2009-10. The cropping intensities in the respective years were 138 and 142 per cent in Gulbarga district.

4.5 Impact of improved chickpea varietal interventions on adoption process

4.5.1 Adoption of improved varieties in Dharwad district

The district wise adoption pattern of improved chickpea varieties and the extent of area covered under these varieties including the ruling Annigeri-1 variety both in the baseline and early adoption periods are presented in Table 4.7.

The results for Dharwad district for baseline survey (Table 4.7) showed distribution of area under chickpea varieties in the cropping year 2007-08. The results on varietal adoption during

baseline-2007-08 revealed that of the total chickpea area (610.47 acres) 86.67 per cent of the sample farmer's cultivated Annigeri-1 variety in the Dharwad district and it occupied major area of 90.65 per cent of the total chickpea area. The other varieties like *kabuli* (5.07%), bhima (2.65%) and local chickpea (0.36%) occupied only a marginal area. Area under these varieties further declined during 2009-10 after the intervention of improved varieties in the TL-II project. The farmers' preferred cultivars demonstrated in the subsequent years after 2007-08. As a consequence, there was adoption of these varieties as observed in the early adoption survey. It was noticed that there was a reduction in the proportion of farmers cultivating chickpea from 86.67 per cent in 2007-08 to 68.89 per cent in 2009-10. The extent of area cultivated under Annigeri-1 to the total chickpea area also decreased to 48.96 per cent during 2009-10 showed a decline of 43.19 per cent area in 2009-10 over 2007-08. Among the new varieties, the highest proportion (20.74%) of the chickpea producers adopted JG-11 on an area of 144.13 acres that occupied 20.74 per cent of the total chickpea area during 2009-10. This was followed by BGD-103, a bold seeded among the *desi* types was found to have been adopted by 14.07 per cent of the chickpea farmers accounting 16.30 per cent of the total chickpea area and JAKI-9218 occupied 7.80 per cent area. Among *kabuli* varieties, KAK-2 was occupied relatively more area (3.70%) than MNK-1 (0.74%) which occupied only a negligible area in the district.

4.5.2 Adoption of improved varieties in Gulbarga district

The results for Gulbarga district with respect to baseline survey (Table 4.7) showed distribution of area under chickpea varieties in the cropping year 2007-08. The results on varietal adoption pattern during baseline-2007-08 revealed that of the total chickpea area (471.77 acres) 71.85 per cent of the sample farmer's cultivated Annigeri-1 variety in the Gulbarga district and it occupied major area of 94.80 per cent of the total chickpea area. The other varieties like *kabuli* (1.27%) and local chickpea (3.92%) occupied only a marginal area. The farmers' preferred cultivars demonstrated in the district in the subsequent years after 2007-08. It was noticed that there was a reduction in the proportion of farmers from 71.85 per cent in 2007-08 to 62.96 per cent in 2009-10. The extent of area cultivated under Annigeri-1 to the total chickpea area also decreased to 46.21 per cent during 2009-10 showed a decline of 49.89 per cent area in 2009-10 over 2007-08. The reduction in the area under Annigeri-1 was taken over by the newly introduced cultivars identified through FPVS process even in Gulbarga district. The varieties namely, JG-11, BGD-103, JAKI-9218 among the *desi* type and MNK-1 and KAK-2 among *kabuli* types were preferred by farmers in the initial stage and adopted them during 2009-10. Among the new varieties, the highest proportion (24.44%) of the chickpea farmers adopted JG-11 on an area of 112.58 acres that occupied 23.20 per cent of the total chickpea area during 2009-10. This was followed by BGD-103, a bold seeded among the *desi* types was found to have been adopted by 14.81 per cent of the chickpea farmers accounting 16.60 per cent of the total chickpea area. Among *kabuli* varieties, MNK-1 occupied 8.90 per cent chickpea area, and KAK-2 was occupied 2.10 per cent chick pea area.

4.5.3 Productivity changes-comparison between baseline and early adoption

The results on the productivities of chickpea ruling and improved varieties between baseline and early adoption are compared and are presented in Table 4.8. Annigeri-1 was the oldest ruling variety cultivated by farmers in the study districts as evidenced by the extent of area occupied by it (Table 4.7). The analysis on the productivities of new varieties showed that on an average the yield per acre of Annigeri-1 during baseline and early adoption varied between 415 kg/acre to 465kg/acre. The other varieties cultivated by farmers in Dharwad district during baseline were bhima, *kabuli* and local chickpea varieties and the corresponding yields of these varieties were 278 kg/acre, 402 kg/acre and 409 kg/acre, respectively. Similarly, in the case of Gulbarga district the other varieties were *kabuli* (408 kg/acre), local variety (387 kg/acre) and considered to be very low. Among the improved *desi* varieties, per acre yield of BGD-103 varied between 557 kg/acre and 581 kg/acre during early adoption. This was followed by JG-11 which registered yield of 532 kg/acre in Dharwad and 566 kg/acre in Gulbarga, JAKI-9218 yield 506 kg/acre and 540.00 kg/acre in Dharwad and in Gulbarga districts, respectively in that order. Among the *kabuli* types, KAK-2 showed highest yield of 443 kg/acre in Dharwad and 507 kg/acre in Gulbarga sample farms. While, MNK-1 yielded 360.00 kg/acre in Dharwad and 497 kg/acre in Gulbarga district during early adoption. It could be observed that per acre yields of all chickpea varieties in Gulbarga were higher than in Dharwad.

4.6 Input utilization pattern in chickpea production

An attempt is made to compare input utilization pattern followed by farmers in the baseline and early adoption periods between ruling old variety Annigeri-1 (A-1) and improved and high yielding.

Table 4.6: Cropping pattern changes between baseline (2007-08) and early adoption (2009-10)

Season	Crop	Dharwad				Gulbarga			
		Area (acre)		% area		Area (acre)		% area	
		2007-08	2009-10	2007-08	2009-10	2007-08	2009-10	2007-08	2009-10
<i>Kharif</i>	Bajra	0.00		0.00	0.00	16.68	20.40	1.41	1.66
	Black gram	7.00	10.00	0.42	0.57	33.00	33.00	2.79	2.69
	Chilli	1.00	2.00	0.06	0.11	0.00	0.00	0.00	0.00
	Cotton	36.00	44.60	2.14	2.56	0.00	0.00	0.00	0.00
	Cowpea	0.00	0.00	0.00	0.00		1.30	0.00	0.11
	Green gram	224.79	196.29	13.36	11.26	87.10	103.47	7.36	8.44
	Groundnut	3.00	3.00	0.18	0.17	11.00	12.00	0.93	0.98
	Maize	331.67	323.17	19.71	18.54	0.00	3.00	0.00	0.24
	Onion	174.26	168.06	10.35	9.64	2.00	2.00	0.17	0.16
	Pigeon pea	0.00	0.00	0.00	0.00	406.05	399.85	34.30	32.62
	Sesamum	0.00	0.00	0.00	0.00	19.00	16.00	1.61	1.31
	Sorghum	96.00	108.20	5.70	6.21	85.25	77.55	7.20	6.33
	Sunflower	36.68	36.88	2.18	2.12	40.25	35.25	3.40	2.88
		<i>kharif Total</i>	910.40	892.20	54.10	51.19	703.33	709.02	59.42
<i>Rabi</i>	Carrot	0.00	0.00	0.00	0.00	0.50	1.00	0.04	0.08
	Chickpea	610.47	629.21	36.27	36.10	472.77	480.21	39.94	39.18
	Onion	0.00	0.00	0.00	0.00	1.00	1.00	0.08	0.08
	Safflower	0.00	10.00	0.00	0.57		12.80	0.00	1.04
	Sorghum	0.00	51.40	0.00	2.95		14.80	0.00	1.21
	Sunflower	0.00	0.00	0.00	0.00	3.12	3.62	0.26	0.30
	Wheat	162.08	160.08	9.63	9.18	3.00	3.30	0.25	0.27
		<i>Rabi Total</i>	772.55	850.69	45.90	48.81	480.39	516.73	40.58
	Gross Cropped Area	1682.95	1742.89	100.00	100.00	1183.72	1225.75	100.00	100.00
	Net Cropped Area	1132	1129			855.31	859.04		
	Cropping intensity (%)	148	154			138	142		

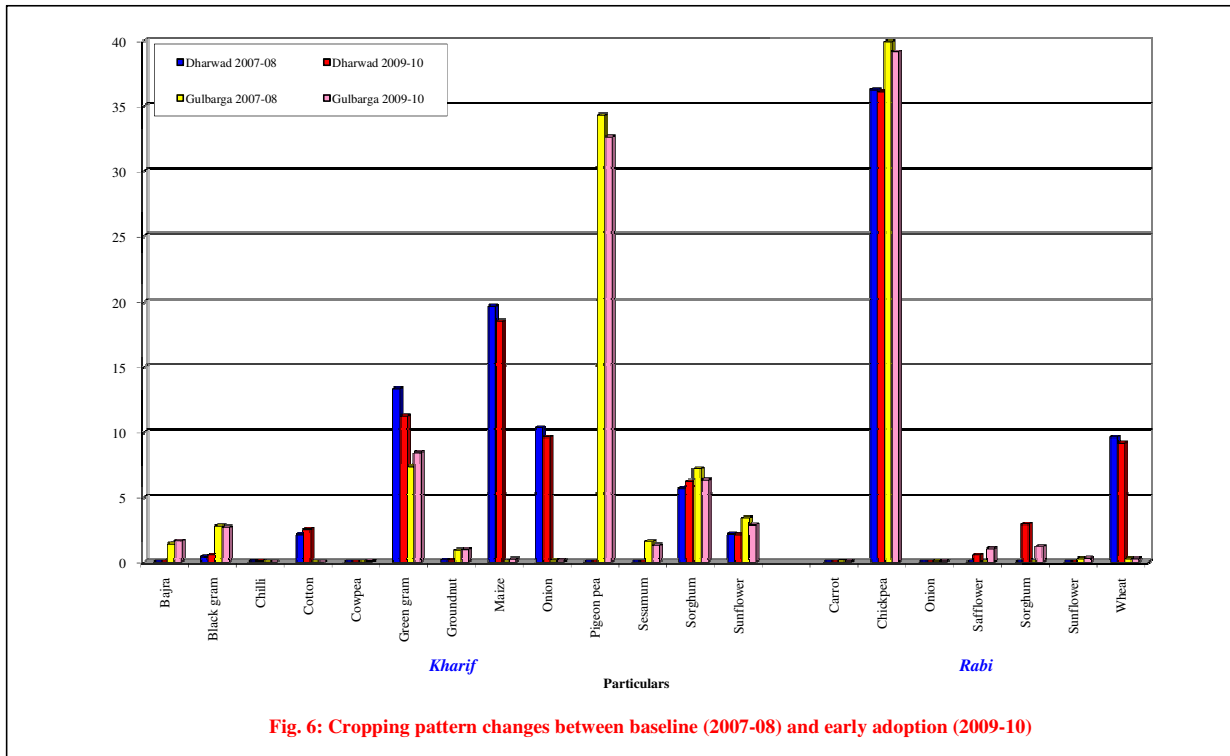


Fig 6: Cropping pattern changes between baseline (2007-08) and early adoption (2009-10)

Table 4.7: Extent of spread and adoption pattern of improved chickpea cultivars during baseline and early adoption

Variety	Dharwad							Gulbarga						
	baseline			Early adoption			% change in area	baseline			Early adoption			% change in area
	% farmers	Area (Acre)	% Area	% farmers	Area (Acre)	%Area		% farmers	Area (Acre)	%Area	% farmers	Area (Acre)	%Area	
Annigeri-1	86.67	553.41	90.70	68.89	314.41	49.10	-43.19	71.85	447.27	94.80	62.96	224.13	46.10	-49.89
BGD103	0.00	No Adoption		14.07	105.23	16.40	Newly Adopted	0.00	No Adoption		14.81	80.50	16.60	Newly adopted
Bhima	2.22	16.18	2.70	3.70	9.18	1.40	-43.26	0.00	0.00		0.74	3.00	0.60	0.00
JAKI-9218	0.00	No Adoption		3.70	50.00	7.80	Newly adopted	0.00	No Adoption		0.74	1.00	0.20	Newly adopted
JG-11	0.00	No Adoption		20.74	144.13	22.40	Newly adopted	0.00	No Adoption		24.44	112.58	23.20	Newly adopted
Kabuli	5.19	31.00	5.10	0.74	2.00	0.30	-93.55	2.22	6.00	1.30	0.74	1.00	8.90	-83.33
MNK-1	0.00	No Adoption		0.74	5.00	0.80	Newly adopted	0.00	No Adoption		6.67	43.20	2.10	Newly adopted
KAK-2	0.00	No Adoption		3.70	12.18	1.90	Newly adopted	0.00	No Adoption		2.22	10.00	2.20	Newly adopted
Local chickpea	2.22	9.88	1.60	0.00			0.00	2.96	18.50	3.90	2.22	10.55		-42.97
Total		610.47	100		642.13	100		100	471.77			485.96	100	

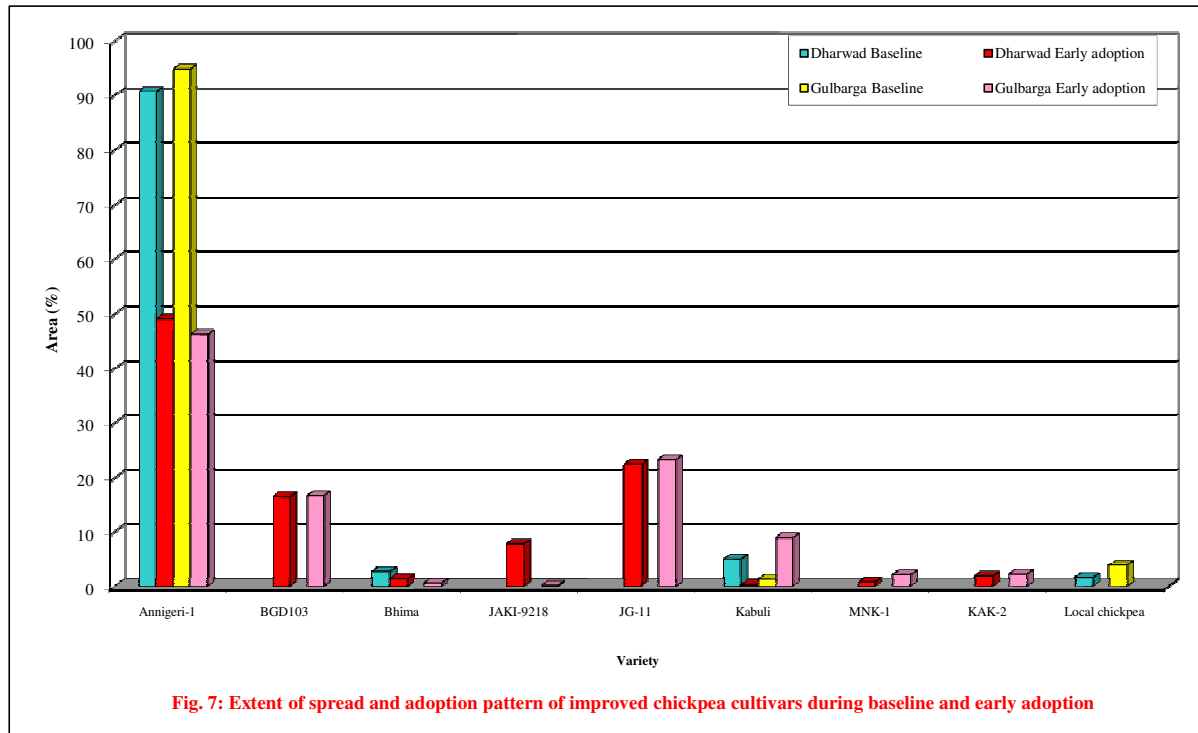


Fig 7: Extent of spread and adoption pattern of improved chickpea cultivars during baseline and early adoption

Table 4.8: Impact of adoption of improved chickpea varieties on productivity during baseline and early adoption

Variety	Old/New variety	Dharwad			Gulburga		
		Yield (kg/ac)		% change	Yield (kg/ac)		% change
		baseline	Early adoption		baseline	Early adoption	
Annigeri-1	Old variety	414.49	416.88	0.57	464.95	444.25	-4.66
BGD-103	New variety	0.00	556.45**	Newly adopted	0.00	581.36**	Newly adopted
BHIMA	Old variety	277.8	450.53	38.34	0.00	469.67	Newly adopted
JAKI -9218	New variety	0.00	505.98**	Newly adopted	0.00	540**	Newly adopted
JG-11	New variety	0.00	532.06**	Newly adopted	0.00	565.83**	Newly adopted
KABULI	Old variety	402	412.50	2.55	408.00	465.00	12.26
MNK-1	New variety	0.00	360.00	Newly adopted	0.00	496.68**	Newly adopted
KAK-2	Old Variety	0.00	443.52	Newly adopted	0.00	507.5**	Newly adopted
Local- chickpea	Old variety	408.65	0.00	0.00	386.67	302.65	-27.76

** = highly significant at 5% level.

Figures in parentheses indicate standard errors of coefficient

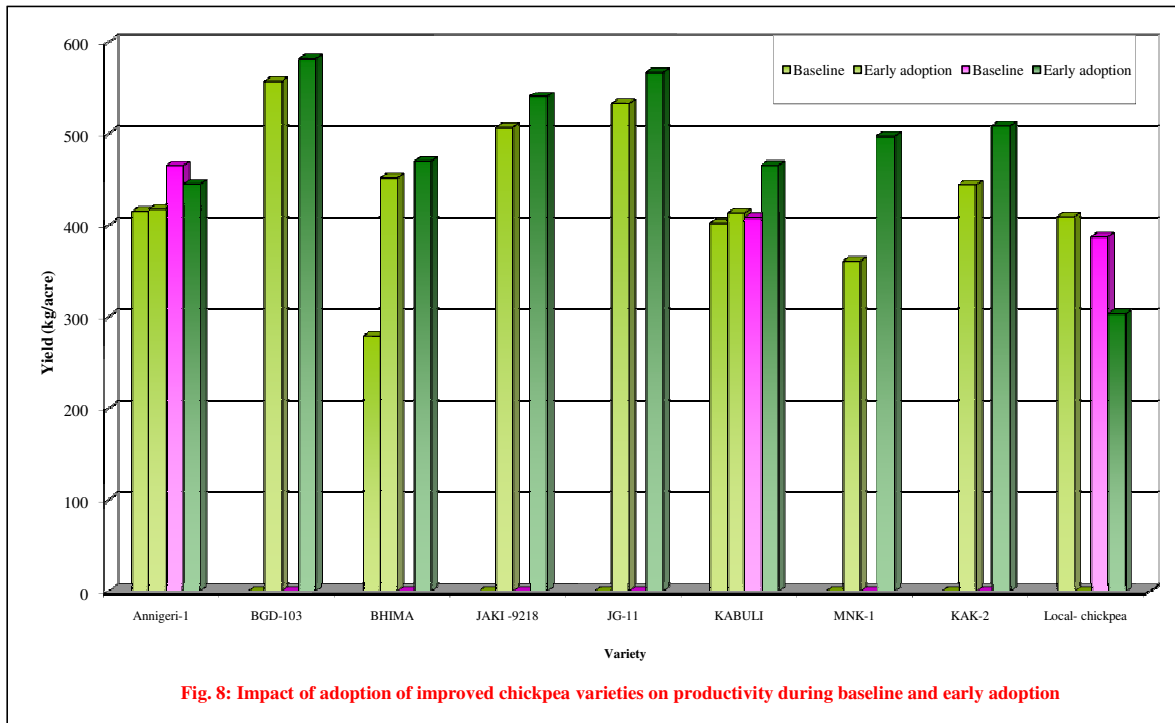


Fig 8: Impact of adoption of improved chickpea varieties on productivity during baseline and early adoption

variety JG-11. As JG-11 was more prominent among the improved cultivars spread in the study districts by a large proportion of farmers when compared to other improved varieties.

4.6.1 Input utilization pattern in chickpea production between baseline and early adoption

The quantities of various inputs used for Annigeri-1 both in baseline and early adoption practices and were compared with JG-11 in early adoption practices are presented in Table 4.9. An attempt was also made to compare various inputs used between adopted and control farmers in each district.

On an average male and female labour in adopted farmers in baseline employed 24.72 and 28.06 man days/ac in both the districts as against 24.33 to 26.97 man days/ac by control farmers for Annigeri-1.

In the case of early adoption, adopted farmers in both the districts employed 22.39 to 22.96 man days/ac of labour as against about 24.00 man days/ac of labour by control farmers for various agricultural operations in the case of Annigeri-1. While in the case of JG-11 variety labour employed were about 23.00 man days/ac by adopted farmers and about 23.15 to 24.43 man days/ac of labour by control farmers. Hence, the results implied that there was almost similar labour use pattern observed for carrying out various agricultural operations in the cultivation of Annigeri-1 variety (both in baseline and early adoption) and JG-11 (in early adoption) the range of labour used across adopted and control farmers for different operations was between 22.39 man days/ac to 28.06 man days/ac implied a marginal variation.

The results on quantity of fertilizers applied (Table 4.9) as a source of nutrient to the crop showed that on an average adopted farmers in baseline applied 41.06 and 50.22 kg/ac of fertilizer in Gulbarga and Dharwad districts, respectively as against 40.18 kg/ac and 53.40 kg/ac fertilizer by control farmers in the respective districts in that order for A-1.

In the case of early adoption the adopted farmers in Gulbarga and Dharwad districts, respectively applied 41.79 kg/ac and 44.01 kg/ac of fertilizers as against 42.34 kg/ac and 53.34 kg/ac of fertilizers by control farmers in the respective districts for A-1. While, in the case of JG-11 variety, quantity of fertilizer applied were 41.09 kg/ac and 47.72 kg/ac by adopted farmers in Gulbarga and Dharwad districts respectively. Whereas control farmers in the respective districts applied 42.86 kg/ac and 45.61 kg/ac fertilizer for JG-11.

The quantity of seed used per acre in the two districts by adopted and control farmers ranged between a minimum of 21.59 kg/ac to 30.43 kg/ac. The farmers applied generally organic manure to the chickpea plot before *kharif* rains commenced and was accounted as being applied to the chickpea crop taken up during *rabi* season. The quantity of organic manure applied varied across districts and adopted and control conditions and applied on an average between one to three tonne per acre for A-1 and JG-11.

Some of the operations in the chickpea cultivation were mechanized in the study areas. Such as ploughing operations. Hence on an average across the districts, adopted and control conditions the farmers used machine power for tillage operations and it was ranged between 4.00 hours to about 13 hours per acre both in A-1 and JG-11 plots. Similar observation was made with respect to PPCs where they applied for control of pest and diseases. However, farmers in Gulbarga in early adoption used relatively more PPCs to control pest and diseases in the case of A-1 to the extent of 2.75 liter/ac to 5.00 litres /ac due to high incidence of pest and diseases.

4.7 Cost structures in chickpea production

In this section an attempt is being made to compare the cost of cultivation of chickpea ruling variety namely, Annigeri-1 and improved variety JG-11 between baseline and early adoption periods across adopted and control conditions in the study districts. The results of the same are presented in Tables 4.10 to 4.12.

4.7.1 Cost structure in chickpea production-comparison between baseline and early adoption

A comparison of total cost of cultivation of Annigeri-1 variety in the baseline period among the adopted and control farmers across districts presented in Table 4.10. The total cost among adopted farms was found to be Rs. 9462.61/acre and Rs. 7323.83/acre in Dharwad and Gulbarga districts,

respectively. Of this total cost, the variable cost accounted highest about 56.14 (Rs. 5313.01/acre) per cent and 55.80 (Rs. 4087.02/acre) per cent, respectively. While, the fixed cost accounted to 43.85 (Rs. 4149.60/acre) per cent and 44.19 (Rs. 3236.80/acre) per cent, respectively. Among the variable cost components for Annigeri-1 variety considering male and female labour together accounted to Rs. 1362.37 (14.47%) and Rs. 1183.85/acre (16.08%) by adopted farmers in Dharwad and Gulbarga districts, respectively. While, the corresponding costs by control farmers in the case of Annigeri-1 were Rs. 1243.97 (13.84%) and Rs. 1114 (15.71%), respectively in Dharwad and Gulbarga districts. Other variable costs like, seed cost varied between 8.12 (Rs. 595.28/acre) per cent and 7.31 (Rs. 692.66/acre) per cent to the total cost of cultivation by adopted farmers, respectively in Gulbarga and Dharwad districts. In the case of control farmers seed cost ranged between 7.91 per cent (Rs. 561.03/acre) and 5.77 per cent (Rs. 519.14/acre). The cost of organic manure across districts and across adopted and control farms ranged between 1.50 to 3.75 per cent, while, fertilizer cost varied between 5.41 to 5.87 per cent of the total cost. In the case of labour-BP, the farmers across adopted and control farms in Gulbarga used more (over 10%) of animal power for tillage operations than machine labour (about 4.00 to 6.00%). While, in the case of Dharwad farmers across adopted and control farms, the labour-BP and machine labour accounted about 6.00 to 8 per cent of the total cost.

A comparison of per acre costs for Annigeri-1 during baseline and early adoption (Table 4.10 and 4.11) showed an increase in the total cost of cultivation during early adoption over baseline. The per acre total cost for adopted farms in the early adoption in Dharwad (Rs. 9796.45/acre) and Gulbarga (Rs. 8377.55/acre) were more than baseline (Rs. 9462.61/acre in Dharwad and Rs. 7326.82/acre in Gulbarga). While, in the case of control farms during early adoption the total costs in Dharwad (Rs. 9606.30/acre) and Gulbarga (Rs. 9208.59/acre) were higher than baseline (Rs. 8982.39/acre and Rs. 7089.65/acre) costs in the respective districts in that order. The variable costs across adopted farms in the early adoption for Annigeri-1 variety varied between Rs. 5141/acre to Rs. 5647/acre) across districts while, for control farms it ranged between Rs. 5498/acre to Rs. 5971/acre.

A comparison of total cost of cultivation of JG-11 variety in the early adoption period among the adopted and control farmers across districts presented in Table 4.12. The total cost among adopted farms was found to be Rs. 8789.62/acre and Rs. 7646.06.83/acre in Dharwad and Gulbarga districts, respectively. Of this total cost, the variable cost accounted highest at 52.78 (Rs. 4640.02/acre) per cent and 57.66 (Rs. 4409.26/acre) per cent, respectively. While, the fixed cost accounted at 42.21 (Rs. 4149.60/acre) per cent and 42.33 (Rs. 3236.80/acre) per cent, respectively. Among the variable cost components for JG-11 variety by considering male and female labour together accounted for Rs. 1767.86 (20.75%) and Rs. 1647.99/acre (21.55%) by adopted farmers in Dharwad and Gulbarga districts, respectively. While, the corresponding costs by control farmers in the case of JG-11 were Rs. 1685.77 (18.37%) and Rs. 2107.89 (24.56%), respectively in Dharwad and Gulbarga districts. Other variable costs like, seed cost varied between 7.77 (Rs. 683.24/acre) per cent and 8.57 (Rs. 656.00/acre) per cent to the total cost of cultivation by adopted farmers, respectively in Gulbarga and Dharwad districts. In the case of control farmers seed cost ranged between 6.61 per cent (Rs. 606.36/acre) and 8.39 per cent (Rs. 720.00/acre). The cost of organic manure in Dharwad district and across adopted and control farms ranged between 2.00 to 2.08 per cent while farmers in Gulbarga did not use organic manure. While, fertilizer cost varied between 4.86 to 5.50 per cent of the total cost. In the case of labour-BP, the farmers across adopted and control farms in Gulbarga used more (about 12%) of animal power for tillage operations than machine labour (about 1.12%). While, in the case of Dharwad farmers across adopted and control farms, the labour-BP and machine labour accounted about 4.00 to 6.80 per cent of the total cost. There was variability in the cost incurred on plant protection chemicals for management of pest and diseases in the baseline and early adoption depending on the incidence of pests and diseases in the study districts across adopted and control farms. However, the farmers in Gulbarga both in adopted and control farms incurred more cost on PPCs which accounted 14.00 to 16.00 per cent of the total cost.

4.8 Impact of varietal interventions on crop income

The profitability of popular ruling variety of chickpea (Annigeri-1) cultivated by farmers both during baseline and early adoption across adopted and control farms in Dharwad and Gulbarga districts were worked out and the results are presented in Table 4.13.

Table 4.9: Input utilization pattern for ruling and improved varieties in baseline and early adoption survey

(Quantity per acre)

		baseline				Early Adoption							
Particular		Annigeri-1				Annigeri-1				JG-11			
Input/output	Unit	Dharwad		Gulbarga		Dharwad		Gulbarga		Dharwad		Gulbarga	
		Adopted n=80	Control n=40	Adopted n=80	Control n=40	Adopted n=40	Control n=20	Adopted n=40	Control n=20	Adopted n=40	Control n=20	Adopted n=40	Control n=20
Seed	Kgs	24.55	21.45	23.44	21.59	25.82	27.98	24.09	30.43	27.97	23.44	27.00	25.71
Seed treatment	Gms	31.49	12.02	31.18	16.98	7.08	0.00	11.71	10.00	7.00	22.09	0.00	0.00
Organic manure	Tonne	2.63	1.91	0.78	1.63	2.76	1.94	0.54	1.13	1.64	1.64	0.00	0.00
Fertilizer	Kgs	50.22	53.40	41.06	40.18	44.01	53.34	41.79	42.34	47.72	45.61	41.09	42.86
Labour-M	Man days	17.61	15.11	12.50	18.19	14.03	13.00	13.09	15.50	10.95	13.45	14.28	16.86
Labour-F	Man days	10.45	9.22	12.22	8.78	8.93	11.19	9.30	8.61	11.87	10.98	8.73	6.29
Labour-B	Pair days	3.35	2.39	4.17	18.88	1.98	1.33	1.52	2.59	1.05	2.05	2.78	2.57
Machine labour	Hrs	7.01	9.13	11.59	8.83	5.85	7.40	8.35	7.58	4.32	13.50	2.10	2.00
PPCs	Litres	1.81	1.07	0.26	0.18	2.93	1.26	5.04	2.75	1.22	1.44	0.90	0.86

Table 4.10: Cost structure for Annigeri-1 variety during baseline survey

(Rs/acre)

Sl. No.	Particular	Dharwad				Gulbarga			
		Adopted		Control		Adopted		Control	
		Cost	Percentage	Cost	Percentage	Cost	Percentage	Cost	Percentage
I	Variable cost								
1	Seed	692.66	7.31	519.14	5.77	595.28	8.12	561.03	7.91
2	Seed Treat	159.31	1.68	99.48	1.10	118.23	1.61	38.75	0.54
3	Organic manures	355.05	3.75	271.22	3.01	107.64	1.46	211.9	2.98
4	Fertilizer	512.63	5.41	522.1	5.81	413.28	5.64	416.19	5.87
5	Labour-M	963.14	10.17	897.64	9.99	730.62	9.97	725.03	10.22
6	Labour-F	399.23	4.21	346.33	3.85	453.23	6.18	389.42	5.49
7	Labour-BP	660.65	6.98	685.2	7.62	762.44	10.41	773.44	10.90
8	Machine labour	583.4	6.16	621.52	6.91	455.4	6.21	272.07	3.83
9	PPCs	639.36	6.75	592.73	6.59	183.53	2.50	212.97	3.00
10	Interest on working capital	347.5801	3.67	318.8752	3.55	267.3755	3.65	252.05	3.55
	Sub Total (I)	5313.01	56.14	4874.23	54.26	4087.02	55.80	3852.85	54.34
II	Fixed cost								
1	Rental value of land	3200	33.81	3200	35.62	2400	32.76	2400	33.85
2	Land revenue	40	0.42	40	0.44	40	0.54	40	0.56
3	Depreciation	465	4.91	428	4.76	450	6.14	450	6.34
4	Interest on fixed capital	444.6	4.69	440.16	4.90	346.8	4.73	346.8	4.89
	Sub Total (II)	4149.6	43.85	4108.16	45.73	3236.8	44.195	3236.8	45.65
	Total cost of cultivation (I+II)	9462.61	100	8982.39	100	7323.82	100	7089.656	100

Table 4.11: Cost structure for Annigeri-1 variety during early adoption survey

(Rs/acre)

Sl. No.	Particular	Dharwad				Gulbarga			
		Adopted		Control		Adopted		Control	
		Cost	percentage	Cost	percentage	Cost	percentage	Cost	percentage
I	Variable cost								
1	Seed	661.07	6.74	712.45	7.41	628.71	7.50	818.31	8.88
2	Seed Treat	34.98	0.35	0	0	40.44	0.48	40	0.43
3	FYM	279.6	2.85	148.74	1.54	69.11	0.82	146.25	1.58
4	Fertilizer	493.35	5.03	642.74	6.69	519.44	6.20	479.71	5.20
5	Labour-M	1027.33	10.48	1183.3	12.31	1017.09	12.14	1105.55	12.00
6	Labour-F	472.3	4.82	435.4	4.53	392.02	4.67	434.95	4.72
7	Labour-BP	664	6.77	463.91	4.82	440.12	5.25	663.56	7.20
8	Machine labour	678.42	6.92	876.16	9.12	550.01	6.56	419.93	4.56
9	PPCs	966.38	9.86	675.75	7.03	1147.5	13.69	1472.86	15.91
10	Interest on working capital	369.42	3.77	359.69	3.74	336.31	4.014	390.67	4.24
	Sub Total (I)	5646.85	57.64	5498.142	57.23	5140.71	61.36	5971.79	64.85
II	Fixed cost								
1	Rental value of land	3200	32.66489	3200	33.31147	2400	28.64	2400	26.01
2	Land revenue	40	0.408311	40	0.416393	40	0.47	40	0.43
3	Depreciation	465	4.746617	428	4.455409	450	5.37	450	4.88
4	Interest on fixed capital	444.6	4.538379	440.16	4.581992	346.8	4.13	346.8	3.76
	Sub Total (II)	4149.6	42.3582	4108.16	42.76526	3236.8	38.63	3236.8	35.149
	Total cost of cultivation (I+II)	9796.45	100	9606.30	100	8377.51	100	9208.98	100

Table 4.12: Cost structure for JG-11 variety during early adoption survey

(Rs/acre)

Sl. No.	Particular	Dharwad				Gulbarga			
		Adopted		Control		Adopted		Control	
		Cost	percentage	Cost	percentage	Cost	percentage	Cost	percentage
I	Variable cost								
1	Seed	683.24	7.77	606.36	6.61	656	8.57	720	8.39
2	Seed Treat	28.00	0.31	41.46	0.45	0	0	0	0
3	FYM	178.04	2.02	191.21	2.08	0	0	0	0
4	Fertilizer	427.43	4.86	460.38	5.01	410	5.36	471.43	5.50
5	Labour-M	985.99	11.21	1011.6	11.02	1156.99	15.13	1685.71	19.6
6	Labour-F	781.87	8.89	674.17	7.35	491.06	6.42	422.18	4.92
7	Labour-BP	377.96	4.30	625.86	6.82	910.08	11.90	971.43	11.3
8	Machine labour	390.09	4.43	585.13	6.37	86	1.12	80	0.94
9	PPCs	483.85	5.50	536.58	5.85	410.68	5.37	642.86	7.50
10	Interest on working capital	303.55	3.45	331.29	3.61	288.45	3.78	349.55	4.07
	Sub Total (I)	4640.02	52.78	5064.04	55.21	4409.26	57.67	5343.16	62.28
II	Fixed cost								
1	Rental value of land	3200	36.40	3200	34.89	2400	31.38	2400	27.97
2	Land revenue	40	0.45	40	0.43	40	0.52	40	0.46
3	Depreciation	465	5.30	428	4.66	450	5.88	450	5.24
4	Interest on fixed capital	444.6	5.05	440.16	4.79	346.8	4.53	346.8	4.041
	Sub Total (II)	4149.6	47.21	4108.16	44.78	3236.8	42.33	3236.8	37.76
	Total cost of cultivation (I+II)	8789.623	100	9172.203	100	7646.067	100	8579.963	100

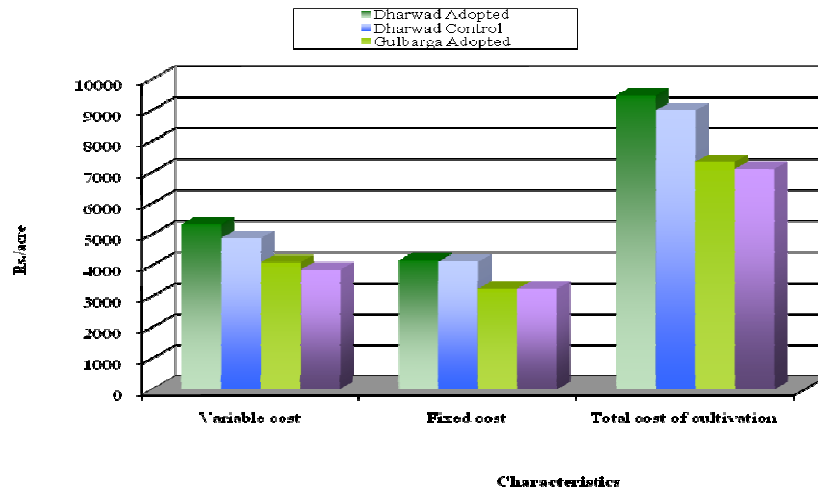


Fig. 9: Cost structure for Annigeri-1 variety during Baseline

Fig 9: Cost structure for Annigeri-1 variety during baseline survey

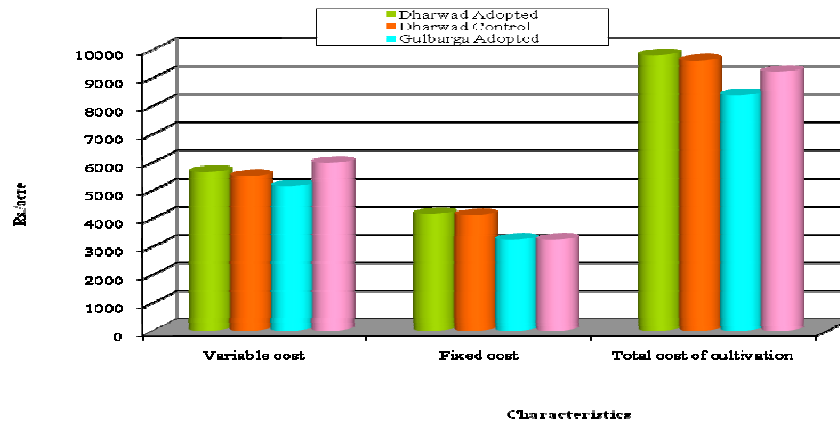


Fig. 10: Cost structure for Annigeri-I variety during early

Fig 10: Cost structure for Annigeri-I variety during early adoption survey

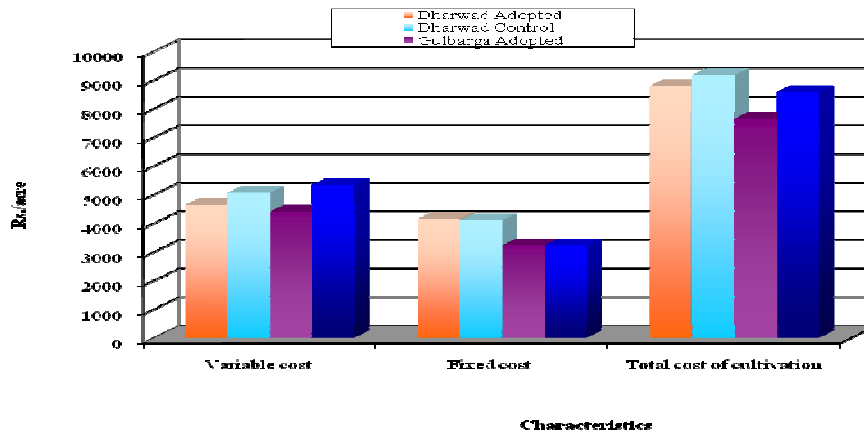


Fig. 11: Cost structure for JG-11 variety during early adoption

Fig 11: Cost structure for JG-11 variety during early adoption survey

4.8.1 Impact of varietal interventions on income for chickpea– between baseline and early adoption

The results on incremental returns on chickpea crop realized by farmers from different improved varieties namely, JG-11, BGD-103, MNK-1 over that of Annigeri-1, a predominant variety cultivated by farmers under rain fed condition. The results indicated that the gross returns realized by farmers from Annigeri-1 variety ranged between Rs. 7637/acre to RS. 9867/acre during the baseline and between Rs. 9345/acre to Rs. 10600/acre in the early adoption.

The gross returns in the case of JG-11 increased substantially over baseline and early adoption yields of Annigeri-1 variety across adopted and control farms and districts. The per acre gross returns realized by farmers ranged between Rs. 14,000 to 16451.00.

The net returns realized by farmers from Annigeri-1 (baseline) variety was found to be as low as Rs. 120/acre to as much as Rs. 2634.38/acre except in the case of adopted farms during baseline in Dharwad where the net returns realized were found to be even negative (Rs. -1825.28). The net returns that obtained from Annigeri-1 (early adoption) were as low as Rs. 266 to high of Rs. 2194.38. While, incremental returns over costs in JG-11 in early adoption quite high and ranged between Rs. 5415.48/acre to Rs. 8358/acre.

The benefic cost ratio for Annigeri-1 (baseline) across farms and districts ranked between 0.80 to 1.36 while the ratio for the same variety in the early adoption was between 1.01 to 1.26. On the contrary, the B-C Ratio for JG-11 showed relatively higher returns for every rupee invested in its production. The ratio's ranged between 1.63 to 2.09 for a rupee investment.

The results of Table 4.13 also revealed that the percentage increase in main yield in between JG-11 (improved variety) over Annigeri-1 (old variety) in both the adopted and control farms of Dharwad district were almost similar (42.52% to 49.80%), whereas in the case of Gulbarga district per cent increase in main yield was relatively less as compared to Dharwad district (32.55% to 37.55%). This implied that the yield of JG-11 is increased over an Annigeri-1 variety. Similarly, in terms of percentage change in total cost of cultivation of Annigeri-1 variety is relatively more in the case of adopted farms (10.28%) and low among control farms (4.52%) as against JG-11 variety in Dharwad district. While in Gulbarga, total cost of cultivation of Annigeri-1 variety was relatively more for adopted farms (8.73%) and low in the case of control farms (6.83%). As a result correlation of the per cent change in gross returns in JG-11 over Annigeri-1 variety is high in both districts *i.e* it ranged between 50 to 58.53 per cent.

In addition to JG-11 there were other varieties which occupied small area and were cultivated by only a small proportion of farmers in the study districts such as, BGD-103 and MNK-1. BGD-103 these were found to have been adopted both districts except in control farms in Dharwad. MNK-1 was found to have been adopted only in Gulbarga district. The gross ranged between Rs. 14887/acre to Rs. 16783/acre in the case of BGD-103 across study districts. It varied between Rs. 16595/acre to Rs. 16783/acre in Gulbarga district for MNK-1. The net returns were also quite high in both of these varieties and were in the range of Rs. 5144/acre to Rs. 7974/acre across farms and districts. The B-C ratio was also found to be high at 1.53 to 1.90.

4.9 Resource use efficiency in chickpea cultivation

The Cobb–Douglas production function was fitted to the input and output data obtained during baseline and early adoption periods from chickpea sample farmers of Dharwad and Gulbarga districts across adopted and control farms in respect of Annigeri-1, a ruling and old chickpea variety and improved variety, JG-11. The estimates of the production functions were used for analyzing the allocative efficiency of resources on these farms.

4.9.1 Chickpea production function estimates for Annigeri-1 baseline

The estimated coefficients of the Cobb-Douglas production function for Annigeri-1 during baseline was fitted to the input costs and output values and the results are presented in Table 4.14.

In the case of adopted sample farms of Dharwad district during baseline, production elasticities of seed (0.02), organic manure (0.003), labour-BP (0.70), were found to influence positively the chickpea yield of Annigeri-1 variety and were significant at one per cent probability. The production elasticity of fertilizer (0.23) was positive and significant at five per cent level. The coefficient of multiple determination (R^2) for the variety during baseline was 0.93. This indicated that the variables included.

Table 4.13: Impact of adoption of improved chickpea varieties on income during baseline and early adoption

(Rupees per acre)

Particular			Dharwad		Gulbarga	
Study period	Variety	Cost/return	Adopted (n=80)	Control (n=40)	Adopted (n=80)	Control (n=40)
baseline	Annigeri-1	Main product (kg/ac)	358.67	440.27	482.10	432.53
		By product (qtl/ac)	4.12	5.05	5.53	4.96
		Total Cost	9462.61	8982.39	7232.82	7089.65
		Gross Returns	7637.33	9102.67	9867.20	9004.02
		Net Returns	-1825.28	120.28	2634.38	1914.37
		Benefit Cost Ratio	0.80	1.01	1.36	1.27
Early adoption (EA)	Annigeri-1	Cost/return	Adopted (n=40)	Control (n=20)	Adopted (n=40)	Control (n=20)
		Main product (kg/ac)	413.06	417.15	459.71	420.34
		By product (qtl/ac)	4.63	4.67	5.15	4.71
		Total Cost	9796.45	9606.30	8377.55	9208.59
		Gross Returns	10062.51	10494.05	10571.93	9344.91
		Net Returns	266.06	887.75	2194.38	136.32
	Benefit Cost Ratio	1.02	1.09	1.26	1.01	
	JG-11	Cost/return	Adopted (n=40)	Control (n=20)	Adopted (n=40)	Control (n=20)
		Main product (kg/ac)	618.69	594.53	634.17	557.14
		By product (qtl/ac)	6.93	6.66	7.10	6.24
		Total Cost	8789.62	9172.20	7646.06	8579.96
		Gross Returns	15952.19	16450.99	16004.19	13995.43
Net Returns		7162.57	7278.79	8357.94	5415.47	
Benefit Cost Ratio	1.81	1.79	2.09	1.63		

Contd....

		Particular	Dharwad		Gulbarga	
Study period	Variety	Cost/return	Adopted (n=6)	Control (n=4)	Adopted (n=6)	Control (n=4)
		% change in main yield in JG-11 over A-1 (EA)	49.78	42.52	37.95	32.55
		% change in cost in JG-11 over A-1 (EA)	-10.28	-4.52	-8.73	-6.83
		% change in gross returns in JG-11 over A-1 (EA)	58.53	56.76	51.38	49.77
Early adoption	BGD103	Main product (kg/ac)	590.00	0	590.00	612.50
		By product (qtl/ac)	6.61	0	6.61	6.86
		Total Cost	9742.62	0	8822.06	9007.31
		Gross Returns	14886.88	0	16782.5	16595.27
		Net Returns	5144.25	0	7960.43	7587.95
	MNK1	Benefit Cost Ratio	1.52	0	1.90	1.84
		Main product (kg/ac)	0	0	492.18	474.18
		By product (qtl/ac)	0	0	5.51	5.31
		Total Cost	0	0	8808.10	9791.31
		Gross Returns	0	0	16782.5	16595.27
		Net Returns	0	0	7974.39	6803.96
		Benefit Cost Ratio	0	0	1.90	1.69

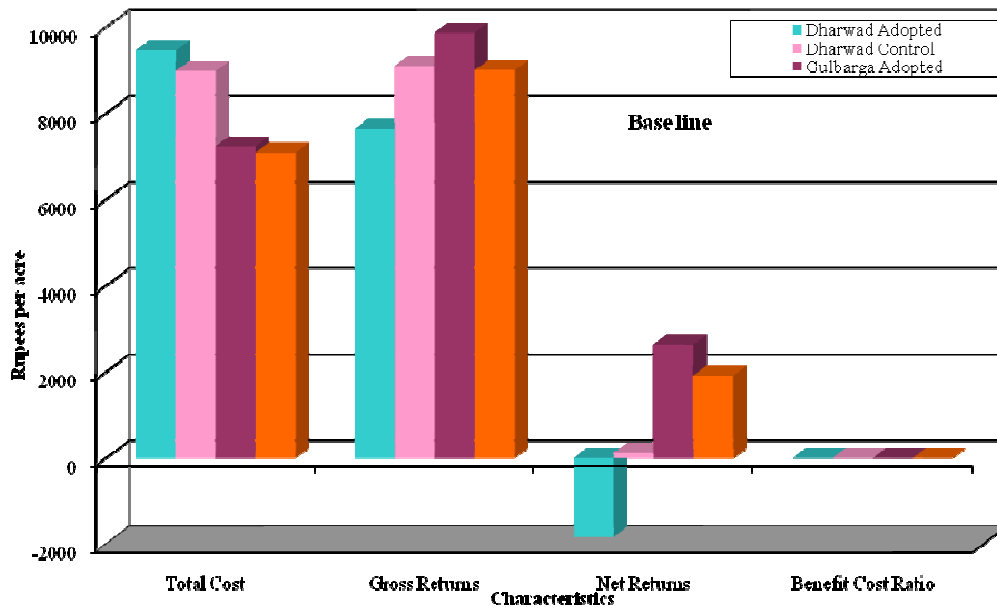


Fig. 12: Impact of adoption of improved chickpea varieties on income during baseline

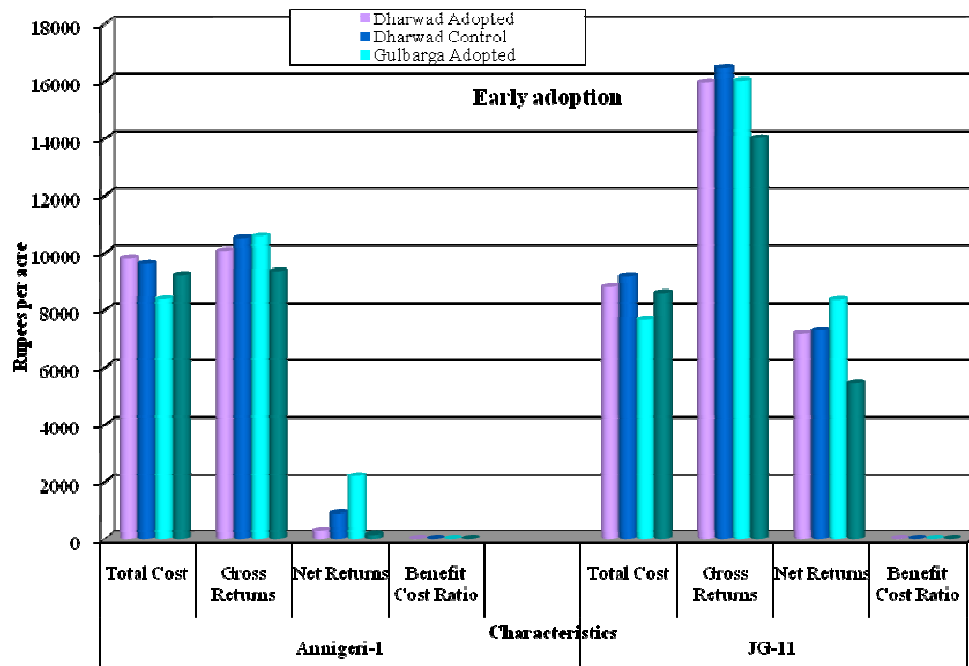


Fig 12: Impact of adoption of improved chickpea varieties on income during baseline and early adoption

in the production function explained 93 per cent of the variation in the chickpea return. The returns to scale in the case of Annigeri-1 variety for adopted farms were found to be 1.06 indicated increasing returns.

In the case of farms of control villages in Dharwad district for the same variety, the production elasticities of organic manure (-0.002), fertilizer (-0.26) and labour-BP (-0.71) were negatively influencing chickpea yield and were also found to be significant at one per cent. The coefficient of multiple determinations (R^2) for Annigeri-1 variety was 0.96. This indicated that 96 per cent of the variation in the production of chickpea was explained by the variables included in the function. The returns to scale in the case of Annigeri-1 variety for control farms were found to be 1.12 indicated increasing returns.

Similarly in the case of Gulbarga district, the production elasticities for adopted farms during baseline with respect to organic manure (-0.23), seed (-0.17) were negative and found to be significant at five per cent where as, human labour (-0.028), contributed negatively and was significant. The coefficient of multiple determinations (R^2) for Annigeri-1 variety was 0.95. This indicated that 95 per cent of the variation in the production of chickpea was explained by the variables included in the function. The returns to scale in the case of Annigeri-1 variety for adopted farms were found to be 0.67 indicated decreasing returns.

In the case of control farms in Gulbarga, the production coefficients for inputs in the case of Gulbarga were fertilizer (-7.36), human labour (-0.23) negatively influenced chickpea production at one per cent probability. While, labour-BP (13.93) was significant at one per cent and contributed positively to the production followed by machine labour (0.80) PPCs (-0.92) which were significant at five per cent level of significance. The coefficient of multiple determinations (R^2) for Annigeri-1 variety was 0.95. This indicated that 95 per cent of the variation in the production of chickpea was explained by the variables included in the function. The returns to scale in the case of Annigeri-1 variety for adopted farms were found to be 1.26 indicated increasing returns.

4.9.2 Allocative efficiency in chickpea production for Annigeri-1 baseline

The Marginal Value Product (MVP) to Marginal Factor Cost (MFC) ratios of resources in the production of chickpea during baseline for Annigeri-1 is presented in Table 4.15.

In the base line survey of (adopted farms) Dharwad district, the MVP to MFC ratio was greater than unity for fertilizer (3.42), labour-BP (8.14), PPCs (7.56) indicated the greater scope for using additional units of fertilizer, labour, PPCs resource to increase gross income from chickpea cultivation. The MVP to MFC ratios was found to be positive but less than unity for seed (0.45), organic manure (0.04) indicated underutilization of these inputs.

The control farms in Dharwad district showed the MVP to MFC ratio as greater than unity for labour-BP (9.45), and machine labour (8.25) indicated the scope to increase the use of these inputs. Thus, labour-BP and machine labour were underutilized, while, organic manure, fertilizer, human labour, PPCS was over-utilized in chickpea cultivation.

In the base line survey of (adopted farms) Gulbarga districts, the MVP to MFC ratio was greater than unity for fertilizer (7.35), labour-BP (4.42), Machine (9.42) indicated the greater scope for using additional units of these resource to increase gross income from chickpea cultivation. The MVP to MFC ratios was found to be positive but less than unity for seed (0.45), organic manure (0.41), and indicated underutilization of these inputs.

In the case of Gulbarga district (baseline), the control villages showed the MVP to MFC ratio as greater than unity for labour-BP (74.46), machine (24.05), indicated the scope to increase the use of these input, While in the case of adopted villages were showed that MVP to MFC ratio was less than unity for all the inputs showed a utilization of resources inefficiently.

4.9.3 Production function estimates for Annigeri-1 and JG-11-in Dharwad district- Early adoption

The estimated coefficients of the Cobb-Douglas production function fitted to the chickpea data for adopted and control farms in the case of Annigeri-1 and JG-11 varieties in Dharwad district are presented in Table 4.16.

The coefficient of multiple determinations (R^2) for Annigeri-1 in Dharwad district was 0.90 for adopted farms and while, in the case of control farmers it was 95 per cent where, in that case so much

variation in the chickpea returns was explained by the included variables. In the farms in adopted villages of Dharwad districts for Annigeri-1 variety (early adoption) showed the contribution of different variable inputs to the returns. The production elasticities of the resources for organic manure (0.011), labour-BP (0.33), indicated their significant contribution at five per cent level of significance. While, PPCs (0.50) contributed positively to the returns and was significant at one per cent probability. Similarly in the case of control farms of Dharwad district, the production coefficients for organic manure (0.13) and human labour (1.22), showed positive influence on gross returns and were significant at one and five per cent levels of probabilities. The returns to scale in the case of Annigeri-1 variety for adopted and control farms were found to be 0.91 and 1.64 which were indicated decreasing and increasing returns to scale respectively.

The coefficient of multiple determinations (R^2) for JG-11 chickpea production in Dharwad was 0.96 in the case adopted and the same was 0.96 in the case of control farms in Dharwad district. In the case of JG-11 chickpea growing farms in the adopted villages of Dharwad district showed that output elasticities of seed (0.006), labour (0.031) and machine (0.094) exerted positive and significant influence on output at one per cent significance level. Whereas, the output elasticities for fertilizer (0.004) was significant at five per cent level of probability. In the case of controlled farms of Dharwad the output elasticities for seed (0.015) and human labour (0.62), Labour-BP (0.64) was positive and significant at one per cent level. On the other hand, the output elasticities of fertilizer (0.0091) and PPCs (0.008) were positive and significant at five per cent level. The returns to scale in the case of JG-11 variety for adopted and control farms were found to be 1.31 and 1.30 which were indicated increasing returns to scale.

4.9.4 Production function estimates for Annigeri-1 and JG-11 in Gulbarga district- Early adoption

The coefficient of multiple determinations (R^2) value was high at 0.90 in the case of adopted farms and whereas it was 0.95 in the case of control farms. Thus, indicated that the variables included in the function explained 90 per cent and 95 per cent variation in the chickpea returns. The output elasticities for Annigeri-1 variety in the adopted farms for seed (-0.0051), organic manure (0.0015), were significant at one per cent level of significance whereas, human labour (0.05), machine (0.00068) was also positive and significant at five per cent level. In the case of control farms the input the production coefficients for fertilizer (0.695) and PPCs (0.440), showed positive influence on returns and were significant at five and one per cent level of probability, respectively. Whereas, labour-BP (-0.42) significantly reduced chickpea returns at five per cent level. The returns to scale in the case of Annigeri-1 variety for adopted and control farms were found to be 0.04 and 0.57 which were indicated decreasing returns.

The coefficient of multiple determinations (R^2) of JG-11 variety value was high at 0.97 in the case of adopted farms and whereas, it was 0.96 in the case of control farms in Dharwad district. This indicated that the variables included in the function explained 97 per cent and 96 per cent of variation in the chickpea returns. In the case of adopted farms, the production elasticity for seed (82.48), labour-BP (82.57), PPCs (20.42), human labour (11.03) was positive implying its positive and significant contribution at five per cent probability, while, in the case of labour-BP (82.57), PPCs (20.42), human labour (11.03) was positive but not significant. The same for fertilizer (0.008) was positive and was significant at five per cent level. In the case of control farms, seed (0.19) positively and significantly contributed to the output at five per cent probability, whereas, the production elasticity of PPCs (-0.02) was negative and implied significant reduction in output at five per cent level. The returns to scale in the case of JG-11 variety for adopted and control farms were found to be 1.19 and 1.02 which indicated increasing returns.

4.9.5 Allocative efficiency in chickpea production in Dharwad district-Early Adoption

The Marginal Value Product (MVP) to Marginal Factor Cost (MFC) ratios of resources in the production of chickpea in the case of Annigeri-1 and JG-11 varieties for Dharwad and Gulbarga districts during early adoption are presented in Table 4.17.

In the case of adopted (Annigeri-1) farms in Dharwad district, the MVP to MFC ratios were greater than unity for, PPCs (5.20) and labour-BP (5.00) thus, it could be inferred that these resources are underutilized offered scope to increase them. The ratios for other resources like, seed (-0.30) machine labour (0.51) and fertilizer (-0.46) were less than one and negative implied over use of the resource in the production and thereby signal towards reduction of these inputs under production. The controlled farms of Annigeri-1, the ratios for inputs like, machine labour (8.00), fertilizer (1.90), human

labour (10.92), labour-BP (5.01), and PPCs (6.12) found to have been positive and more than unity values implying scope for additional usage. However, in the case of inputs such as seed (-1.33) the ratios were negative thereby indicating over utilization of the resources in chickpea production.

In the case of adopted (JG-11) farms in Dharwad district had MVP to MFC ratios greater than unity for organic manure (32.40), PPCs (24.63), labour-BP (18.47) machine labour (3.68). The ratios for other resources like, seed (0.13), human labour (0.50) and fertilizer (0.15) were observed to be ratios less than unity indicating their over use. In the case of controlled farms with respect to JG-11 variety, the MVP and MFC ratios for majority of the inputs were less than unity and also negative. Those which had ratios positive and more than one were labour-BP (1.69) implied the under utilization and hence could be increased to enhance profits. However, in the case of inputs such as, fertilizer (-0.32), human labour (-1.01), machine labour (-0.009) the ratios were not only less than one but negative thereby indicating their over use in the production.

4.9.6 Allocative efficiency in chickpea production-Annigeri-1 and JG-11 in Gulbarga district -Early adoption

In the case of adopted (Annigeri-1) farms in Gulbarga district, The ratios for other resources like, seed (-0.09) and machine labour (0.02), were not only less than unity but also negative thereby implying over use of them in the production and hence, must be reduced. The inputs human labour (0.21), labour-BP (0.18) were under utilized. In the case of controlled farms of Annigeri-1, the ratios for inputs like, fertilizer (14.26) and PPCs (2.79) were found to have significantly high positive values. However, for inputs such as seed (-0.66), labour-BP (-5.91), machine labour (-3.84), the ratios were not only less than one.

The adopted (JG-11) farms in Gulbarga district had very high MVP to MFC ratios for seed (2067.30) and machine labour (3938.30) indicating their underutilization. Hence, there is a scope to intensify the use of seed machine labour, for higher productivity and to maximize profitability. The ratios for other resources like PPCs (0.20) was observed to be positive and. However, in the case of inputs such as the MVP and MFC ratios for inputs were more than unity for fertilizer (-434.40), labour-BP (-159.40), human labour (-1129.80), implied their over use and scope to reduce the usage in production. The controlled farms with respect to JG-11 variety had MVP to MFC ratios greater than unity for seed (4.80), labour-BP (15.82), machine labour (9.48) and labour (15.82) indicated their underutilization. The inputs which had positive ratios and less than one were human labour (0.006), fertilizer (0.069) implied the over utilization and hence could be reduced for better profits. However, in the case of input like PPCs (-0.50), the ratios were not only less than one but negative thereby indicating their over use and need for reduction in the production.

4.10 Decomposition approach

The results presented so far represented that there was difference in the chickpea yields between Annigeri-1 and JG-11 varieties. The various sources contributing to yield difference between ruling Annigeri-1 (old) variety 1 and JG-11 improved variety was estimated through decomposition analysis for Dharwad and Gulbarga districts separately.

The results of estimated structural break, geometrical means for costs and returns and decomposition of total yield difference in chickpea varieties for Dharwad district are presented in the Tables 4.18 to 4.20.

4.10.1 Structural break in the production relations between JG-11 and Annigeri-1 Varieties in Dharwad district

Before going for decomposition analysis to estimate variability in productivity differences and analyze the causes for such yield differences there is need establish the presence of structural break in the production relations between JG-11 and Annigeri-1 varieties. To identify the structural break in chickpea production relations with the introduction of JG-11 variety as improved technology against Annigeri-1 as the ruling (old) variety in Dharwad district. The direct estimates of Cobb-Douglas type of production function were used and are presented in the Table 4.18.

In order to test the existence of structural break in the production relationship between the two varieties of chickpea production, the Cobb-Douglas production function was estimated with both the intercept and slope dummies.

Table 4.14: Production function estimates in chickpea production - (Annigeri-1) - baseline survey

SI. No.	Particular	Dharwad			Gulbarga	
		Estimates	Adopted n=80	Control n=40	Adopted n=80	Control n=40
1	Intercept	ln A	13.92	11.17	12.09	-36
2	Seed	X ₁	0.002*** (0.02)	0.25 (0.24)	-0.17** (0.16)	-4.76 (5.15)
3	Organic manure	X ₂	0.003*** (0.001)	-0.002*** (0.086)	-0.23** (0.107)	-0.20*** (0.16)
4	Fertilizer	X ₃	0.23** (0.60)	-0.26*** (0.20)	0.087** (0.68)**	-7.36*** (9.01)
5	Human labour	X ₄	-0.36 (0.48)	-0.09 (0.43)	-0.028*** (0.006)	-0.23*** (0.51)
6	Labour-BP	X ₅	0.70*** (-0.2052)	0.71*** (0.533)	0.6548 (0.71)	13.93*** (9.10)
7	Machine labour	X ₆	-0.20 (0.68)	0.57 (0.26)	0.43 (0.42)	0.80** (1.74)
8	PPCs	X ₇	0.68 (1.08)	-0.057 (0.102)	-0.07 (0.055)	-0.92** (0.38)
		R	0.93	0.96	0.95	0.95
		F	0.53	56.20	121.45	5.88
		Σbi	1.06	1.12	0.67	1.26

Note: *** - Significant at 1% level

** - Significant at 5% level -

Figures in parentheses indicate standard errors of coefficient

Table 4.15: MVP to MFC ratios of resources in chickpea production (Annigeri-1) - baseline survey

Sl. No.	Particular	Dharwad		Gulbarga	
		Adopted n=80	Control n=40	Adopted n=80	Control n=40
		MVP/MFC	MVP/MFC	MVP/MFC	MVP/MFC
1	Seed	0.02	4.35	-2.83	-77.73
2	Organic manure	0.04	-0.06	-1.51	-10.66
3	Fertilizer	3.42	-4.45	7.35	-67.86
4	Human labour	-2.84	-0.93	-0.02	-1.68
5	Labour-BP	8.14	9.45	4.42	74.46
6	Machine labour	-2.67	8.25	9.42	24.05
7	PPCs	7.56	-0.87	-4.90	-54.58

Table 4.16: Production function estimates in chickpea production-Early adoption

Sl. No.	Particular	Annigeri-1					JG-11			
		Dharwad			Gulbarga		Dharwad		Gulbarga	
		Estimate s	Adopted	Control	Adopted	Control	Adopted	Control	Adopted	Control
1	Intercept	ln A	4.02	15.44	8.81	4.21	0.89	9.63	-277.8	10.97
2	Seed	X ₁	-0.02 (0.07)	-0.09 (0.52)	-0.0051** (0.025)	-0.058 (0.89)	0.0061*** (0.009)	0.015*** (0.017)	82.48** (35.90)	0.19** (0.17)
3	Organic manure	X ₂	0.011** (0.017)	0.13*** (0.05)	0.0015*** (0.0043)	-0.014 (0.148)	0.00	0.00	0.00	0.00
4	Fertilizer	X ₃	-0.02 (0.04)	0.10 (0.104)	-0.015 (0.011)	0.69** (0.12)	0.004** (0.008)	0.0091** (0.003)	0.008** (30.94)	0.0017 (0.085)
5	Human labour	X ₄	0.09 (0.14)	1.22** (0.51)	0.05** (0.033)	0.025 (0.056)	0.031*** (0.307)	0.62*** (0.02)	11.03 (40.49)	0.00041 (0.00082)
6	Labour-BP	X ₅	0.33** (0.09)	0.23 (0.09)	0.0073 (0.0117)	-0.42** (1.19)	0.43 (0.591)	0.64*** (0.023)	82.57 (36.940)	0.81 (0.094)
7	Machine labour	X ₆	0.02 (0.08)	0.46 (0.32)	0.00068** (0.0097)	-0.085 (0.16)	0.094*** (0.373)	-0.0003 (0.001)	-8.16 (5.70)	0.049 (0.024)
8	PPCs	X ₇	0.50*** (0.29)	0.41 (0.35)	0.0052 (0.0089)	0.44*** (0.65)	0.75 (1.406)	0.0080** (0.0080)	20.42 (31.17)	-0.02** (0.096)
		R ²	0.90	0.95	0.90	0.95	0.96	0.97	0.97	0.98
		F	2.92	6.73	1.77	2.81	0.31	2.40	3.23	2.30
		Σbi	0.91	1.64	0.04	0.57	1.31	1.30	1.19	1.02

Note: *** - Significant at 1% level ** - Significant at 5% level ; Figures in parentheses indicate standard errors of coefficient

Table 4.17: MVP to MFC ratios of resources in chickpea production - Early Adoption

Sl. No.	Particular	Annigeri-1				JG-11			
		Dharwad		Gulbarga		Dharwad		Gulbarga	
		Adopted	Control	Adopted	Control	Adopted	Control	Adopted	Control
		MVP/MFC	MVP/MFC	MVP/MFC	MVP/MFC	MVP/MFC	MVP/MFC	MVP/MFC	MVP/MFC
1	Seed	-0.30	-1.33	-0.09	-0.66	0.13	0.37	2067.30	4.850
2	Organic manure	0.40	8.67	0.23	-0.90	32.40	0.0019	0.00	0.000
3	Fertilizer	-0.46	1.90	-0.36	14.26	0.15	-0.32	-434.4	0.069
4	Human labour	0.88	10.92	0.52	0.21	0.50	-1.01	-1129.8	0.006
5	Labour-BP	5.00	5.01	0.18	-5.91	18.47	1.69	-159.4	15.823
6	Machine labour	0.51	8.00	0.02	-3.84	3.68	-0.009	3938.3	9.482
7	PPCs	5.20	6.12	0.02	2.79	24.63	0.24	0.20	-0.504

Table 4.18: Production function estimates in chickpea production on JG-11 and Annigeri-1 in Dharwad district

Sl. No.	Particular	Parameter	JG-11	Annigeri-1	Pooled
1	No. of observations	N	60	60	120
2	Intercept	A	19.679 (16.513)	9.00 (12.32)	9.007 (46.48)
3	Seed	X ₁	0.172*** (2.279)	-0.01 (0.077)	-0.012 (1.93)
4	Organic manure	X ₂	-0.0009 (0.005)	0.014** (0.015)	0.015*** (0.38)
5	Fertilizer	X ₃	0.004** (0.010)	-0.007 (0.04)	-0.008*** (1.13)
6	Human labour	X ₄	2.220*** (0.327)	-0.0108 (0.135)	0.011*** (3.35)
7	Labour-BP	X ₅	0.330** (0.510)	0.29** (0.083)	0.293*** (2.08)
8	Machine labour	X ₆	3.179*** (0.531)	0.087 (0.079)	0.088*** (1.84)
9	PPCs	X ₇	0.89*** (0.488)	-0.32 (0.15)	-0.328*** (3.38)
10	Intercept dummy	X ₈	-	-	16.289*** (3.993)
	Slope Dummy				
11	Seed	X ₉	-	-	0.18*** (2.57)
12	Organic manure	X ₁₀	-	-	-0.015** (0.388)
13	Fertilizer	X ₁₁	-	-	0.012 (1.13)
14	Human labour	X ₁₂	-	-	2.20*** (3.36)
15	Labour-BP	X ₁₃	-	-	0.62*** (2.11)
16	Machine labour	X ₁₄	-	-	-3.26*** (1.88)
17	PPCs	X ₁₅	-	-	-0.57*** (3.40)
18	Coefficient of multiple determination	R ²	0.99	0.93	0.99
19	Adjusted R ² Value	R ²	0.96	0.90	0.99
20	F Value	F	170.69	1573.72	15431.12

Note: *** - Significant at 1% level

** - Significant at 5% level

Figures in parentheses indicate standard errors of coefficient

The estimated equation was a good fit as indicated by the significant F-ratio (170.69). It could be noticed that all of the slope dummies were significant with the only exception of the dummy variables for two varieties. In other words, the hypothesis of homogeneity in the regression coefficients of two varieties between the two production functions was rejected whereas, the same hypothesis was accepted in the case of all other inputs. The intercept dummy was significant (19.67).

In the case of pooled chickpea production function with JG-11 variety practice as dummy variable with value assigned as 1 was used for identifying structural break if any in production relation with the introduction of JG-11 variety intervention as a new variety against Annigeri-1 as an old variety. The regression co-efficient for intercept dummy variable (16.289) was significant at one per cent level and also calculated 'F' value (15431.12) was greater than 'F' critical value (2.2157) at one per cent for 15 and 104 degrees of freedom. The pooled regression co-efficient for organic manure (0.015) and human labour (0.011) were found to be positive and significant at one per cent level of significance. The regression co-efficient for seed (-0.012), PPCs (-0.328) were negative and significant at one per cent whereas, for bullock labour-BP (0.293) and machine labour (0.088) were found to be positively influencing the yield and significant at one per cent level.

The regression co-efficient for slope dummy variables, seed (0.18), human labour (2.20), and labour-BP (0.62) were positive and significant at one per cent level of significance. The regression coefficients of machine labour (-3.26), organic manure (-0.015) and PPCs (-0.57) were negative and significant at one per cent level of probability.

4.10.2 Geometric mean levels of cost and returns in chickpea production in Dharwad district

The per acre geometric mean levels of gross returns and input costs in the chickpea production are presented in the Table 4.19.

It is clear from the Table 4.19 that the gross returns on JG-11 variety (Rs. 10129) were more than that on Annigeri-1 variety (Rs. 5113.265). With regard to input costs the JG-11 variety practice involved about 2.16 per cent more seed cost, 50.22 per cent less organic manure cost, 30.85 per cent less fertilizers cost, 27.62 per cent less human labour cost, 43.21 per cent less plant protection chemicals cost, while, 39.31 per cent more bullock labour cost and 5.10 per cent more machine labour cost.

4.10.3 Decomposition of total differences in chickpea yield between JG-11 and Annigeri-1 in Dharwad district

The total change in yield received from chickpea production due to adoption of JG-11 variety was decomposed using decomposition equation (4) developed by Bisaliah provided in Chapter III, using the production function parameters (estimates) from Table 4.18 and geometric mean levels of returns and cost of inputs from Table 4.19. The results of output decomposition analysis are presented in Table 4.20.

A perusal of Table 4.20 revealed that between the adopters of JG-11 and Annigeri-1 there was variability in the yield to the extent of 25.68 per cent between the varieties. The difference in the yield was further decomposed into different sources of change such as adoption of JG-11 variety (technology) and all other inputs under production. The JG-11 variety as a technology component contributed positively to the extent of 17.35% to the income variation, while, the contribution to the yield difference by input levels was found to be also positive and they together contributed to 11.65% variation in income. Amongst the various inputs, seed (2.58%), human labour (2.16%), fertilizer (2.02%), bullock labour (1.57%), organic manure (1.38%), machine labour (1.22%) and PPCs (0.72%) contributed positively to the income variation.

The results of estimated structural break, geometrical means for costs and returns and decomposition of total yield difference in chickpea varieties for Gulbarga district are presented in the Tables 4.21 to 4.23.

4.10.4 Structural break in the production relations between JG-11 and Annigeri-1 Varieties in Gulbarga district

The results of estimated structural break, geometrical means for costs and returns and decomposition of total yield difference in chickpea varieties for Gulbarga district are presented in the Tables 4.21 to 4.23.

Table 4.19: Geometric mean levels of returns and cost involved in the production of Annigeri-1 and JG-11 in Dharwad district

Sl. No.	Particular	JG-11	Annigeri-1	Difference (%)
1	No of observation	60	60	
2	Seed	683.51	669.06	2.16
3	Organic manure	122.65	246.35	-50.22
4	Fertilizer	315.83	456.71	-30.85
5	Human labour	762.33	1053.27	-27.62
6	Labour-BP	620.52	376.58	39.31
7	Machine labour	453.88	431.87	5.10
8	PPCs	513.52	904.19	-43.21
	Gross return	10129.49	5113.26	49.52

Table 4.20: Estimated difference in income between JG-11 and Annigeri-1 varieties in Dharwad district

Sl. No.	Particular	In per cent
I	Total estimated difference in the gross income	25.68
II	Sources of income growth	
1	Technology component	17.35
a	Neutral component	68.18
b	Non-neutral component	-50.83
2	Input use difference	11.65
a	Seed	2.58
b	Organic manure	1.38
c	Fertilizer	2.02
d	Human labour	2.16
e	Labour-BP	1.57
f	Machine labour	1.22
g	PPCs	0.72

Before going for decomposition analysis to estimate variability in productivity differences and analyze the causes for such yield differences there is need establish the presence of structural break in the production relations between JG-11 and Annigeri-1 varieties. To identify the structural break in chickpea production relations with the introduction of JG-11 variety as improved technology against Annigeri-1 as the ruling (old) variety in Gulbarga district. The direct estimates of Cobb-Douglas type of production function were used and are presented in the Table 4.21.

In order to test the existence of structural break in the production relationship between the two varieties of chickpea production, the Cobb-Douglas production function was estimated with both the intercept and slope dummies.

The estimated equation was a good fit as indicated by the significant F-ratio (0.31). It could be noticed that all of the slope dummies were significant with the only exception of the dummy variables for two varieties. In other words, the hypothesis of homogeneity in the regression coefficients of two varieties between the two production functions was rejected where as, the same hypothesis was accepted in the case of all other inputs. The intercept dummy was significant (8.63).

In the case of pooled chickpea production function with JG-11 variety practice as dummy variable with value assigned as 1 was used for identifying structural break if any in production relation with the introduction of JG-11 variety intervention as a new variety against Annigeri-1 as an old variety. The regression co-efficient for intercept dummy variable (14.289) was significant at one per cent level of significance and also calculated 'F' value (6.65) was greater than 'F' critical value (2.2157) at one per cent for 15 and 104 degrees of freedom. The pooled regression co-efficient for machine labour (0.10) and PPCs (0.047) were found to be positive and significant at one per cent level of significance.

The regression co-efficient for slope dummy variables, organic manure (0.14) was positive and significant at one per cent level of significance. Where as Fertilizer (-0.011) was negative and significance at one per cent level of probability.

4.10.5 Geometric mean levels of cost and returns in chickpea production in Gulbarga district

The per acre geometric mean levels of gross returns and input costs in the chickpea production are presented in the Table 4.22.

It is clear from Table 4.22 that the gross returns on JG-11 variety (Rs. 16930.59) were more than that of Annigeri-1 variety (Rs. 10326). With regard to input costs the JG-11 variety practice involved about 7.19 per cent more seed cost, 102.82 per cent more human labour, 10.57 more organic manure cost 11.53 per cent more plant protection chemicals cost where as 68.16 per cent less bullock labour, 47.33 per cent less fertilizers cost, 70.20 per cent less machine labour cost, while, and 68.16 less bullock labour cost.

4.10.6 Decomposition of total differences in chickpea yield between JG-11 and Annigeri-1 in Gulbarga district

The total change in yield received from chickpea production due to adoption of JG-11 variety was decomposed using decomposition equation (4) developed by Bisaliah provided in Chapter III, using the production function parameters (estimates) from Table 4.21 and geometric mean levels of returns and cost of inputs from Table 4.22. The results of output decomposition analysis are presented in Table 4.23.

A perusal of Table 4.23 revealed that between the adopters of JG-11 and Annigeri-1 there was variability in the yield to the extent of 11.36 per cent between the varieties. The difference in the yield was further decomposed into different sources of change such as adoption of JG-11 variety (technology) and all other inputs under production. The JG-11 variety as a technology component contributed positively to the extent of 8.03% to the yield variation, while, the contribution to the yield difference by input levels was found to be also positive and they together contributed to (3.33%) variation in yield. Amongst the various inputs, seed (1.12%), human labour (0.16%), fertilizer (0.32%), bullock labour (0.57%), organic manure (0.52%), machine labour (0.24%) and PPCs (0.40%) contributed positively to the yield variation.

The results of estimated structural break, geometrical means for costs and returns and decomposition of total yield difference in chickpea varieties for Gulbarga district are presented in the Tables 4.21 to 4.23.

Table 4.21: Production function estimates in chickpea production on JG-11 and Annigeri-1 in Gulbarga district

Sl. No.	Particular	Parameter	JG-11	Annigeri-1	Pooled
1	No. of observations	n	60	60	120
2	Intercept	a	8.63 (175.14)	9.59	9.59 (175.75)
3	Seed	X ₁	40.15*** (23.67)	0.16*** (0.05)	-0.16 (22.54)
4	Organic manure	X ₂	0.007** (0.00)	-0.009 (0.01)	-0.0092 (4.76)
5	Fertilizer	X ₃	-0.00283 (0.1912)	-0.17 (0.031)	-0.017 (11.86)
6	Human labour	X ₄	24.92*** (17.017)	-0.0027 (0.070)	-0.0027 (4.066)
7	Labour-BP	X ₅	1.56*** (4035)	-0.016 (0.035)	-0.016 (13.54)
8	Machine labour	X ₆	-1.57 (3.58)	0.105*** (0.020)	0.10** (7.57)
9	PPCs	X ₇	15.55*** (6.01)	0.04 (0.02)	0.047** (8.67)
10	Intercept dummy	X ₈	-	-	14.289*** (3.993)
	Slope Dummy				
11	Seed	X ₉	-	-	-39.9877
12	Organic manure	X ₁₀	-	-	0.148786***
13	Fertilizer	X ₁₁	-	-	-0.01124***
14	Human labour	X ₁₂	-	-	-0.00013
15	Labour-BP	X ₁₃	-	-	24.9408
16	Machine labour	X ₁₄	-	-	-1.68369
17	PPCs	X ₁₅	-	-	15.50 (9.78)
18	Coefficient of multiple determination	R ²	0.96	0.90	0.99
19	Adjusted R ² Value	R ²	0.95	0.90	0.96
20	F Value	F	0.31	2485.7	6.65

Note: *** - Significant at 1% level

** - Significant at 5% level

Figures in parentheses indicate standard errors of coefficient

Table 4.22: Geometric mean levels of returns and cost involved in the production of JG-11 and Annigeri-1 in Gulbarga district

Sl. No.	Particular	Annigeri-1	JG-11	Difference (%)
1	No of observation	60	60	
2	Seed	78.97	84.65	7.19
3	Organic manure	441.85	488.58	10.57
4	Fertilizer	1029.83	1517.24	47.33
5	Human labour	473.31	959.98	102.82
6	Labour-BP	281.02	89.47	-68.16
7	Machine labour	2398.13	714.57	-70.20
8	PPCs	658.854	734.794	11.53
	Gross return	10326.25	16930.59	63.96

Table 4.23: Estimated difference in income between JG-11 and Annigeri-1 in Gulbarga district

Sl. No.	Particular	In per cent
I	Total estimated difference in the gross income	11.36
II	Sources of income growth	
1	Technology component	8.03
a	Neutral component	12.59
b	Non-neutral component	-4.56
2	Input use difference	3.33
a	Seed	1.12
b	Organic manure	0.52
c	Fertilizer	0.32
d	Human labour	0.16
e	Labour-BP	0.57
f	Machine labour	0.24
g	PPCs	0.40

Table 4.24: Garrett Scores for Preferred Traits (Production) in chickpea Cultivars

District	Dharwad						Gulbarga						Overall					
	Annigeri-1	JG-1	BGD-103	JAKI-9218	MNK-1	KAK-2	Annigeri-1	JG-1	BGD-103	JAKI-9218	MNK-1	KAK-2	Annigeri-1	JG-1	BGD-103	JAKI-9218	MNK-1	KAK-2
HY	0.00	70.25	72.07	73.75	50.00	52.33	0.00	72.20	72.31	0.00	50.00	39.25	0.00	71.21	72.15	73.75	50.00	71.96
SD	30.66	32.79	39.47	48.25	70.00	40.00	30.59	38.40	45.08	0.00	70.00	30.00	30.76	36.28	41.15	48.25	70.00	55.00
DRR	70.92	50.42	47.33	55.00	0.00	0.00	71.12	54.10	49.46	0.00	0.00	0.00	71.03	52.11	47.98	55.00	0.00	0.00
PR	45.10	40.75	19.60	33.75	0.00	0.00	45.18	47.80	21.69	0.00	0.00	0.00	45.14	43.48	20.80	33.75	0.00	0.00
DIR	0.00	57.63	64.33	65.00	0.00	0.00	0.00	63.90	66.31	0.00	0.00	0.00	0.00	60.33	64.87	65.00	0.00	0.00
ISF	55.31	19.17	16.27	27.25	31.00	20.67	55.11	26.60	16.92	0.00	31.00	15.50	55.07	22.71	16.20	27.25	31.00	28.42

*Note: GS=Garrett Score

HY=High Yield

SD=Short Duration

DIR=Disease Resistance

FCS=Fitness into Cropping System

DRR=Drought Resistance

ISF=Improvement in Soil Fertility

Table 4.25: Preferred marketing traits in the cultivated varieties of chickpea

District	Dharwad						Gulbarga						Overall					
	Annigeri-1	JG-1	BGD-103	JAKI-9218	MNK-1	KAK-2	Annigeri-1	JG-1	BGD-103	JAKI-9218	MNK-1	KAK-2	Annigeri-1	JG-1	BGD-103	JAKI-9218	MNK-1	KAK-2
Varieties	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS
Marketing Trait	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS
High demand	57.96	49.54	58.20	50.25	31.00	70.00	53.85	60.10	60.85	50.25	37.33	52.50	56.09	55.92	58.88	25.08	37.33	48.13
Fetches higher price	54.94	52.63	52.73	60.00	60.00	43.67	52.02	46.35	47.23	60.00	63.33	32.75	53.21	48.50	50.63	31.67	58.33	30.02
Bigger grain size	38.10	48.00	40.07	40.75	60.00	37.33	44.25	43.60	42.92	40.75	50.33	28.00	41.31	45.31	41.50	18.75	55.33	25.67

Table 4.26: Perception on constraints in chickpea cultivars in Karnataka - Garrett Scores-early adoption

District	Dharwad					Gulbarga						Overall					
Variety	Annigeri-1	JG-11	BGD-103	JAKI-9218	KAK-2	Annigeri-1	JG-11	BGD-103	JAKI-9218	MNK-1	KAK-2	Annigeri-1	JG-11	BGD-103	JAKI-9218	MNK-1	KAK-2
Constraints	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS
LY	73.67	0.00	0.00	0.00	0.00	76.20	0.00	0.00	0.00	0.00	0.00	74.89	0.00	0.00	0.00	0.00	0.00
HPI	54.49	65.38	72.00	72.25	71.00	51.95	68.65	71.38	72.25	68.00	71.00	52.62	67.07	71.69	36.75	68.00	71.00
HDI	62.91	35.63	39.67	37.75	35.00	62.85	47.45	39.62	37.75	58.57	35.00	63.28	41.36	38.14	37.75	58.39	35.00
LD	46.19	0.00	0.00	0.00	0.00	43.97	0.00	0.00	0.00	0.00	0.00	45.14	0.00	0.00	0.00	0.00	0.00
SGS	24.00	0.00	0.00	0.00	0.00	15.88	0.00	0.00	0.00	0.00	0.00	19.73	0.00	0.00	0.00	0.00	0.00
LMP	41.12			53.00		34.90			53.00	44.43		38.04			27.83	44.43	

*Note: GS=Garrett Score
LY=Low Yield
HPI=High Pest Incidence

LD=Long Duration
SGS=Small Grain Size

LRS=Low Recovery/Shelling %
LMP=Low Market Price

HDI=High Disease incidence

4.11 Preferred production and marketing traits in chickpea cultivars

To analyse the traits preferred in chickpea cultivars by the farmers Garrett Ranking Method was used and the traits were grouped under different heads, namely, production (Table 4.24) traits and market (Table 4.25) traits. By and large, the traits preferred by the farmers in the new cultivars are conversant of the constraints faced by them in the existing cultivars.

4.11.1 Preferred production traits in chickpea cultivars

High yielding characteristics was the single most preferred production trait (Table 4.24) across varieties and districts. While, Annigeri-1, according to farmers was preferred for its undamaged by drought in Dharwad (GS: 70.92) and Gulbarga districts (GS: 71.92) with overall preference of farmers towards Annigeri-1 for its drought resistance as indicated by high Garrett's score (GS: 71.03). However, farmers assigned moderate Garrett's scores for drought resistance with respect to JG-11 (GS: 52.11), BGD-103 (GS: 47.98), and JAKI-9218 (GS: 55.00) varieties. The farmers preferred new varieties because of high yielding characteristics as indicated by their respective high Garrett's scores in the case of JG-11 (GS: 71.21), BGD-103 (GS: 72.15), JAKI-9218 (GS: 73.75), and KAK-2 (GS: 71.96). Similar high weightage through scores were assigned to these varieties in Dharwad and Gulbarga districts. The farmers indicated the presence of disease resistance (DIR) quality as an important trait in the new cultivars and was evidenced by high scores assigned by them for both districts together in respect of varieties namely, JG-11 (GS: 60.33), BGD-103 (GS: 64.87), and JAKI-9218 (GS: 65.00). Similar, high scores were assigned to these cultivars for disease resistance by the sample farmers when analysed separately for each district. Moderate scores were assigned to the improved varieties namely, JG-11 (GS: 36.28), BGD-103 (GS: 41.15), and JAKI-9218 (GS: 48.25) for their short duration quality. The overall Garrett's scores assigned were low to moderate in respect of pest resistance of the varieties such as BGD-103 (GS: 20.80), JAKI-9218 (GS: 33.75) and JG-11 (GS: 43.48) with similar impression by farmers expressed in the two study districts. Similar observation through assigned Garrett's scores in respect of improved varieties was found with respect to their contribution towards improvement in soil fertility (GS: varied between 16.20 and 27.25).

4.11.2 Preferred marketing traits in chickpea cultivars

The farmers opined and indicated their market preferences for the improved varieties which they adopted in the tropical legumes-II project in Dharwad and Gulbarga districts. The farmers who adopted improved varieties like, JG-11 (GS: 55.92), BGD-103 (GS: 58.88) (both *desi* types) and KAK-2 (GS: 48.13) (*kabuli* type) had high preference to these varieties because of their high demand in the market as revealed by moderately high weightage given/assigned through Garrett's scores. Annigeri-1 variety was also assigned approximately the same weightage (GS: 56.09) as that of the improved ones for its preference due to high demand in the market. Farmers scores were relatively low with respect to JAKI-9218 (GS: 25.08) and MNK-1 (GS: 37.33) as they felt that these varieties lack high demand in the market. Farmers preferred JG-11 (GS: 48.50), BGD-103 (GS: 50.63) and MNK-1 (GS: 58.33) with moderately high Garrett's scores indicated against their names due to their ability to fetch higher market price. This could be supported by the fact that JG-11 which almost has a resemblance to the Annigeri-1 variety along with slightly bigger and uniform grain size (GS: 45.31). Similar observation could be made with respect to BGD-103 which has extra bold seed size (GS: 41.50) most preferred by traders. MNK-1, *kabuli* type has a bigger grain size (GS: 55.33) and there by farmers preferred it as it also fetched higher price in the market.

4.12 Production and marketing constraints in chickpea cultivars

The constraints faced by the chickpea cultivars in Dharwad and Gulbarga districts in terms of production and marketing were analyzed by using Garrett Ranking Method and the results were presented in Table 26. These are based on the opinions expressed by the respondents of the sample districts.

Low yielding character was a most important constraint with respect to Annigeri-1 variety (GS: 74.89) across different farms and districts. According to farmers, Annigeri-1 was an age old variety cultivated extensively by farmers under rain fed condition. The extensive cultivation of this variety according to farmers was due to its high drought tolerance potential. In the absence of any alternative variety they continued to produce it. Further, the other constraints associated were severe problem of heavy pest (GS: 52.62) and high disease incidence (GS: 63.28) as expressed by farmers across farms and districts. Similar observation was made through assigned Garrett's scores with respect to its long duration (GS: 45.14) nature. Farmers also implied low market price (GS: 38.04) for Annigeri-1 produce

as a result of smaller grain size (GS: 71.92) besides lack of uniform grains size of Annigeri-1 variety could be another reason for low market price.

The farmers preferred new varieties because of high yielding characteristics as indicated by their respective high Garrett's scores (Table 4.24). The farmers felt that the improved varieties were highly susceptible to insect problem and assigned high Garrett's scores for varieties like, JG-11 (GS: 67.07), BGD-103 (GS: 70.81) among *desi* and in the case of *kabuli* varieties such as, KAK-2 (GS: 71.00) and MNK-1 (GS: 68.00) this could be due to change in the host plant in place of Annigeri-1, plant canopy, and taste. In the case of disease incidence when compared to Annigeri-1, improved varieties found to be less susceptible as opined by farmers. Hence, they assigned low scores to high disease incidence with respect to JG-11 (GS: 41.36) followed by BGD-103 (GS: 38.14), JAKI-9218 (GS: 37.75) and MNK-1 (GS: 58.57) followed by KAK-2 (35.00) when compared to Annigeri-1 (GS: 63.28).

DISCUSSION

The results of the study presented in the previous chapter are discussed under the following sub-headings:

5.1 Growth rate in chickpea area production and productivity and their instability

5.2 Growth rates, their instability and direction of chickpea trade

5.3 Socio-economic characteristics of sample farmers

5.4 Composition of chickpea in the cropping pattern

5.5 Impact of improved chickpea varietal interventions on adoption process

5.6 Input utilization pattern in chickpea production

5.7 Cost structures in chickpea production

5.8 Impact of varietal interventions on income/returns

5.9 Resource use efficiency in chickpea cultivation

5.10 Decomposition approach

5.11 Preferred production and marketing traits in chickpea cultivars

5.12 Constraints in chickpea cultivars

5.1 Compound growth rates and instability in area, production and productivity of chickpea

5.1.1 Compound growth rates and instability in area, production and productivity of chickpea

Among the states, Madhya Pradesh is the largest chickpea producing state in the country (mean annual area of 25.04 lakh ha) under the crop showed growth in area and production by 1.14 and 2.26 per cent annually, respectively during the study period (Table 4.1). Thus implied that Madhya Pradesh contributed substantially to the area and production followed by Maharashtra, Rajasthan, Uttar Pradesh, Karnataka and Andhra Pradesh in that order in term of area under chickpea. The annual growth in area in these states ranged between 0.08 per cent to 14.47 per cent and that for production ranged between 1.61 per cent to 21.18 per cent except for Uttar Pradesh where a marginal decline in production was observed (0.68%).

Among the major states, Andhra Pradesh ranked first in respect of productivity (1248.10 kg/ha) and showed an annual increase in yield by 2.10 per cent. The instability was also low (14.70%). In the case of Madhya Pradesh the average productivity was 902.81 kg/ha with a growth rate in yield by 0.72 per cent and low yield instability (11.14%). Thus, these states provide greater scope for enhancing chickpea productivity in the country. The results on instability index for area (3.44%) and production (3.69%) showed a lowest value in the case of Madhya Pradesh followed by Uttar Pradesh (8.13% and 0.12%, respectively), Maharashtra (10.51% and 0.12%, respectively) and implied more stable area and production under chickpea crop over the study period. In the case of Andhra Pradesh, Karnataka and Rajasthan the area instability index was moderately high (16.52% to 19.73%). While, production instability in Karnataka (0.24%) and Maharashtra (0.12%) during the study period was low. This indicated their stable contribution to production. Whereas, production instability in Rajasthan (25.56%) and Andhra Pradesh (24.80%) were found to be relatively high which needed to be over come through spread of production technology especially by popularizing high yielding cultivars? Considering the existing productivity levels in different states it could be noticed that Andhra Pradesh had highest per hectare productivity of 1248.10 kg/ha. While, for other states excepting Madhya Pradesh which had second highest per hectare productivity it was ranged between 650.80 kg/ha to 675.70 kg/ha.

The states of Uttar Pradesh and Rajasthan occupy a predominant position in respect of chickpea area in the country. However, the cause for concern was decline in per hectare productivity in Uttar Pradesh (-7.12%) and Rajasthan (-1.85%). On the whole, for all the major chickpea producing states together it could be inferred that increased production in chickpea in these major states was guided by increased area (1.60%) and productivity (0.89%) of chickpea crop. Thus, the hypothesis

made on increase in area, production and productivity of chickpea in major chickpea producing states of India is accepted. However, focus needed to be placed towards enhancing crop area and productivity for increasing chickpea production in these major chickpea growing states in the country. This could be achieved through strengthening extension approaches for promotion of production technologies and development of high yielding cultivars suitable for each agro-climatic condition. However, most of the earlier studies especially conducted during the green revolution period in India have reported productivity led increase in production as observed by (Acharya (1993), Dhindsa and Anjusharma (1997)) in the production of different pulses in India.

5.1.2 Compound growth rates and instability in area, production and productivity of chickpea in Karnataka

The compound growth rates and instability indices for area, production and productivity were worked out for Karnataka state for the study districts as well. For the state as a whole, there was a significant increase in the area (6.96%), productivity (3.98%) and production (10.72%) of chickpea during the study period. Thus, it implied that there was an expansion in the chickpea area in the recent years. This could be attributed to shifting cultivation of chickpea crop from earlier inter crop to a mono-crop in the recent years due to favourable price in the market. On the contrary, there was a considerable decline in area under chickpea (Table 4.2) both in Gulbarga (-27.00%) and Dharwad (-14.56%) districts during study period. The Gulbarga being one of the drought prone districts of the state with high seasonal variations resulted reduction in the chickpea area. It further also influenced towards a decline in the productivity (-4.50%) and production (-30.35%) during the study period. While, in the case of Dharwad district although there was decline in area the increased productivity (13.43%) growth off-set to some extent of decrease in production which declined annually by 2.89 per cent.

The main reason for slow growth of yield compared to area and production is the prevalence of prolonged drought conditions during the study period. The variation in production was comparatively less in Gulbarga when compared to Dharwad. Thus, the hypothesis made on increase in area, production and productivity of chickpea in major chickpea producing study districts in Karnataka is rejected except for productivity in Dharwad district. However, earlier studies conducted in India have reported productivity led increase in production as observed by Acharya (1993), Dhindsa and Anjusharma (1997) for different pulses in India.

5.2 Growth rate and instability in export and import of chickpea

The compound growth and instability in export and import of chickpea and direction of chickpea trade in India have been discussed (Tables 4.3 and 4.4) here under in the following sub-head.

5.2.1 Growth and instability in export and import of chickpea

The results on export and import of chickpea over the study period indicated that the India's chickpea import both by quantity and value terms was almost twice that of exports. However, there was growth in the chickpea exports (4.31%) from India. The imports on the other hand declined by 2.72 per cent annually during same period. Thus, increase in exports could be due to growth in chickpea area and as well as productivity in the major chickpea producing states besides having greater stability in respect of area and productivity (Table 4.1). The instability index for chickpea imports (24.75%) in value terms was more stable than exports (81.18%). This implied that there was a high variability between year to year in exports of chickpea during the study period while, imports were rather more stable.

Similarly, results on chickpea imports (Table 4.3) by India for the study period (2001-02 to 2011-12) showed that India's chickpea imports increased at an annual growth of 5.16 per cent in value terms with an instability index of 24.75 per cent. This could be due to fluctuations in the chickpea prices in the international market and also a high variability in the year to year international market prices. The quantity of imports no doubt declined (-2.73%) during the study period and but this was also accompanied by a high variability in India's imports indicated by high instability index of 96.08 per cent during the period. The negative growth in imports could be a good indicator of India's lesser dependence on imported chickpea and this could be because of greater emphasis towards enhancing productivity and production of pulses under Technology Mission on Oilseed and Pulses particularly in crops like chickpea due to greater domestic demand as India is a largest consumer of chickpea in the world. India produces and consumes approximately four to six million tonne of mainly *desi* type chickpea each year. India is the world leader in chickpea production followed by Pakistan and Turkey.

Besides, a greater thrust towards pulses production could be one of the reasons for increasing exports of chickpea from India as indicated by annual export growth rate of 4.31 per cent in the study period. Stock Markets Review (2009-10) study revealed that over the years, India continues to be the largest producer and consumer of pulses in the world. Among all other pulses, chana (chickpea) continues to be the largest consumed in this complex, and chickpea comprises of 45-50% of the total pulses production of India.

Hence, the hypothesis that increased India's growth in exports both by quantity and value terms were accepted while, hypothesis of increased growth in imports by value terms has been accepted whereas, in terms of quantity it is rejected.

5.2.3 Direction of trade of chickpea

The direction of chickpea trade by India was attempted only for its imports from other countries and for exports it was not carried out as the importing countries/destinations of chickpea from India did not remain stable during the study period as is demanded by the Markov Transitional Probability Matrix model.

The dynamics of imports trend was an important aspect in drafting import oriented programs by the policy makers in order to reduce the current import trends which cost exchequer. Hence, the knowledge on changing exporters and their share in the India's total imports considered as important to know the loyal and stable exporting destinations in to India.

The finite Markov Chain (stochastic) process was used in the analysis of the changes in the direction of imports of chickpea by India to capture the net effect of switching pattern of import trade over a period of time. This was achieved by examining gains and losses in the export share of chickpea by major exporting countries by deriving Transitional Probability Matrices (TPM) presented in Table 4.4.

The analyses of Transitional Probability Matrix of chickpea import by India revealed that of the country's total imports of chickpea from different exporting destinations, Tanzania Republic retained 84.87 per cent of its previous year's export share to India. This was due to the fact that among the trading countries, Tanzania Republic was the growing potential and loyal India's chickpea import destination. This high retention of market share of chickpea by Tanzania republic may be due to increasing demand for chickpea in India. The remaining 12.97 per cent of Tanzania Republic export share was directed towards to Myanmar.

Myanmar appeared to be next most loyal and stable chickpea exporter to India indicated by retention of 47.10 per cent of its previous years' export trade share to India. Of the remaining export share, 39.93 per cent was directed to Iran and 12.97 per cent to Tanzania Republic.. This indicated that both Tanzania Republic. and Myanmar were the most potential export markets for chickpea to India.

Australia had moderate probability retention of 24 per cent of its previous year's share of exports to India. Of the remaining export share, 62.59 per cent was directed to other countries and 12.64 per cent to Myanmar.

Other chickpea exporting countries retained 31.79 per cent of their previous year's share. While, 30.36 per cent of its previous years' exports share to India were directed towards Australia and 17.07 per cent to Iran.

The main conclusions were that the Indian chickpea market is segmented mainly by the end-use and also because of preference towards desi type chickpea. Australian *desi* chickpeas are perceived as not suitable for consuming as whole or for making roasted chickpea because of their bitter taste. The size of *kabuli* chickpea is considered very important and Australia's *kabuli* chickpea is smaller than the preferred size. *Desi* chickpeas from Tanzania Republic. and Myanmar are considered to have a sweet taste. Australian *desi* is suitable for making dhal and flour, because the bitterness is masked in cooking and is also preferred against local varieties and other imported chickpeas as it has high recovery rate, large sized grains and uniformity and low contamination. Similar results were found by Frank Agbola *et al.* (2000) who analyzed the factors influencing the market demand for chickpea in India.

5.3 Socio-economic characteristics of sample farmers

The demographic characteristics and general characteristics of the households (Table 4.5) showed that mean age of the household heads across districts proved to be of productive age (49 years) and where their ability to with stand risks in farming enterprises would be always high when at productive age. Caste-wise composition was almost on par in both the study districts as majority belonged to forward caste (63.00%) followed by other backward caste (23.00%).

The gender ratio (1.02) observed for both the districts together indicated female out numbered male. The average family size ranged between 7 to 8 members per household across districts while the size was slightly more in Dharwad (about 8) than in Gulbarga (about 7). Majority (50.00%) of them belonged to age group between 40-64 years followed by the age group 20-40 (32.59%) years. The remaining 14.07 per cent of them were over 65 years of age. This indicated availability of substantial work force in the age groups of more than 20 years.

Educational achievements among the farmers showed that a large proportion (about 60.00%) of them had primary and higher secondary education and collegiate education was also quite high among respondents (19.00%). About 21 per cent farmers had no formal education. Thus, it could be ascertained from the results that while adopting strategies for promoting technology adoption there is need to focus similar extension strategies involving demonstrations, trainings to appraise about the modern technologies. The level of participation in local bodies among the farmers was found to be poor (91.48%). This showed the farmers were well experienced and matured in the cultivation of chickpea. High literacy rate among the farmers in the study area was the resultant of their sound economic strength.

Agriculture/livestock has been the main occupation for Dharwad of about 96.30 per cent of the farm families in the selected talks, Gulbarga was 90.37. In the case of secondary occupation Agriculture/livestock Dharwad was 3.70 per cent it's very less as compared to Gulbarga showed 9.63 this speaks of importance of farming. More than 90 per cent of the farm land owned by households in Gulbarga was dry land than the Dharwad district; this is predominantly a drought prone district.

5.4 Cropping pattern on the sample farms

5.4.1 Cropping pattern and major crops grown by chickpea growers in Dharwad District

The area under *kharif* crops accounted to 54.13 per cent of the gross cropped area during *kharif* 2007-08 (Table 4.6). While, during 2009-10 there was a marginal reduction in the *kharif* cropped area at 51.19 per cent of the gross cropped area and could be attributed to seasonal conditions owing to rainfall. The major crops in the *kharif* season in the district were cereals and pulses (maize, sorghum and green gram). Among the *rabi* crops, chickpea occupied substantial area of about 36 per cent of the gross cropped area both during 2007-08 and 2009-10. This implied the prominence of the crop in the Dharwad district and of its commercial importance due to favorable market price. The cropping intensity in 2007-08 was less (148%) compared to 2009-10 (154%).

5.4.2 Cropping pattern and major crops grown by chickpea growers in Gulbarga district

The area under different crops grown on the chickpea growing sample farms in Gulbarga district (Table 4.6) depicted that of the total gross cropped area during the cropping year 2007-08, *kharif* crops occupied 59.42 per cent area. The same during 2009-10 accounted 57.84 per cent of the gross cropped area. The major crops in the *kharif* season in the district were pigeon pea, sorghum, and green gram. Among the *rabi* crops, chickpea occupied substantial area of about 39 to 40 per cent area to the gross cropped both during 2007-08 and 2009-10. As observed in the case of Dharwad, chick pea even in Gulbarga was a prominent crop in during *rabi* season. The cropping intensity in the respective years was 138 and 142 per cent. Thus, results signified that chickpea crop assumed a greater importance in both districts and it was earlier grown as an inter crop with *rabi* sorghum was being cultivated as mono crop extensively in recent years by the farmers. This could also due to stable prices and better returns apart from being lesser management requirement of the crop.

5.5 Impact of improved chickpea varietal interventions on adoption process

5.5.1 Adoption of improved varieties in Dharwad district

The results (Table 4.7) on varietal adoption during baseline-2007-08 revealed that of the total chickpea area, 90.70 per cent of it was allocated for Annigeri-1 with as large as 86.67 per cent of the farmers found to have adopted this age old variety in Dharwad district. The other varieties namely, *kabuli*, bhima and local chickpea occupied 9.30 per cent area and cultivated by 13.33 per cent farmers. The area under Annigeri-1 declined significantly and occupied only 49.10 per cent area (68.89% farmers) during 2009-10.

The reduction in the area under Annigeri-1 was taken over by the newly introduced cultivars identified through FPVS process under TL-II project. The varieties such as JG-11, BGD-103, JAKI-9218 among the *desi* type and MNK-1 and KAK-2 among *kabuli* types were preferred by farmers in the initial stage adopted them. Among the new varieties, JG-11 occupied 22.40 per cent of the total chickpea by area by as many 20.74 per cent of farmers during 2009-10. This was followed by BGD-103, a bold seeded *desi* type that occupied 16.40 per cent chickpea area and was adopted by 14.07 per cent farmers. JAKI-9218 occupied 7.80 per cent area (3.70% farmers). Among *kabuli* varieties, KAK-2 occupied relatively more area than MNK-1.

5.5.2 Adoption of improved varieties in Gulbarga district

The results (Table 4.7) on varietal adoption during baseline-2007-08 in Gulbarga district revealed that of the total chickpea area, 94.80 per cent of it was allocated for Annigeri-1 with as large as 71.85 per cent of the farmers found to have adopted this age old variety in the district. The other varieties namely, *kabuli* and local chickpea occupied 5.20 per cent area and cultivated by 28.15 per cent farmers. The area under Annigeri-1 declined significantly and occupied only 46.10 per cent area (62.96% farmers) during 2009-10.

The area reduction under Annigeri-1 was taken over by the newly introduced cultivars identified through FPVS process under TL-II project. The varieties such as JG-11, BGD-103, JAKI-9218 among the *desi* type and MNK-1 and KAK-2 among *kabuli* types were preferred by farmers in the initial stage of adoption. Among the new varieties, JG-11 occupied 23.20 per cent of the total chickpea by area by as many 24.44 per cent of farmers during 2009-10. This was followed by BGD-103, a bold seeded *desi* type that occupied 16.60 per cent chickpea (14.81% farmers). JAKI-9218 occupied a negligible area of 0.20 per cent area (less than 1.00% farmers). Among *kabuli* varieties, MNK-1 and KAK-2 occupied 2.10 per cent area each. These results observed for both districts were in line with the results obtained by Karunakaran (2009) in groundnut production. This clearly indicated that the farmers in the Gulbarga district also accepted new chickpea cultivars in place of Annigeri-1, an old variety cultivated popularly for many years by farmers because of its drought tolerant nature and which yields even under adverse production conditions especially in Gulbarga district which is one of the drought prone districts of the state and a pulse bowl.

The acceptability of these varieties by farmers in both districts during the early adoption was considered quite high. According to farmers in the study districts JG-11, a high yielder and resembling Annigeri-1 and is also resistant to wilt disease was much preferred as against BGD-103 which has an extra bold sized seed and generally comes up well under good management conditions with adequate moisture regime.

The early results of adoption process of new varieties by farmers indicated that their preference was high towards *desi* types when compared to *kabuli* types. The results thus are indicative of farmers' inclination towards new and improved high yielding varieties of chickpea in place of Annigeri-1. This was mainly due to higher yield potentials with desired traits in these new varieties along with high market demand.

This shift in the varietal adoption in both the districts was mainly due to intervention of improved varieties promoted under the TL-II project during 2007-08 to 2009-10. The promotion of new chickpea cultivars in the districts was carried out through varietal trials, crop demonstrations and intensive extension programmes such as trainings, field days which created awareness about these new varieties. Therefore, the hypothesis made before hand regarding increase in the adoption of new chickpea cultivars by farmers in the study districts is accepted.

5.5.3 Productivity changes-comparison between baseline and early adoption

The discussion on the productivities of chickpea old and improved varieties between baseline and early adoption are compared (Table 4.8). The analysis on the productivities of these varieties showed that on an average the yield per acre of Annigeri-1 during baseline and early adoption varied between 415 kg/acre to 465kg/acre. The other varieties cultivated by farmers in Dharwad district during baseline were bhima (278 kg/acre), *kabuli* (402 kg/acre) and local chickpea (409 kg/acre). Similarly, in the case of Gulbarga, the other varieties were *kabuli* (408 kg/acre), local variety (387 kg/acre) and also considered to be very low. The intervention efforts made in the project towards popularizing new and high yielding chickpea varieties resulted into adoption of improved varieties which were not found earlier. These improved ones registered high productivities when compared to Annigeri-1 cultivated by farmers. Among these *desi* varieties, per acre yield of BGD-103 varied between 557 kg/acre and 581 kg/acre during early adoption. This was followed by JG-11 which registered a yield of 532 kg/acre in Dharwad and 566 kg/acre in Gulbarga, JAKI-9218 yielded 506 kg/acre and 540.00 kg/acre in Dharwad and in Gulbarga districts, respectively in that order. Among the *kabuli* types, KAK-2 showed highest yield of 443 kg/acre in Dharwad and 507 kg/acre in Gulbarga sample farms. While, MNK-1 yielded 360.00 kg/acre in Dharwad and 497 kg/acre in Gulbarga district during early adoption. The results on yields when compared between districts clearly indicated that chickpea productivities for all the varieties including Annigeri-1 were substantially higher in Gulbarga when compared to yields in Dharwad district. This could be attributed to the fact that Gulbarga district in the state has been recognized as pulse bowl of the state with suitability of production conditions for pulses. As a result, the district was a largest producer of chickpea in the state with highest area under it. Thus, considering the higher productivities of newly introduced cultivars in the district it could be said that they offered alternative to old variety, Annigeri-1 which is being cultivated since long in the study districts because of its drought tolerance nature and its ability to give some yield even under adverse production conditions. In addition to this, lack of alternative genotypes in place of Annigeri-1 was another reason. Therefore, the hypothesis made beforehand that intervention of new chickpea varieties lead to increased productivity among the farmers in the study area over ruling variety is accepted.

5.6 Input utilization pattern in chickpea production

5.6.1 Input utilization pattern in chickpea production between baseline and early adoption

The inputs utilization in chickpea cultivation (Table 4.9) for Annigeri-1 both in baseline and early adoption were compared with JG-11 in early adoption between adopted and control farms in each district. Hence, the results implied that there was almost similar labour use pattern observed for carrying out various agricultural operations in the cultivation of Annigeri-1 variety (both in baseline and early adoption) and JG-11 (in early adoption) across adopted and control farmers (ranged between 22 man days/ac to 28 man days/ac).

It could be inferred from the results across the districts that on an average adopted and control farmers in Dharwad district applied marginally more fertilizer than farmers of Gulbarga in chickpea production and this could be largely attributed to fairly better and assured rainfall condition with command irrigation in Dharwad. Lesser fertilizer application in Gulbarga was predominantly could be that the district is often drought prone.

The quantity of seed used per acre in the two districts by adopted and control farmers ranged between a 21.59 kg/ac to 30.43 kg/ac. Thus, implied variability in quantity of seed rate/ acre both in A-1 and JG-11 influenced by soil moisture regime at the time of sowing as influenced by varied *rabi* rains distribution in the study districts.

Some of the operations mechanization was adopted in the chickpea cultivation such as ploughing operations (land shaping during land preparation). Hence on an average across the districts adopted and control conditions farmers used machine power for tillage operations. Similar observation was made with respect to PPCs where they applied for control of pest (pod borer) and diseases (wilt disease). However, farmers in Gulbarga in early adoption used relatively more PPCs to control pest and diseases in the case of A-1 (2.75 litre/ac to 5.00 litres /ac) due to high incidence of pest and diseases.

Thus, it could be inferred that, there was a marginal variability in the quantum of inputs used by farmers for Annigeri-1 and JG-11 varieties both in baseline and early adoption periods. The crop as

such not very much of input intensive nature and this could be seen from the input utilization results. These results were in line with the results obtained by Mundinamani and Kunnal (2004) for cotton production.

5.7 Costs profile in chickpea production

5.7.1 Cost structures in chickpea production-comparison between baseline and early adoption

The total cost of cultivation of Annigeri-1 variety in the baseline period among the adopted and control farmers across districts (Table 4.10). The total cost incurred among adopted (Rs. 9462.61/acre) farms in Dharwad was more than half of in Gulbarga (Rs. 7323.83/acre). The variable cost in both districts was about 56.00 per cent and the remaining was fixed cost. Among the variable cost components for A-1 variety, male and female labour together accounted to about 15.00 per cent to 16.00 per cent in both districts. While, the labour cost by control farmers in the case of A-1 was about 14.00 per cent to 16.00 per cent in two districts. Adopted and control farmers in Gulbarga incurred marginally more cost on seed in Gulbarga than in Dharwad. Fertilizer cost was another important cost (5.41 to 5.87 per cent of the total cost) across districts and farm types. Gulbarga farmers applied marginally less fertilizer than Dharwad farmers. This could be due to poor moisture conditions, especially during sowing regime when farmers practice fertilizer application to crop under rainfed situation. In the case of labour-BP, the adopted and control farms in Gulbarga used more (over 10%) of animal power for tillage operations than machine labour. While, that of Dharwad, the labour-BP and machine labour ranged about 6.00 to 8 per cent of the total cost.

The comparison of per acre costs for Annigeri-1 variety during baseline and early adoption (Table 4.11 and 4.12) indicated an increase in the total cost of cultivation in the latter period. In the case of control farms during early adoption, the total costs in Dharwad (Rs. 9606.30/acre) and Gulbarga (Rs. 9208.59/acre) were higher than baseline (Rs. 8982.39/acre and Rs. 7089.65/acre, respectively) costs. The incremental cost of cultivation in the early adoption over baseline in both districts was due to increase in the variable costs especially due to labour, PPCs, fertilizer and machineries.

A comparison of total cost of cultivation of JG-11 variety in the early adoption period among the adopted and control farmers across districts (Table 4.12) is made. The total cost among adopted farms was found to be Rs. 8789.62/acre and of which about 53 per cent was variable cost in Dharwad and a total cost of Rs. 7646.06.83/acre (about 58% as variable cost) in Gulbarga district. Among the variable costs components in the cultivation of JG-11 variety, cost of male and female labour together was about 20 per cent in Dharwad and about 22 per in Gulbarga districts. The cost of cultivation of JG-11 in the case of control farms was Rs. 9172.20/acre in Dharwad whereas it was Rs. 8579.96/acre in Gulbarga. The labour cost was the highest share in the variable cost and was 18.35 per cent in Dharwad and 24.52 per cent in Gulbarga district. Other variable costs like, seed cost was about 7.00 to 8.00 per cent in Dharwad across adopted and control farms whereas, it was about 8 to 9 per cent of the total cost in Gulbarga. The fertilizer cost across district varied between 4.86 to 5.50 per cent and the labour-BP and machine labour accounted about 4.00 to 6.80 per cent of the total cost. The variability in the cost incurred on plant protection chemicals was about 5.00 to 6.00 per cent except in the case of control farms of Gulbarga where the PPCs cost was 7.50 per cent of total cost. This was largely depended on pest and diseases incidence in the study districts. Interestingly, the amount of cost incurred on PPCs on Annigeri-1 (9.00% to 16.00% across adopted and control farms) crop was more than JG-11 (5.00% to 8.00%). This could be due to high pest load and susceptibility of Annigeri-1 to wilt disease and on the contrary lesser cost of PPCs in the case of JG-11 could be attributed to its tolerance to wilt.

5.8 Impact of varietal interventions on crop income

The returns of popular ruling variety of chickpea (Annigeri-1) cultivated during baseline and early adoption across adopted and control farms in Dharwad and Gulbarga districts were worked out and are discussed below (Table 4.13)

5.8.1 Impact of varietal interventions on crop income on chickpea– between baseline and early adoption

The per acre returns on different improved varieties such as JG-11, BGD-103, MNK-1 increased over that of ruling variety Annigeri-1 under rain fed condition. There has been a greater

emphasis on chickpea crop in the rain fed areas in recent years in the study districts owing to higher returns. Hence, the Tropical Legume-II project intervened with new chickpea cultivars through FPVS process which have high adoptability to the local production conditions. Thus, would be important to discuss the potential benefits that improved varieties offered to the farmers in the study districts. The gross returns were lower for Annigeri-1 (ranged between Rs. 7637/acre to Rs. 9867/acre) variety low during the baseline and also during early adoption (ranged between Rs. 9345/acre to Rs. 10600/acre.) A marginal increase in gross returns in the early adoption was mainly due to increase in the output price in the case of Annigeri-1.

There was a substantial increase in the gross returns in both districts in the case of JG-11 in the early adoption over Annigeri-1 across adopted and control farms in baseline and early adoption. In the early adoption the per acre gross returns for JG-11 in ranged between Rs. 14,000 to 16451.00. Thus, there was almost one and half times to two times increase in the gross returns from JG-11 over Annigeri-1 (baseline) and one and half times increment in gross returns in JG-11 over Annigeri-1 (early adoption). Thus, it could be inferred in general that there was nearly 50.00 to 60.00 per cent increase in the gross returns of JG-11 over Annigeri-1 in the early adoption across farm types in both districts as a result of incremental productivity of 33.00 to 50.00 per cent.

The incremental returns over costs in JG-11 in early adoption was quite high ranging between Rs. 5415.48/acre to Rs. 8358/acre over Annigeri-1 across districts and farms. Thus, it could be inferred that the incremental net returns of JG-11 three to forty five times over Annigeri-1 (when compared with baseline) and about four to twenty times increase over Annigeri-1 (when compared with early adoption).

The benefit-cost ratio for Annigeri-1 (baseline) across farms and districts ranked between 0.80 to 1.36 while, ratio for the same variety in the early adoption was 1.01 to 1.26. This indicated almost identical returns for every rupee spent. On the contrary, the B-C Ratio for JG-11 was high and was between 1.63 to 2.09 for every rupee investment. The higher net returns in the case of JG-11 were also influenced by not only higher yields but also attracted premium price for its output in the market. While, the marginally lower cost of cultivation in improved variety JG-11 over Annigeri-1 implied varietal potential to yield and higher returns.

Therefore, the results on increased returns proved that the hypothesis made beforehand with respect to increase in the returns of new chickpea cultivars among the farmers in the study area over ruling variety is accepted.

In addition to JG-11, other improved varieties such as BGD-103 (desi) and MNK-1 (kabuli) cultivated by farmers on only a small proportion of chickpea area. It could be inferred that the farmers' preference for these varieties was less in the early adoption period. The popularization through trials and demonstrations could be continued to appraise the potentials of these varieties among the farmers. The gross return across districts in the case of BGD-103 (Rs. 14887/acre to Rs. 16783/acre) and MNK-1 (Rs. 16783/acre to Rs. 16595/acre) were also quite high and comparable with that of JG-11. The overall net returns for both BGD-103 and MNK-1 were also quite high (range between Rs. 5144/acre to Rs. 7974/acre). These results were in line with the results obtained by Nanjareddy *et al.* (1990) studied the economics of producing hybrid and local tomato varieties.

5.9 Resource use efficiency in chickpea cultivation

5.9.1 Chickpea production function estimates of Baseline Survey in Dharwad district- (2007-08)

The Cobb–Douglas production function was fitted to the data collected from chickpea farmers during baseline and early adoption periods from chickpea sample farmers of Dharwad and Gulbarga districts across adopted and control farms in respect of Annigeri-1, a ruling variety and improved variety, JG-11. The estimates of the production functions were used for analyzing the allocative efficiency of resources on these farms.

5.9.1 Chickpea production function estimates for Annigeri-1 Baseline

The estimated coefficients of the Cobb-Douglas production function for Annigeri-1 during baseline was fitted to the input costs and output values and the results are presented in Table 4.14.

The coefficient of multiple determinations (R^2) for the variety during baseline (adopted) was 0.93 and for control farms it was 0.96. This indicated that the variables included in the production function explained 93 and 96 per cent of the variation in the chickpea yield.

In the adopted sample farms of Dharwad district during baseline, output elasticities of seed, organic manure, and labour-BP were found to influence positively the yield of Annigeri-1 variety and the production elasticity of fertilizer was negative and declines the yield. While, in control farms of the district, the production elasticities of organic manure, fertilizer and labour-BP were negatively influencing chickpea yield.

Similarly in the case of Gulbarga district, the production elasticities for adopted farms during baseline for organic manure, seed were negative. Whereas, human labour (-0.028), contributed negatively to the total output. In the case of control farms, the production coefficients for inputs like fertilizer (-7.36) and human labour (-0.23) negatively influencing chickpea output. While, labour-BP contributed positively to the production. The returns to scale of Annigeri-1 variety was increased except in the case of adopted farms of Gulbarga district. The coefficient of multiple determination (R^2) for Annigeri-1 variety was 0.95 in both adopted and control farms. This indicated 95 per cent of the variation in the production of chickpea was explained by the variables included in the function. Hence, the hypothesis of resource use efficiency by farmers in the study districts is accepted. The same results were found by Rajkumar Biradar (2007) in red gram based cropping systems.

5.9.2 Allocative efficiency in chickpea production for Annigeri-1 baseline

In the base line survey of (adopted farms) Dharwad district, The MVP to MFC ratios in the production of chickpea presented in table 4.15 revealed that the MVP to MFC ratios for fertilizer (3.42), labour-BP (8.14), PPCs (7.56) were more than one indicating their under use and that still there was scope for higher utilization of these inputs and which in turn would have increased the gross income and there by to maximize their profit. The MVP to MFC ratios was found to be positive but less than unity for seed (0.02), organic manure (0.04), indicated as over used which in turn would decrease the gross income. Whereas, in the case of control farms of Dharwad district showed that MVP to MFC ratio as greater than unity for labour-BP and machine labour indicated the scope to increase the use of these inputs. While, organic manure, fertilizer, human labour, PPC was over-utilized in chickpea cultivation.

In the base line survey of (adopted farms) Gulbarga districts, the MVP to MFC ratio was greater than unity for fertilizer (7.35), labour-BP (4.42), Machine (9.42) indicated the greater scope for using additional units of labour resource to increase gross income from chickpea cultivation. The MVP to MFC ratios was found to be positive but less than unity for seed (0.45), organic manure (0.41), and indicated overutilization of these inputs.

Similarly in the case of Gulbarga district (baseline), the control villages showed the MVP to MFC ratio as greater than unity for labour-BP (74.46), machine (24.05), indicated the greater scope to increase the use of these input, While these adopted villages were less than unity for all the inputs revealing utilization of resources inefficiently. The same results were found in the Rajkumar b. Biradar (2007) on economics of red gram based cropping systems.

5.9.3 Production function estimates for Annigeri-1 and JG-11 in Dharwad district- Early adoption

The coefficient of multiple determinations (R^2) for Annigeri-1 was 0.90 for adopted farms. This indicated that the variables included in the production function (Table 4.16) explained 90 per cent of variation in returns in the case of adopted farms and while, in the case of control farmers it was 95 per cent where, in that case so much variation in the chickpea returns was explained by the included variables. In the farms of adopted farms of Dharwad districts for Annigeri-1 variety (early adoption) showed the contribution of different variable inputs to the returns. The production elasticities of the resources for organic manure (0.011), labour-BP (0.33), indicated their significant contribution to the total output. While, PPCs (0.50) contributed positively to the returns. Similarly in the case of control farms of Dharwad district, the production coefficients for organic manure (0.13) and human labour (1.22), showed positive influence on gross returns. The returns to scale of Annigeri-1 variety were increased in control and adopted farms of Dharwad district.

The coefficient of multiple determinations (R^2) for JG-11 chickpea production in Dharwad was 0.96 in the case adopted and 0.97 in the case of control farms, this indicated that the variables included in the functions explained to the extent of 96 per cent and 97 per cent of the variation in the

chickpea production. In the case of JG-11 chickpea growing farms in the adopted villages of Dharwad district showed that output elasticities of seed (0.006), labour (0.031) and machine (0.094) exerted positive and significant influence on output at one per cent significance level. Whereas, the output elasticities for fertilizer (0.004) and organic manure (0.360) were significant at five per cent. In the case of controlled farms of Dharwad the output elasticities for seed (0.0015) and human labour (0.62), Labour-BP (0.64) fertilizer (0.091) and PPCs (0.0008) were positive contribution to the total production. The returns to scale of Annigeri-1 variety were decreased in the case of adopted farms of Gulbarga district. The hypothesis made on resource use efficiency by farmers in the study district is accepted. The same results were found in the Rajkumar Biradar (2007) on economics of red gram based cropping systems.

5.9.4 Production function estimates for Annigeri-1 and JG-11 in Gulbarga district- Early adoption

The coefficient of multiple determinations (R^2) value of Annigeri-1 (Table 4.16) was 0.90 (adopted farms) and whereas it was 0.95 (control farms) Thus, indicated that the variables included in the function explained 90 per cent and 95 per cent variation in the chickpea returns. The output elasticities for Annigeri-1 variety in the adopted farms for organic manure, human labour, machine labour were positively contributed to the total output. While in the case of control farms the inputs of the production coefficients for fertilizer, and PPCs showed positive, whereas, labour-BP (-0.42) significantly reduced chickpea returns. The returns to scale of Annigeri-1 variety were increased in the case of adopted and farms of Gulbarga district.

In the case of JG-11 in the adopted farms, the production elasticity for seed (82.48), labour-BP (82.57), PPCs (20.42), human labour (11.03) was positive implying its positive to the total output. Production elasticity of labour-BP, PPCs, human labour was positive but not significant contributed to production. In the case of control farms seed (0.19) positively contributed to the output at five per cent probability, whereas, the production elasticity of PPCs (-0.02) was negative and implied significant reduction in output. The coefficient of multiple determinations (R^2) value of JG-11 was 0.97 (adopted farms) and whereas it was 0.98 (control farms) Thus, indicated that the variables included in the function explained 97 per cent and 98 per cent variation in the chickpea returns. The hypothesis made on resource use efficiency by farmers in the study districts is accepted. The same results were found in the Rajkumar Biradar (2007) on economics of red gram based cropping systems (system-II) district.

5.9.5 Allocative efficiency in chickpea production in Dharwad district-Early Adoption

In the case of adopted (Annigeri-1) farms in Dharwad district (Table 4.17) the MVP to MFC ratios were greater than unity for, PPCs, labour-BP thus, it could be inferred that these resources are less utilized and hence offer scope to intensify their use to enhance profitability. The ratios for other resources negative to seed, machine labour, and fertilizer were less than one and negative implied to the total output, thereby alarm decline of these inputs under production. In the case of controlled farms of Annigeri-1, the ratios for inputs like, machine labour, fertilizer, human labour, labour-BP, and PPCs found to be positive and properly utilized and hence could be intensified for higher profits. However, in the case of inputs such as seed, the ratios were not only less than one but negative thereby indicated over utilization of the resources in chickpea production.

In the case of adopted (JG-11) farms in Dharwad district, the MVP to MFC ratios were greater than unity and were considerably high for organic manure, PPCs, labour-BP, machine labour thus, it could be inferred that these resources are highly less utilized and hence offer substantial scope to intensify their use in order to enhance and optimize the level of output of this improved chickpea variety, JG-11 which responds very well under better input management conditions for higher yields and thereby to maximize profitability. The ratios for other resources like, seed (0.13), human labour (0.50) and fertilizer (0.15) were observed to have ratios less than unity indicated their over use. In the case of controlled farms with respect to JG-11 variety, the MVP and MFC ratios for majority of the inputs were less than unity and also negative. Those which had ratios positive and more than one were labour-BP implied the not utilized properly and hence could be reduced to increase profits. Upon analyzing the results, the hypothesis of resource use efficiency by farmers in the study districts is accepted. The same results were found in the Rajkumar b. Biradar (2007) on economics of red gram based cropping systems (system-II).

5.9.6 Allocative efficiency in chickpea production-Annigeri-1 and JG-11 in Gulbarga district -Early adoption

In the case of adopted (Annigeri-1) farms in Gulbarga district (Table 4.17), The ratios resources like, seed and fertilizer were not only less than unity but also negative thereby implied over use of them in the production and hence, must be reduced. The extreme over use of input was observed especially in the case of PPCs which considerably off-set the profits gained in chickpea production. Hence, proper and timely application of PPCs could be highly recommended to prevent unnecessary and excessive use of chemicals for control of pest and diseases. Human labour (0.52) and labour-BP (0.18) were overutilized. In the case of controlled farms with respect to Annigeri-1, the ratios for inputs like, fertilizer and PPCs were found to have significantly high and positive (but more than unity) values. Thus implied their under utilization and indicated a potential and high scope for their intensification for greater profits. However, in the case of inputs such as seed (-0.66), labour-BP (-5.91), machine labour (-3.84), the ratios were not only less than one but negative thereby indicated excessive/over utilization of these resources in chickpea production particularly for inputs like seed, machine labour and labour-BP. Hence, need for training the farmers on scientific cultivation practices and input management aspects could pave way towards timely operations and optimum utilization of essential inputs.

In the case of adopted (JG-11) farms in Gulbarga district (Table 4.17), the MVP to MFC ratios was greater than unity for seed very high (2067.30) and machine labour (3938.30), indicate their underutilization. Hence, there is a scope to intensify the use of seed machine labour for higher productivity and to maximize profitability. The ratios for other resources like, PPCs was observed to be positive and less than unity indicated realization of less than one rupee as return for every rupee invested on the factor and over utilized. However, in the case of inputs such as the MVP and MFC ratios for inputs were less than unity and negative for fertilizer, labour-BP, human labour implied their overuse and scope to reduce the in production. In the case of control farms with respect to JG-11 variety, the MVP to MFC ratios was greater than unity for seed, labour-BP, machine labour and human labour indicate their underutilization. The inputs which had positive ratios and less than one were human labour, fertilizer implied the over utilization and hence could be reduced for better profits. However, in the case of input PPCs, the ratios were not only less than one but negative thereby indicated their overuse and need for reduction in the production. There is an inefficient use of resources in chickpea production. These results were also found by Rajkumar b. Biradar (2007) on economics of red gram based cropping systems System II).

5.10 Decomposition analysis

5.10.1 Structural break in the production relations of JG-11 and Annigeri-1 variety of chickpea in Dharwad district

The production function estimates for chickpea produced under JG-11 cultivation and Annigeri-1 variety cultivation (Table 4.23) revealed that the value of co-efficient of multiple determinations (R^2) was found to be 0.96 and 0.90 in the case of JG-11 and Annigeri-1 variety farmers respectively. This revealed that the independent variables included in the model have explained 96 per cent and 90 per cent of variation in the dependent variable yield of JG-11 and Annigeri-1 variety, respectively. The elasticities organic manure were positive and significant, implies that an increase in the use of this factors over and above their present level result in increase in gross returns of Annigeri-1 farmers where as in the case of JG-11 farmers, the elasticities of variables such as chemical fertilizers, plant protection chemicals, human, bullock and machine labour were found to be significant.

For identifying the structural break in production relations with the introduction of JG-11 in chickpea production, the Cobb-Douglas type of production function was used. Production function with technology dummy variable was fitted for identifying structural break in production relations between the JG-11 and Annigeri-1 variety farmers. Production function with one for JG-11 farmers and zero for Annigeri-1 farmers was estimated.

The regression co-efficient for dummy variable seed (1.36), chemical fertilizers (0.012), Human labour (2.20) and machine (-3.26) was significant at one per cent level of significance. This implied that the parameters governing the input-output relations in the case of JG-11 farmers were different from those of Annigeri-1 farmers. Thus, the results provided the necessary proof for decomposing the total change in per acre income with the adoption of JG-11. In the case of pooled chickpea production function the co-efficient of multiple determinations (R^2) was found to be 0.99, this

revealed that the independent variables included in the model have explained 99 per cent of variation in the dependent variable of pooled chickpea production function. The elasticity coefficients for slope dummy variables such as, seed, organic manure, plant protection measures and bullock labour were positive and found to be significant, but for organic manure/PPCs, human and machine labour were negative and found to be significant. This result is in conformity with those of Bisaliah (1977) for Punjab wheat economy and Ravichandran *et al.* (2006) for wheat economy.

5.10.2 Geometric mean levels of cost and returns in chickpea production in Dharwad district

The per acre geometric mean levels of gross returns and input costs in the chickpea production presented in the Table 4.19 revealed that the gross returns in JG-11 (Rs. 10129.49) were more than that of Annigeri-1 variety farms (Rs. 5113.26) this was mainly due to the fact that the JG-11 chickpea could fetch the premium price in the market. With regard to input costs the JG-11 practice involves less cost than Annigeri-1 variety, this is because the chemical fertilizers and plant protection chemicals were costlier.

5.10.3 Decomposition of total differences in chickpea yield between JG-11 and Annigeri-1 in Dharwad district

With the identification of structural break, the growth in income due to adoption of JG-11 variety was decomposed into constituent forces *i.e.*, efficiency of JG-11 variety and change in level of input use. The total change in income due to adoption of JG-11 variety was computed by using decomposition analysis. The results of output decomposition analysis are presented in Table 4.20.

A perusal of Table 4.25 revealed that the adopters of JG-11 technology produced 5.52 per cent higher income from chickpea production than the adopters of JG-11. The increase in the income was further decomposed into different sources of change such as adoption of JG-11 variety and all other inputs. The JG-11 variety contributed positively (17.31) to the income, while the contribution of change in the input levels was found to be positive (6.34%) of JG-11 variety and all other inputs. The JG-11 variety contributed positively (17.35%) to the income, while the contribution of change in the input levels was found to be positive (11.65%). Amongst the various inputs, organic manure (1.38%), human labour (2.16%), bullock labour (1.57%) and machine labour (1.22%) contributed positively to the income. This implied that the adoption of JG-11 by the chickpea growers has to be encouraged by extension activities to harvest its full benefits. The result highlights the judicious utilization of resources to increase the income from chickpea cultivation.

5.10.4 Structural break in the production relations between JG-11 and Annigeri-1 varieties in Gulbarga district

The production function estimates for chickpea produced under JG-11 cultivation and Annigeri-1 variety cultivation presented in Table 4.21 revealed that the value of co-efficient of multiple determinations (R^2) was found to be 0.95 and 0.90 in the case of JG-11 and Annigeri-1 variety farmers respectively. This revealed that the independent variables included in the model have explained 95 per cent and 90 per cent of variation in the dependent variable yield of JG-11 and Annigeri-1 variety.

The elasticities organic manure were positive and significant, implies that an increase in the use of these factors over and above their present level will result in increase in gross returns of organic farmers where as in the case of JG-11, the elasticities of variables such as chemical fertilizers, plant protection chemicals, human, bullock and machine labour were found to be significant. The elasticities of organic manure, human and bullock labour were positive but non-significant in JG-11 variety.

For identifying the structural break in production relations with the introduction of JG-11 (new variety) in chickpea production, the Cobb-Douglas type of production function was used. Production function with technology dummy variable was fitted for identifying structural break in production relations between the JG-11 and Annigeri-1 variety farmers. Production function with one for JG-11 farmers and zero for Annigeri-1 variety farmers was estimated.

The regression co-efficient for dummy variable for machine labour (0.10) and PPCs (0.047) was significant at five per cent level of significance and the pooled regression co-efficient for machine labour (0.10) and PPCs (0.047) were found to be positive and significant at one per cent level of significance. This implied that the parameters governing the input-output relations in the case of JG-11 variety farmers were different from those of JG-11 variety. Thus, the results provided the necessary

proof for decomposing the total change in per acre income with the adoption of JG-11 variety. In the case of pooled chickpea production function the co-efficient of multiple determination (R^2) was found to be 0.99, this revealed that the independent variables included in the model have explained 99 per cent of variation in the dependent variable of pooled chickpea production function. The elasticity coefficients for slope dummy variables such as, machine labour and PPCs were positive and found to be significant, but Fertilizer (-0.011) were negative and found to be significant. This result is in conformity with those of Bisaliah (1977) for Punjab wheat economy and Ravichandran *et al.* (2006) for paddy economy.

5.10.5 Geometric mean levels of cost and returns in chickpea production in Gulbarga district

The per acre geometric mean levels of gross returns and input costs in the chickpea production presented in the Table 4.22 revealed that the gross returns in JG-11 variety (Rs. 16930.59) were more than that of Annigeri-1 variety (Rs. 10326) this was mainly due to the fact that the JG-11 chickpea could fetch the premium price in the market. With regard to input costs the JG-11 variety practice involves less cost than JG-11 variety this is because the chemical fertilizers and plant protection chemicals, human labour, were costlier.

5.10.6 Decomposition of total differences in chickpea yield between JG-11 and Annigeri-1 in Gulbarga district

With the identification of structural break, the growth in income due to adoption of JG-11 variety was decomposed into constituent forces *i.e.*, efficiency of JG-11 variety and change in level of input use. The total change in income due to adoption of JG-11 variety was computed by using decomposition analysis. The results of output decomposition analysis are presented in Table 4.23.

The JG-11 variety contributed positively (8.05%) to the income, while the contribution of change in the input levels was found to be positive (3.33%). Amongst the various inputs, organic manure (0.52%), labour (0.16%), bullock labour (0.57%) and machine (0.24%), seed (1.12%), fertilizers (0.32%) and plant protection measures (0.40%) contributed positively to the income.

A perusal of Table 4.23 revealed that the adopters of JG-11 variety produced 11.36 per cent higher income from chickpea production. The increase in the income was further decomposed into different sources of change such as adoption of JG-11 variety and all other inputs. The JG-11 variety contributed positively (8.03) to the income, while the contribution of change in the input levels was found to be positive (3.33%). of JG-11 practices and all other inputs. This implied that the adoption of JG-11 variety by the chickpea growers has to be encouraged by extension activities to harvest its full benefits. The result highlights the judicious utilization of resources to increase the income from chickpea cultivation. This result is in conformity with those of Bisaliah (1977) for Punjab wheat economy.

5.11 Preferred production and marketing traits in chickpea cultivars

To discussion on the traits preferred in chickpea cultivars by the farmers Garrett Ranking Method was used and the traits were grouped under different heads, namely, production traits (Table 4.24) and market traits (Table 4.25).

5.11.1 Preferred production traits in chickpea cultivars

High yielding characteristics was the single most preferred production trait (Table 4.24) across varieties and districts. While, Annigeri-1, according to farmers was preferred for its drought resistance in Dharwad and Gulbarga districts with overall preference of farmers towards Annigeri-1 for its drought resistance as indicated by high Garrett's score. However, farmers assigned moderate Garrett's scores for drought resistance with respect to JG-11 followed by BGD-103 and JAKI-9218 varieties. The farmers preferred new varieties because of high yielding characteristics as indicated by their respective high Garrett's scores in the case of JG-Similar high weightage through scores were assigned to these varieties in Dharwad and Gulbarga districts. The farmers indicated the presence of disease resistance (DIR) quality as an important trait in the new cultivars and were evidenced by high scores assigned by them for both districts together in respect of varieties namely, JG-11, BGD-103, and JAKI-9218.

Moderate scores were assigned for short duration quality to the improved varieties namely, JG-11 (GS: 36.28), BGD-103 (GS: 41.15), and JAKI-9218 (GS: 48.25). The overall Garrett's scores

assigned were low to moderate in respect of pest resistance of the varieties such as BGD-103, JAKI-9218 and JG-11 with similar impression by farmers expressed in the two study districts. Similar observation through assigned Garrett's scores in respect of improved varieties was found with respect to their contribution towards improvement in soil fertility BGD-103, JAKI-9218 and JG-11. Considering the results, the hypothesis of farmers' having varied trait preferences in the new chickpea cultivars by farmers in the study districts is accepted. These results are in conformity with results of Suhasini P *et al.* (2009) with respect to Preferred production traits in chickpea cultivars conducted a baseline research report for Tropical Legumes- II project.

5.11.2 Preferred production traits (Market traits) early adoption

The farmers who adopted improved varieties like, JG-11, BGD-103 (both *desi* types) and KAK-2 (*kabuli* type) had high preference to these varieties (Table 4.25) because of their high demand in the market as revealed by moderately high weightage given/assigned through Garrett's scores. Annigeri-1 variety was also assigned approximately the same weightage as that of the improved ones for its preference due to high demand in the market. This was mainly because it being the oldest and ruling variety popular among farmers since had its preference in the market in the absence of improved varieties. Farmer's scores were relatively low with respect to JAKI-9218 and MNK-1 as they felt that these varieties lack high demand in the market. Farmers preferred JG-11 with moderately high Garrett's scores indicated against their names due to their ability to fetch higher market price. This could be supported by the fact that JG-11 which almost has a resemblance to the Annigeri-1 variety along with slightly bigger and uniform grain size (GS: 45.31) attracted the attention of the purchasers/traders and their by high price/premium price over ruling variety. Similar observation could be made with respect to BGD-103 which has extra bold seed size (GS: 41.50) most preferred by traders in the market for processing in to different value added products such as split grains, flour making *etc.* MNK-1, *kabuli* type has a bigger grain size and there by farmers preferred it as it also fetched higher price in the market. Considering the results, the hypothesis of farmers' having varied production and marketing trait preferences in the new chickpea cultivars by farmers in the study districts is accepted. For JG-11, BGD-103 variety, high demand and low price fluctuations were the most preferred ones, in that order, in both the districts. Additionally, Dharwad farmers preferred fetching higher price and bigger grain size in both adopted and control areas. Considering the results, the hypothesis of farmers' were having varied marketing trait preferences in the new chickpea cultivars by farmers in the study districts is accepted. These results are in conformity with results of Suhasini *et al.* (2009) with respect to Preferred marketing traits in chickpea cultivars conducted a research report for Tropical Legumes- II.

5.12 Production and marketing Constraints in chickpea cultivars

The constraints faced by the chickpea cultivars in Dharwad and Gulbarga districts in terms of production and marketing were analyzed by using Garrett Ranking Method (Table 4.25).

Low yielding character was a most important constraint with respect to Annigeri-1 variety across different farms and districts. According to farmers opinions Annigeri-1 was an age old variety cultivated extensively by farmers under rain-fed condition. The extensive cultivation of this variety according to farmers was due to its high drought tolerance potential. In the absence of any alternative variety they continued to produce it. Further, the other constraints associated were severe problem of heavy pest and high disease incidence expressed by farmers across farms and districts. These constraints eventually have high correlation with low productivity in the case of Annigeri-1 as indicated earlier by high Garrett's score. Major pests infested to chickpea crop in the study areas were pod borer (*Helicoverpa armigera*.L), and wilt (*fusarium* wilt) in the case of disease. Similar observation was made through assigned Garrett's scores with respect to its long duration nature. Farmers also implied low market price for Annigeri-1 produce as a result of smaller grain size besides lack of uniform grains size of Annigeri-1 variety could be another as another reason for low market price. However, the smaller grain size, and low market price were not considered by farmers as constraints in the case of improved varieties and not assign any scores against these cultivars. This could be largely attributed to incorporating improvement in the new varieties introduced under Tropical Legumes-II project with respect concerning grain size in tune with the market demand (price).

The farmers preferred new varieties because of high yielding characteristics as indicated by their respective high Garrett's scores (Table 4.24). The farmers felt that the improved varieties were highly susceptible to pest (pod borer) problem and assigned high Garrett's scores for varieties this could be due to change in the host plant in place of Annigeri-1, plant canopy, and taste. In the case of

disease incidence when compared to Annigeri-1, improved varieties found to be less susceptible as opined by farmers, Nothing can be done by the researchers about grain size and low market price, at least pests and diseases could be controlled through improved agronomic practices which would probably enhance its yield and promote its adoption in Gulbarga district and other areas of Dharwad district.

Thus, the crop improvement efforts should concentrate on at least two or three constraints faced by the farmers in the study area by prioritizing these constraints, if the research budgets are limited. Upon analyzing the results, the hypothesis of farmers' have varied production and marketing constraints in the new chickpea cultivars by farmers in the study districts is accepted. These result are in conformity with results of Suhasini P *et al.* (2009) with respect to constraints in production and marketing in chickpea cultivars conducted a research report for Tropical Legumes- II Garrett score of chickpea reveals that low yield, long duration, late Maturity, pest incidence, disease occurrence, less recovery or shelling came to be important Constraints in that order.

SUMMARY AND POLICY IMPLICATIONS

Chickpea is known in this country since ancient times. It is said to be one of the oldest pulses known and cultivated pulse crop in Asia and Europe. According to Aykroid and Doughty (1964), the centre of origin of chickpea is stated to be eastern Mediterranean region, but its probable place of origin lies in South Western Asia, *i.e.* countries lying to North-West of India such as Afghanistan and Persia. According to De Candolle, the fact that gram has a Sanskrit name “Chanaka” which indicates that the crop was under cultivation in India longer than in any other country in the world.

The *Desi* type of chickpea is mainly cultivated in India has a smaller seed and is of Indian origin. *Desi* chickpea accounts for about 85% of world production while, *Kabuli* chickpea accounts for about 15% of the production. India occupies the first position in the world in terms of chickpea area (9.18 m.ha.) and production (8.22 million tonne) during 2010-11 accounting for nearly 30.9 per cent and 39.9 per cent of total pulses area and production, respectively. The largest chickpea producing state in the country is Madhya Pradesh followed by Uttar Pradesh, Maharashtra, Andhra Pradesh and Karnataka. Madhya Pradesh, Rajasthan and Haryana.

The growth in chickpea exports for eleven years period from 2000-01 to 2010-11 was 4.31 per cent annually. Both the *desi* and *Kabuli* types of chickpea are traded in the international market. The *desi* type accounts for approximately 80 per cent of the total trade in chickpea. The *Kabuli* type commands a higher price owing to larger seed size compared to the *desi* type. Australia, Myanmar, Tanzania Republic, Iran and Turkey are the largest exporter of chickpea. India is by far the largest importer accounting for over a quarter of global imports and 40% of Asia's imports. Myanmar and Tanzania Republic. are major suppliers of dry peas and *Kabuli* chickpeas to the Indian market, each supplying about one-third of India's pea imports. The present study has been taken up with the following objectives. Hence, the present study has been taken up with the following specific objectives.

1. To study the growth and instability in area, production and productivity of chickpea in India.
2. To analyze India's import and export performance of chickpea
3. To study the impact of varietal interventions on area allocation, productivity and income of chickpea growers in the study area.
4. To assess the costs, returns and resource use efficiency in chickpea production in the study area.
5. To identify farmers' preferred traits in chickpea varieties and constraints in its production and marketing.

Hypotheses

1. There is a significant growth in area, production and productivity of chickpea in major chickpea producing states and in the selected study districts.
2. There is a significant growth in import and export trade of chickpea in India
3. Intervention of new chickpea varieties lead to increased adoption by farmers and results in increased productivity and income among the farmers.
4. The resource use in chickpea production is inefficient.
5. Farmers' have varied trait preferences in the new chickpea varieties and have many constraints in the production and marketing of the crop.

6.1 Methodology

The primary data generated under Tropical Legumes-II (TL-II) project entitled “Enhancing Grain Legumes Productivity, Production and Incomes of Poor Farmers in Drought-Prone Areas of Sub-Saharan Africa and South Asia” for chickpea crop in Gulbarga and Dharwad districts of Northern Karnataka were used for evaluating the specific objectives of the present research. The database created through baseline survey before varietal interventions during 2007-08 on the existing cultivation pattern of chickpea crop in the study districts was compared with the information generated after identification of preferred chickpea cultivars through FPVS process. These preferred varieties were intervened through field demonstrations in identified villages of the two districts from 2008-09 onwards. Thus, baseline variables specific to objectives were compared with early adoption data collected during 2009-10. A multistage sampling technique was used to choose the respondents.

Secondary data for the study were collected from various published sources. Time series secondary data on area, yield, production, export quantity and value of chickpea for a period of 11 years from 2000-2001 to 2011-12 were obtained from the publications of Ministry of Agriculture, Govt. of India, FAO, APEDA. The total production and exports of different countries were also obtained from FAO trade yearbook. Study period was selected based on the availability of data and primary data represented the period 2011-12.

The tabular presentation method was followed to study the socio-economic characteristics, area allocation, and productivity and of sample farmers in chickpea cultivation

Exponential growth function and instability index technique were employed to compute the compound growth rate and instability index of chickpea in terms of area, production, productivity, export quantity, value and unit price realized. Markov Chain Analysis of first order was used to analyze the direction of trade of chickpea.

The Cobb-Douglas type of production function was used to study the effect of various inputs on chickpea output and allocative efficiency of resources in chickpea cultivation was analyzed calculating MVP to MFC ratios for the resources.

Decomposition model to identify the structural break, if any, in the production relations between the varieties, the output elasticities were estimated by ordinary least square method by fitting log linear regression separately for JG-11 and Annigeri-1. The pooled regression was run in combination with JG-11 and Annigeri-1 variety by including dummy variables for farmers. The dummy variable was quantified as one for JG-11 farmers and zero for farmers producing Annigeri-1 variety.

Garette's ranking technique was used to find out the extent and status of constraints in production, marketing and preferred traits in production and marketing.

6.2 Findings of the study

1) Growth in area, production and productivity and instability index of chickpea

The overall area growth in chickpea for the country as whole for the study period indicated on a positive (1.60%) but was non-significant with an average area 7.32 million hectares. The area instability was also found to be very low at 4.46 per cent about its mean area during the period of study. Similarly, corresponding growth in productivity and production in chickpea for the country increased at the rate of 0.89 per cent and 5.58 per cent. The productivity increase was significant at five per cent while, for production it was significant at one per cent probability. The average productivity was 836.10 kg/ha with a low instability in productivity at 5.90 per cent and that of production instability also relatively low at 9.72 per cent about its mean for the study period.

The growth rates in area, production and productivity of chickpea of Gulbarga districts were -27.002 per cent, -30.35 per cent and 3.98 and its instability index was 33.43, 32.66, and 11.00 per cent respectively. Whereas Dharwad registered a growth rate of -14.56 per cent in the case of area, -2.89 per cent in production and 13.43 per cent in the case of productivity and their instabilities were 32.90, 67.06, and 43.68 respectively.

2) Compound growth rates and instability of export of chickpea

Chickpea exports during 2000-01 to 2011-12 registered a growth of 4.31 and 81.08 per cent and their instability index was 0.43 and 47.21 per cent in terms of export quantity and value.

Chickpea imports during 2000-01 to 2011-12 registered a growth of -2.72 and 5.16 per cent with instability index of 96.08 and 24.75 per cent in terms of imports quantity and value.

3) Direction of chickpea trade

The other countries category, Tanzania Republic, Myanmar, Australia were the most stable exporter for chickpea during the study period as indicated by 84.00, 47.00 and 24.00 per cent of market share retention by the Transitional Probability Matrix of Markov Chain Analysis.

Tanzania Republic and Myanmar were also moderately loyal to chickpea with retention of 84.00 and 47.00 per cent respectively during the study period.

4) Impact of improved chickpea varietal interventions on adoption process Adoption of improved varieties in Gulbarga and Dharwad district

The results on varietal adoption pattern during baseline-2007-08 revealed that of the total chickpea area (471.77 acres) 71.85 per cent of the sample farmer's cultivated Annigeri-1 variety in the Gulbarga district and it occupied major area of 94.80 per cent of the total chickpea area. whereas in the case of Dharwad district of the total chickpea area (610.47 acres) 86.67 per cent of the sample farmer's cultivated Annigeri-1 variety in the Dharwad district and it occupied major area of 90.65 per cent of the total chickpea area.

Area cultivated under Annigeri-1 to the total chickpea area also decreased to 46.21 per cent during 2009-10 showed a decline of 49.89 per cent area in 2009-10 over 2007-08. Whereas in the case of Dharwad district the extent of area cultivated under Annigeri-1 to the total chickpea area also decreased to 48.96 per cent during 2009-10 showed a decline of 43.19 per cent area in 2009-10 over 2007-08. The reduction in the area under Annigeri-1 was taken over by the newly introduced cultivars identified through FPVS process even in Gulbarga district.

The varieties namely, JG-11 (23.16%), BGD-103 (14.81%) among the *desi* type and MNK-1 (8.90%) and KAK-2 (2.05%) among *Kabuli* types were preferred by farmers in the initial stage and adopted them during 2009-10. Where as in the case of Dharwad district JG-11 (22.44%), BGD-103 (14.07%) among the *desi* type and MNK-1 (0.74%) and KAK-2 (3.70%) among *kabuli* type.

5) Productivity changes-comparison between baseline and early adoption

In the baseline and early adoption Annigeri-1 variety yield is more in the study variety against local varieties, varied between 415 kg/acre to 465kg/acre in Dharwad and Gulbarga district.

Among improved *desi* varieties, per acre yield of BGD-103 varied between 557 kg/acre and 581 kg/acre during early adoption. This was followed by JG-11 which registered yield of 532 kg/acre in Dharwad and 566 kg/acre in Gulbarga. Likewise other introduced varieties showed more yield/ac compared to Annigeri-1 variety in the respective study area.

6) Input utilization pattern in chickpea production

labour use pattern observed for carrying out various agricultural operations in the cultivation of A-1 variety (both in baseline and early adoption) and JG-11 (in early adoption) the range of labour used across adopted and control farmers for different operations was between 22.39 man days/ac to 28.06 man days/ac.

In the case of early adoption the adopted farmers in Gulbarga and Dharwad districts respectively applied 41.79 kg/ac and 44.01 kg/ac of fertilizers as against 42.34 kg/ac and 53.34 kg/ac of fertilizers by control farmers in the respective districts for A-1. While, in the case of JG-11 variety quantity of fertilizer applied were 41.09 kg/ac and 47.72 kg/ac by adopted farmers in Gulbarga and Dharwad district respectively. Whereas control farmers in the respective districts applied 42.86 kg/ac and 45.61 kg/ac fertilizer for JG-11.

The quantity of seed used per acre in the two districts by adopted and control farmers ranged between a minimum of 21.59 kg/ac to 30.43 kg/ac. Farmers used machine power was ranges between 4.00 hours to about 13 hours per acre both in A-1 and JG-11 plots. Similar observation was made with respect to PPCs used in the case of A-1 to the extent of 2.75 litre/ac to 5.00 litres /ac due to high incidence of pest and diseases.

7) Cost structures in chickpea production

Total cost of cultivation of Annigeri-1 variety in the baseline period among the adopted and control farmers found to be Rs. 9462.61/acre and Rs. 7323.83/acre in Dharwad and Gulbarga districts. Of this total cost, the variable cost accounted highest about Rs. 5313.01/acre and Rs. 4087.02/acre. While, the fixed cost accounted to Rs. 4149.60/acre and Rs. 3236.80/acre.

The per acre total cost for adopted farms in the early adoption was Rs. 9796.45/acre in Dharwad and (Rs. 8377.55/acre) in Gulbarga. While, in the case of control farms during early adoption the total costs in Dharwad (Rs. 9606.30/acre) and Gulbarga (Rs. 9208.59/acre) were higher than baseline. The variable costs across adopted farms in the early adoption for Annigeri-1 variety varied between Rs. 5141/acre to Rs. 5647/acre) across districts while, for control farms it ranged between Rs. 5498/acre to Rs. 5971/acre.

Total cost of cultivation of JG-11 variety in the early adoption the total cost among adopted farms was found to be Rs. 8789.62/acre and Rs. 7646.06.83/acre in Dharwad and Gulbarga districts, respectively. Of this total cost, the variable cost accounted about Rs. 4640.02/acre and Rs. 4409.26/acre, respectively. While, the fixed cost accounted at Rs. 4149.60/acre and Rs. 3236.80/acre respectively.

8) Impact of varietal interventions on crop income

Gross returns realized by farmers from Annigeri-1 variety ranged between Rs. 7637/acre to Rs. 9867/acre during the baseline and between Rs. 9345/acre to Rs. 10600/acre in the early adoption. The net returns realized by farmers from Annigeri-1 (baseline) variety were found to be as low as Rs. 120/acre to as much as Rs. 2634.38/acre. The net returns that obtained from Annigeri-1 (early adoption) were as low as Rs. 266 to high of Rs. 2194.38.

The gross returns in the case of JG-11 increased substantially over baseline and early adoption yields of Annigeri-1 variety across adopted and control farms and districts. The per acre gross returns realized by farmers ranged between Rs. 14,000 to 16451.00. While, incremental net returns over costs in JG-11 in early adoption quite high and ranged between Rs. 5415.48/acre to Rs. 8358/acre.

The benefic cost ratio for Annigeri-1 (baseline) across farms and districts ranked between 0.80 to 1.36. While the ratio for the same variety in the early adoption was 1.01 to 1.26. JG-11 the ratio's ranged 1.63 to 2.09 for a rupee investment.

The gross ranged between Rs. 14887/acre to Rs. 16783/acre in the case of BGD-103 in the study districts and between Rs. 16783/acre to Rs. 16595/acre in Gulbarga district in the case of MNK-1. The net returns were in the range of Rs. 5144/acre to Rs. 7974/acre across farms and districts. The B-C ratio was also found to be high at 1.53 to 1.90.

The percentage change in main yield between JG-11 (improved variety) and Annigeri-1 (old variety) of both the adopted and control farms of Dharwad district were almost similar (49.80% to 42.52%), whereas in the case of Gulbarga district per cent change in main yield is low as compared to Dharwad district (37.55% to 32.55%). In the case of percentage change in total cost of cultivation of Annigeri-1 variety in the case of adopted farms (10.28%), while in the case of control farms (4.52%) as against JG-11 variety in the case of Dharwad district. While in the case of Gulbarga total cost of cultivation of Annigeri-1 variety is of adopted farms (8.73%) and in the case of control farms (6.83%). As a result correlation of the per cent change in gross returns in JG-11 over Annigeri-1 variety is high in both districts *i.e* it ranges between 50 to 58.53 per cent.

9) Resource use efficiency in chickpea production

Chickpea production function estimates for Annigeri-1 baseline

In the adopted sample farms of Dharwad district during baseline, the results showed output elasticities of seed (0.002), organic manure (0.003), labour-BP (0.7084) and In the case of farms of control villages in Dharwad district for the same variety, the production elasticities of organic manure (-0.002), fertilizer (-0.26) and labour-BP (-0.71) were significant at one per cent. Among these, organic manure showed negative growth.

Similarly, in the case of Gulbarga district, the production elasticities for adopted farms during baseline with respect to organic manure (-0.23), seed (-0.17) were negative and found to be significant at five per cent where as, human labour (-0.028), contributed negatively and was significant. In the case of control farms, the production coefficients for inputs in the case of Gulbarga were fertilizer (-7.36), human labour (-0.23) negatively influencing chickpea production at one per cent probability. While, labour-BP (13.93) was significant at one per cent and contributed positively to the production followed by machine labour (0.80) PPCs (0.92) which were significant at five per cent level of significance.

Allocative efficiency in chickpea production-Base line

In the base line survey of (adopted farms) Dharwad district, the MVP to MFC ratio was greater than unity for labour-BP (8.14), fertilizer (3.42), PPCs (7.56) and The MVP to MFC ratios was found to be positive but less than unity for seed (0.02), organic manure (0.04), and indicated underutilization of this input. In the case of control farms in Dharwad district showed the MVP to MFC ratio as greater than unity for labour-BP (9.45), and machine labour (8.25).

In the base line survey of (adopted farms) Gulbarga districts, the MVP to MFC ratio was greater than unity for fertilizer (7.35), labour-BP (4.42), Machine (9.42). The MVP to MFC ratios was found to be positive but less than unity for seed (0.45), organic manure (0.41), and indicated underutilization of these inputs. In the case of Gulbarga districts (baseline), the control villages showed the MVP to MFC ratio as greater than unity for labour-BP (74.46), machine (24.05).

Production function estimates for Annigeri-1 and JG-11 in Dharwad district-Early adoption

In the case of Annigeri-1 (early adoption) variety output elasticity's of the resources for organic manure (0.011), labour-BP (0.33), similarly in the case of control farms of Dharwad district, the production coefficients for organic manure (0.13) and human labour (1.22).

The JG-11 growing chickpea growers output elasticities of seed (0.006), labour (0.031) and machine (0.094) significant influence on output at one per cent significance level. Whereas the output elasticities for fertilizer (0.004) and organic manure (0.360) were significant at five per cent level of probability. In the case of controlled farms of Dharwad the output elasticities for seed (0.0015) and human labour (0.62), Labour-BP (0.64) was positive and significant at one per cent level. On the other hand, the output elasticities of fertilizer (0.091) and PPCs (0.0008) were positive and significant at five per cent level.

Production function estimates for Annigeri-1 and JG-11 in Gulbarga-Early adoption

The output elasticities for Annigeri-1 variety in the adopted farms for seed (-0.0051), organic manure (0.0015), were significant at one per cent whereas, human labour (0.05), machine (0.00068) was also positive and significant at five per cent level. In the case of controlled farms fertilizer (0.695), and PPCs (0.440), showed positive influence on returns and were significant at five and one per cent level of probability.

In the case of production of JG-11 variety in the adopted farms, the production elasticity for seed (82.48), labour-BP (82.57), PPCs (20.42), human labour (11.03) significant contribution at five per cent probability, labour-BP (82.57) while, in the case of PPCs (20.42), human labour (11.03) was positive but not significant. The same for fertilizer (0.008) was positive and was significant at five per cent level. In the case of controlled farms seed (0.19) positively.

Allocative efficiency in chickpea production in Dharwad district-Early Adoption

In the case of adopted (Annigeri-1) farms in Dharwad district, the MVP to MFC ratios was greater than unity for, PPCs (5.20) labour-BP (5.00). The ratios for other resources like, seed (-0.30) machine labour (-2.67) and fertilizer (-0.46) were less than one. Where as in the case of control farms (Annigeri-1) the ratios for inputs like, machine labour (8.00), fertilizer (1.90), human labour (10.92), labour-BP (5.01), and PPCs (6.12) found to have positive and more than unity. However, in the case of inputs such as seed (-1.33) the ratios was not only less than one but negative.

In the case of adopted (JG-11) farms in Dharwad district, the MVP to MFC ratios was greater than unity for organic manure (32.40), PPCs (24.63), labour-BP (18.47) machine labour (3.68). Those which had ratios positive and more than one were labour-BP (1.69) However, in the case of inputs such as, fertilizer (-0.32), human labour (-1.04), machine labour (-0.009) the ratios was not only less than one but negative.

Allocative efficiency in chickpea production-Annigeri-1 and JG-11 in Gulbarga district -Early adoption

In the case of adopted (Annigeri-1) farms in Gulbarga district, the ratios for other resources like, seed (-0.09) and machine labour (-3.84), were not only less than unity but also negative thereby implied over use of them in the production and hence, must be reduced. The inputs human labour (0.21), labour-BP (0.18) were under utilized. In the case of controlled farms with respect to Annigeri-1, the ratios for inputs like, fertilizer (14.26) and PPCs (2.79) were found to have significantly high and positive values. However, in the case of inputs such as seed (-0.66), labour-BP (-5.91), machine labour (-3.84), the ratios were not only less than one.

In the case of adopted (JG-11) farms in Gulbarga district, the MVP to MFC ratios was greater than unity for seed very high (2067.30) and machine labour (3938.30), However, in the case of inputs such as the MVP and MFC ratios for inputs were more than unity for fertilizer (-434.40), labour-BP (-159.40), human labour (-1129.80). In the case of controlled farms with respect to JG-11 variety, the MVP to MFC ratios was greater than unity for seed (4.80), labour-BP (15.82), machine labour (9.48) and labour (15.82). The inputs which had positive ratios and less than one were human labour (0.006), fertilizer (0.069).

10) Structural break in the production relations between JG-11 and Annigeri-1 varieties

Decomposition of total differences in chickpea yield between JG-11 and Annigeri-1 in Dharwad district (Structural break in the production)

Structural break in the production between the adopters of JG-11 and Annigeri-1 there was variability in the yield to the extent of 25.68 per cent between the varieties. The JG-11 variety as a technology component contributed positively to the extent of 17.35% to the income variation, while, the contribution to the yield difference by input levels was found to be also positive and they together contributed to 11.65% variation in income.

Decomposition of total differences in chickpea yield between JG-11 and Annigeri-1 in Gulbarga district (Structural break in the production)

Structural break in the production that between the adopters of JG-11 and Annigeri-1 there was variability in the yield to the extent of 11.36 per cent between the varieties. The JG-11 variety as a technology component contributed positively to the extent of 8.03% to the yield variation, while, the contribution to the yield difference by input levels was found to be also positive and they together contributed to (3.33%) variation in yield.

11) Preferred traits in chickpea cultivars

Preferred production traits in chickpea cultivars

High yielding characteristics was the single most preferred production trait Annigeri-1 assigned a score of (GS: 70.92) and Gulbarga districts (GS: 71.92) its drought resistance as indicated by high Garrett's score (GS: 71.03). In the case improved varieties of Garrett's scores for drought resistance with respect to JG-11 (GS: 52.11), BGD-103 (GS: 47.98), and JAKI-9218 (GS: 55.00) varieties. The farmers preferred new varieties because of high yielding characteristics as indicated by their respective high Garrett's scores in the case of JG-11 (GS: 71.21), BGD-103 (GS: 72.15), JAKI-9218 (GS: 73.75), and KAK-2 (GS: 71.96). The farmers indicated the presence of disease resistance (DIR) assigned a score both districts together in respect of varieties namely, JG-11 (GS: 60.33), BGD-103 (GS: 64.87), and JAKI-9218 (GS: 65.00). Moderate scores were assigned to the improved varieties namely, JG-11 (GS: 36.28), BGD-103 (GS: 41.15), and JAKI-9218 (GS: 48.25) for their short duration quality.

Preferred marketing traits in chickpea cultivars

The farmers who adopted improved varieties like, JG-11 (GS: 55.92), BGD-103 (GS: 58.88) (both *desi* types) and KAK-2 (GS: 48.13) (*kabuli* type) had high preference to these varieties and for Annigeri-1 variety was also assigned approximately the same weightage (GS: 56.09). Farmers scores were relatively low with respect to JAKI-9218 (GS: 25.08) and MNK-1 (GS: 37.33). Farmers preferred JG-11 (GS: 48.50), BGD-103 (GS: 50.63) and MNK-1 (GS: 58.33) ability to fetch higher market price. This could be supported by the fact that JG-11 which almost has a resemblance to the Annigeri-1 variety along with slightly bigger and uniform grain size (GS: 45.31). Similar observation could be made with respect to BGD-103 which has extra bold seed size (GS: 41.50) most preferred by traders. MNK-1, *kabuli* type has a bigger grain size (GS: 55.33).

12. Constraints in chickpea cultivars

Low yielding character was a most important constraint with respect to Annigeri-1 variety (GS: 74.89) across different farms and districts. Further, the other constraints associated were severe problem of heavy pest (GS: 52.62) and high disease incidence (GS: 63.28) as expressed by farmers across farms and districts. Similar observation was made through assigned Garrett's scores with respect to its long duration (GS: 45.14) nature. Farmers also implied low market price (GS: 38.04) for Annigeri-1 produce as a result of smaller grain size (GS: 71.92).

The farmers felt that the improved varieties were highly susceptible to insect problem and assigned high Garrett's scores for varieties like, JG-11 (GS: 67.07), BGD-103 (GS: 70.81) among *desi* and in the case of *kabuli* varieties such as, KAK-2 (GS: 71.00) and MNK-1 (GS: 68.00) in the case of high disease incidence they assigned low scores to high disease incidence with respect to JG-11 (GS: 41.36) followed by BGD-103 (GS: 38.14), JAKI-9218 (GS: 37.75) and MNK-1 (GS: 58.57) followed by KAK-2 (35.00) when compared to Annigeri-1 (GS: 63.28).

6.3 Policy implications

The policy implications emerging out of the findings of the present study are outlined below.

1. A significant increase in the production of chickpea (CGR: 5.58%) in the country was found to be due to increased per hectare productivity (CGR: 0.89%). However, there was a significant productivity decline in states like Rajasthan and Uttar Pradesh which contribute substantially to the country's chickpea area. Hence, there is a need for intensive extension efforts for enhancing per hectare productivity through technological interventions under Technology Mission on Oil seeds and Pulses in these states in particular and in other chickpea producing states in general.
2. The area under chickpea in Gulbarga and Dharwad districts was found to be decreasing (CGR: 14.56% to 27.00%) over the years. Considering the importance of the districts (Gulbarga known as pulse bowl of the state) in terms of their contribution to both area and production in the states. There is a need for promoting area expansion in these districts by popularizing high yielding cultivars and strengthening breeding programmes for development of drought tolerant genotypes which withstand terminal drought.
3. Chickpea occupy significantly a large proportion of (36% to 40%) the cropped area in during *rabi* season in both districts and this signify economic and commercial significance of the crop. Majority of the farmers (63% to 69%) still continue with old cultivar Annigeri-1 on a substantial (about 50%) area under it. The improved varietal interventions under TL-II found to increase per hectare yield (21% to 30%) over old cultivar. Hence, large scale efforts need to be made to upscale the technology adoption by farmers through large-scale demonstrations of new cultivars such as JG-11, BGD-103 and others. Also to link the seed subsidy programme implemented by the Government to new cultivars alone to discourage cultivation of Annigeri-1 variety.
4. The resource use efficiency analysis revealed that the resources are not optimally used in cultivation of chickpea as indicated by MVP/MFC ratios. The extension agencies need to promote the judicious and optimum use of resources by educating the farmers about the recommended quantities of various inputs.
5. The cultivation of chickpea with the adoption of JG-11 and other improved varieties increased productivity (30% to 50%) and additional benefits to the farmers. Hence, there is need to popularize improved varieties like JG-11, BGD-103 etc, through intensive extension programmes like trainings, field visits and demonstrations among farming community.
6. High commercial importance attached to chickpea crop by farmers due to its mono-cropping also opined of several constraints in existing cultivar (Annigeri-1) such as low yielder (GS: 75), smaller and non-uniform grain size (GS: 72), high disease (GS: 63) and pest incidence (GS:53), and long duration (GS: 45). Thus, long-term breeding and screening for desired traits and their multiplication efforts are to be made by both public sector institutions and private sector agencies to mitigate the constraints.

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PRODUCTION, TRADE COMPETITIVENESS AND VARIETAL TRAIT PREFERENCES IN CHICKPEA IN KARNATAKA-AN ECONOMIC ANALYSIS

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ABSTRACT

The study was conducted in Gulbarga and Dharwad districts of Karnataka using primary data under Tropical Legumes-II (TL-II) project to analyze varietal adoption, their impact on yield, income, resource efficiency, constraints and trait preferences of farmers in addition to secondary data to assess area, production and productivity growth and export and import performance and trade direction in chickpea.

There was a stable and positive growth in area (4.46%), production (9.72%) and productivity (5.90%) of chickpea in India (2000-01 to 2011-12) during the period. The countries like Tanzania Republic (84.87%), Myanmar (47.10%) were the most stable exporters of chickpea to India. With the varietal interventions, there was increased area allocation, yield and income from cultivation of improved cultivars over age-old variety, Annigeri-1 across districts. Improved varieties namely, JG-11 (22% to 23%), and BGD-103 (16% to 17%) occupied considerable area to the total chickpea area with a reduction in area under Annigeri-1 (over 90% before to 46% after varietals intervention).

Across baseline and early adoption periods there was a marginal variability in the quantum of inputs used for Annigeri-1 and JG-11 varieties and hence the cost of cultivation. For Annigeri-1 it was relatively more (Rs. 8377.51/acre to Rs. 9796.45/acre) compared to JG-11 (Rs. 7646.06/acre to Rs. 9172.20/acre) due to more use of PPCs, fertilizers and human labour. The resource use efficiency, (Cobb-Douglas production function) showed that they were not optimally used in the cultivation of both JG-11 and A-1. The farmers across districts preferred improved chickpea cultivars with respect to production and market traits compared to Annigeri-1. The presence of disease resistance (DIR) assigned a high Garrett's score in both districts in respect of varieties namely, JG-11 (GS: 60.33), BGD-103 (GS: 64.87), and JAKI-9218 (GS: 65.00). Low yielding character was a most important constraint with respect to Annigeri-1 variety (GS: 74.89) across farms and districts.