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Targeting of Grain Legumes for Income and Nutritional Security in South Asia

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"Targeting of Grain Legumes for Income and Nutritional Security in South Asia"

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ABSTRACT

Chickpea, Pigeonpea and Groundnut are the most important food legumes in South Asia. They are integral part of cropping systems and farmers' livelihoods. Besides enriching soil fertility, food legumes also provide substantial income to the farm households and also contribute towards household nutritional security. Since 2007, ICRISAT along with partners from National Agricultural Research System (NARS) in India and Bangladesh has been implementing a joint project namely 'Tropical Legumes-II' for increasing the production and availability of legumes particularly for small holder farmers and poor consumers in South Asia. Specifically, this initiative has been focusing on proper targeting for development of improved cultivars of food legumes, promotion of their adoption, proactive public sector policies and finally linking these small holders to markets and value chains.

A number of studies have been completed in five states (Andhra Pradesh, Bihar, Karnataka, Odisha and Tamil Nadu) in India and Barind region of Bangladesh during last eight years (2007-2014) of project implementation. These studies have examined and documented the existing situation in legumes cultivation, constraints faced by the farmers, market linkages, potential opportunities for their expansion etc. In close association with the legume breeders, agricultural economists have also assessed the farmers preferred traits for chickpea, pigeonpea and groundnut varieties expressed during the 'Farmer Preferred Varietal Selection (FPVS)' demonstrations. These farmers preferred varieties were identified, released formally, multiplied and supplied as seed samples to legume growers in intervention sites. Later, studies were also conducted for monitoring early adoption of newly introduced improved cultivars and their performance in the targeted locations. Based on those research findings, these studies have put forward some suggestions to accelerate the food legumes productivity and profitabilityin India and Bangladesh

The proposed parallel session titled 'Targeting of Grain Legumes for Income and Nutritional Security in South Asia' is going to present eight selected research papers. We feel that it would be a great opportunity for the research team involved in this project to share the findings of the research project to a wider audience and contribute towards main theme of the 8th ASAE Conference on "Viability of Small Farmers in Asia".

The titles of the Eight research papers as follows:

S.no	Paper Title	Speaker (s)
1.	Current Trends and Plausible Futures of food legumes in South and South East Asia	S Nedumaran, D Kumara Charyulu, P Jyosthnaa and Uttam Kumar Deb, ICRISAT, Hyderabad.
2.	Targeting and diffusion of Chickpea improved cultivars in Andhra Pradesh state of India	K Suhasini, Professor, ANGRAU, Rajendranagar, Hyderabad
3.	Targeting and diffusion of Groundnut improved cultivars in Tamil Nadu state of India	K Karunakaran, Professor, TNAU, Coimbatore, Tamil Nadu
4.	Targeting and diffusion of Chickpea improved cultivars in Karnataka state of India	G Kulkarni, Associate Professor, UAS-Dharward, Karnataka
5.	Targeting of Chickpea improved cultivars in Barind region of Bangladesh	Md. Abdur Rashid, Principal Scientific Officer, BARI, Bangladesh
6.	Targeting of Chickpea improved cultivars in Bihar state of India	Meera Kumari, Asst. Professor, BAU – Bhagalpur, Bihar, India
7.	Targeting of Groundnut improved cultivars in Odisha state of India	Debdutt Behura, Asst. Professor, OUAT- Bhubaneshwar, Odisha, India
8.	Increasing Productivity and Profitability in Legumes Cultivation: Opportunities, Challenges and Lessons Learnt from Tropical Legumes- II (Phase 1 and 2) project	D Kumara Charyulu, D Moses Shyam, Cynthia Bantilan, P Parthasarathy Rao, Uttam Kumar Deb and GD Nageswara Rao, ICRISAT, Hyderabad

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Current Trends and Plausible Future outlooks of Food Legumes in Asia

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Abstract

Food legumes play an important and diverse role in the farming systems and in the diets of the poor people around the world and for achieving food and nutritional security in the developing countries. Given the importance of food legumes in the developing countries especially in Asia, the objective of this paper is to assess crop specific trends, distribution and developments in area, production and productivity of three important legumes crops like groundnut, chickpea and pigeonpea and also to provide the plausible futures of these crops under the changing future climate. In this study, a global partial equilibrium multi-commodity trade model was used to assess the future projection of supply, demand, prices and trade of the food legume producing and consuming countries around the world. The study revealed that production has not been able to meet demand due to the secondary treatment of pulses in Asian countries. The projected demand for groundnut, chickpea and pigeonpea in Asia will grow much faster than production as direct consequence of growing population in the region. By 2050 the production of chickpea is about 8% less than that of demand in Asia. Although yield increases compensate for much of the production forgone due to area contraction, it does not fully satisfy demand, leading to a deficit of chickpea production intensifying with time. The aggregate production and consumption of pigeonpea in Asia more than doubles in 2050 compared to the level in 2000 which was 3 mt. The projected demand for groundnut in Asia will increase from 7 mt in 2010 to 8.9 mt in 2050. To meet the increasing demand of food legumes in the region, there is need to improve the average yield and profitability of the legume crops by developing short duration, drought resistant, high yield varieties and ensuring competitive prices to increase the adoption of new technologies by farmers in the regions.

Key words: Food legumes; trend analysis; plausible future outlook; partial equilibrium model

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Current Trends and Plausible Future outlooks of Food Legumes in Asia

Introduction

Legumes play an important and diverse role in the farming systems and diets of poor people and are aptly referred to as the "poor man's meat". They share a significant part of the diet of vegetarians being vital sources of protein, calcium, iron, phosphorus and other minerals (Latham 1997). Legumes are multipurpose crops and are consumed either directly as food or in various processed forms, or as feed. They fetch higher income than cereals and hence used to supplement farmers income (Gowda et al. 1997) and grown as rotation crops, helping in enhancing nitrogen fixation. Integration of legume cover crops in the farming systems may offer feasible solutions for maintaining and improving soil fertility in smallholder farming. Legumes have numerous advantages, which include improved soil productivity through increased soil organic matter content, improved soil physical and microbial properties, suppression of weeds and pests, and erosion control (Mugendi et al 2011). They are ideal crops for achieving multiple developmental goals of reducing poverty, improving health and nutrition, and enhancing ecosystem resilience (Sitou Akidobe and Mywish Maredia 2011).

The per capita consumption of food legumes has fallen, and is a matter of concern, particularly in South Asia where 39% of the population is poor (earning less than US$1.25 per day) and 21% of population is undernourished (Rao et al. 2010). Particularly in India, the largest producers and consumers of legumes, the per capital consumption declined from 11.6 kg/year in 1983 to 9 kg/year in 2004/05 (Kumar et al. 2009).

Among legumes, groundnuts, chickpea and pigeonpea is the major food legumes grown and consumed in Asian continent. Asia accounts for 89%, 85% and 48% of global chickpea, pigeonpea and groundnut area respectively (Table 1) and produces about 85%, 64% and 82% of global chickpea, groundnuts and pigeonpea respectively.

Table 1. Percentage share of global area and production of food legumes, 2010-12

Region	Chickpea	Groundnut	Pigeonpea	Chickpea	Groundnut	Pigeonpea
	Area			Production		
Asia	88.52	47.77	84.56	84.54	64.21	82.66
Africa	4.51	47.72	13.05	5.48	27.07	14.75
Developed World	6.98	4.48	2.39	9.99	8.70	2.59

In Asian countries food legumes got secondary treatment after cereals which are reflected in the lower research investments made on these crops compared to cereals both at national and international levels despite their growing importance and relevance for sustaining the food security in the developing countries (Kumar et al. 2007; Rao et al. 2010). Agricultural research and development efforts in many of these countries concentrated on increasing cereal yields and production and lowering crop losses to tentatively achieve food security by the supply of food. Research on legumes will have significant impacts on nutritional security and soil fertility and will help in sustaining food security in the long run. Due to lack of research, the production levels of

these crops are much below their potential which has resulted in demand-supply mismatch triggering sharp price hikes.

Despite the crucial role of food legumes for nutritional security and environmental sustainability in the dryland, much less is known about the potential impacts of globalization, increasing population, rise in incomes, change in markets, consumption patterns and biophysical conditions on the future of food legumes around the world particularly in Asia. The important questions are: what are the alternative futures and outlooks for the food legumes under changing population and income growth scenarios? What are the potential impact of changing consumption patterns and growing preferences for rice, wheat, maize and livestock products and how it affect production, demand, and trade opportunities for food legume crops? What kinds of policies and technological innovations required to limit the negative impacts of climatic variability, water scarcity and land degradation and to accelerate sustainable intensification of agriculture in Asia to feed the growing population?

The main objective of this paper is to analyze the global and regional trends in area, yield, and production of three important legumes namely groundnut, chickpea and pigeonpea and to examine the plausible future of these legume crops in term of likely changes in area, production, yield and prices in major Asian countries growing these crops under different socio economic and climate change scenarios.

Methodology

The analysis consists of two parts. In the first part the historical trends in area, yield and production have been analysed using secondary data available at FAOSTAT[2]. In the second part the plausible futures and likely changes in area, yield, production and prices of food legume crops are simulated using the IFPRI's IMPACT[3] model for the alternate socioeconomic and climate change scenarios (Figure 1). The IMPACT model is a partial equilibrium model used to project the plausible futures of agriculture and livestock commodities (Nelson et al. 2010). The IMPACT model is a multi-commodity, multi-country partial equilibrium agricultural model for 40 commodities of crop and livestock, including cereals, soybeans, roots and tubers, meats, milk, eggs, oilseeds, oilcakes/meals, sugar/sweeteners, and fruits and vegetables. The IMPACT model includes 281 spatial units, called Food Production Units (FPUs) based on 126 major river basins within 115 regions or country boundaries. The model links the various countries and regions through international trade using a series of linear and nonlinear equations to approximate the underlying production and demand functions. World agricultural commodity prices are determined annually at levels that clear international markets. Growth in crop production in each country is determined by crop and input prices, the rate of productivity growth, investment in irrigation, and water availability. Demand is a function of prices, income, and population growth. The IMPACT model incorporates climate effects from the DSSAT modelling results as a shifter in the supply

[2]The accuracy of the results presented in this part here are directly dependent on the data reported. Compounded annual growth rates = (final year value/initial year value) ^ (1/no.of years)-1 have been computed to analyze the trends.

[3]The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) was developed in the early 1990s to contribute towards the discussion over what actions are required to meet the future needs for food and feed in the world, reduce malnutrition, and maintain strong levels of agricultural growth and productivity (Rosegrant et al., 1995).

functions (Richardson et al., 2012). The basic IMPACT model is combined with the Water Simulation Model (WSM) in order to estimate the interactions between water supply and demand and food supply, demand, and trade. The scenarios for water are downscaled from and calibrated to Global Circulation Models (GCM) that represents future climates in the different IPCC SRES (Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios) (Rosegrant et al. 209a).

Socioeconomic Scenarios

Three socioeconomic pathway scenarios[4] were developed using combinations of economic and demographic drivers. Table 2 shows the GDP and population growth choices used in the three overall scenarios mostly derived from the three GDP projections and the three population projections obtained from the United Nations Population office. The "optimistic scenario" combines high GDP with low population. The "baseline scenario" combines the medium GDP projection with the medium population projection. Finally, the "pessimistic scenario" combines the low GDP projection with the high population projection. Note that the scenarios used apply to all countries; that is, in the optimistic scenario, every country in the world is assumed to experience high GDP growth and low population growth.

Table 2. GDP and population data for the three socio-economic scenarios

	Pessimistic	Baseline	Optimistic
GDP, constant 2000 US$	Lowest of the four GDP growth rate scenarios from the Millennium Ecosystem Assessment GDP scenarios (Millennium Ecosystem Assessment 2005) and the rate used in the baseline (next column)	Based on the rates from World Bank (EACC study, Margulis et al., 2010), updated for sub-Saharan Africa and South Asian countries	Highest of the four GDP growth rate scenarios from the Millennium Ecosystem Assessment GDP scenarios (Millennium Ecosystem Assessment 2005) and the rate used in the baseline (next column)
Population	UN low variant, 2008 revision	UN medium variant, 2008 revision	UN high variant, 2008 revision

Source: Nelson et al. (2010).

[4]The scenarios used apply to all countries/regions in the IMPACT model; that is, in the optimistic scenario, every country in the world is assumed to experience high GDP growth and low population growth.

Climate Change Scenarios[5]

Two climate scenarios, downscaled from 2 GCMs–CSIRO and MIROC– driven by SRES emission scenario A1B or B1, were used to accommodate the likely ranges of future temperature and precipitation changes. The CSIRO scenario, for example, represents a dry and relatively cool future, while the MIROC scenario represents a wet and warmer future. The scenario-based temperature and precipitation were used to simulate the crop yields using DSSAT crop model (Richardson et al. 2012).

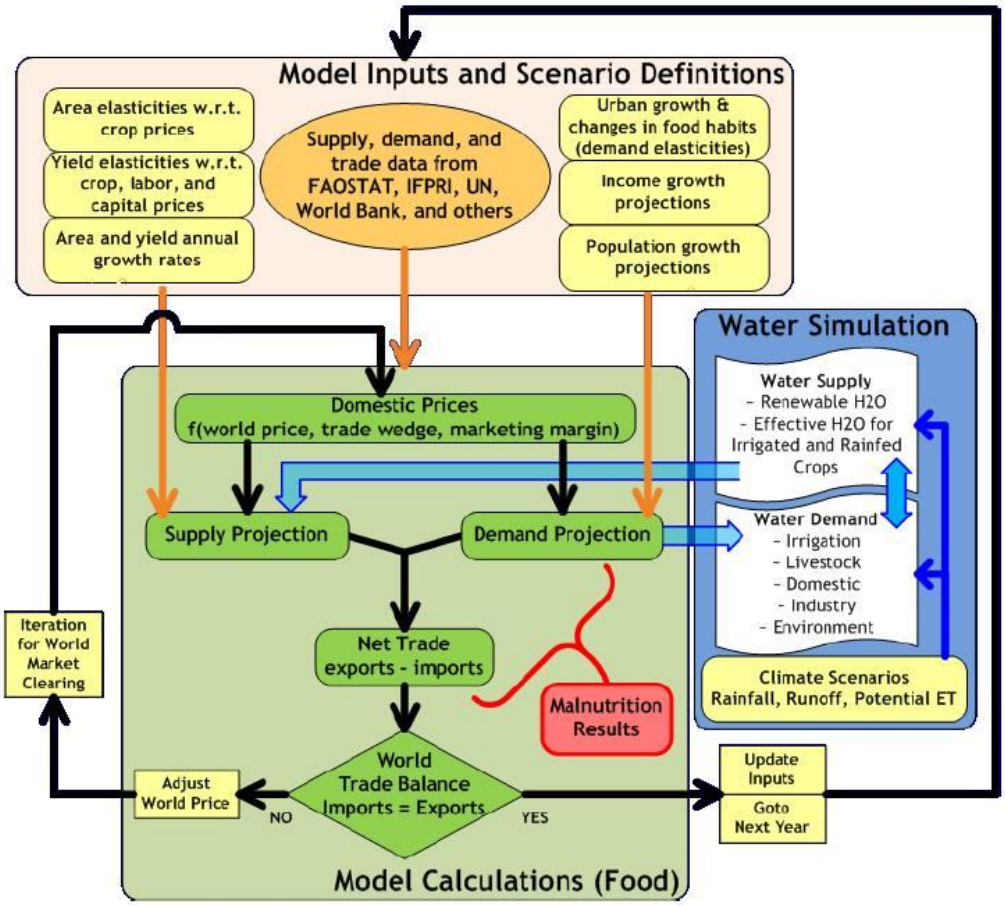

Figure 1. The IMPACT modeling framework

Source: Nelson et al. (2010)

[5] CSIRO - climate model developed at the Australia Commonwealth Scientific and Industrial Research Organization (CSIRO) Atmospheric Research; MIROC - Model for interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.
A1B - greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources; B1 - greenhouse gas scenario which assumes rapid economic growth, a population that peaks midcentury, but with rapid changes towards a service and information economy and introduction of clean and resource efficient technologies.

Results and Discussions

Trends in area, yield and production of food legume crops

Groundnut: Groundnut is grown extensively in the developing countries of Asia. Groundnut is one of the important oilseed crops in the world with diverse uses ranging from food and oil production to providing feed for animals. During the last two decades, world groundnut area expanded from 20.7 million ha in 1991-93 to 24.9 million ha in 2011-13 (Table 3) at an annual growth rate of 0.77% (Table 4). Asia's groundnut area decelerated to an annual rate of -5.8% from 13.2 million ha in 1991-93 to 11.7 million ha in 2012-13. In Asia, India and China accounts for more than 80% of groundnut area in the region. During 1991-2013, the groundnut area in India declined from 8.3 million ha in 1991-93 to 5.1 million ha in 2011-13 with an annual growth rate of –2.20% during 1991-2013 (Table 4). About 83% of groundnut in India is cultivated in rainfed condition (Rao et al. 2010) and decline trend in groundnut area can be attributed to consecutive droughts in major producing regions and also increasing competition from crops like Bt cotton, soybean and maize in the rainfed regions.

Southeast and East Asian regions experienced a positive trend in groundnut area, which increased from 1.5 million ha in 1991-93 to 1.7 million ha in 2011-13 (Table 3). In East Asia, the area under groundnut in China increased rapidly from 3.7 million ha in 1991-93 to 4.6 million ha in 2011-13 (Table 3), at an annual rate of 1.60% (Table 4). Yao (2004) reported that the rapid expansion of groundnut in China was due to its comparative advantage over other crop cultivated under similar agro-climatic conditions. In china, the gross returns for groundnut is 2-3 times higher compared to other field crops like wheat, soybean and rapeseed (Rao et al. 2010). Myanmar is another country in the region shows positive trend in groundnut area, during 1991-2013 the groundnut area grew at an annual rate of 3.47%, which very high compare to other major groundnut growing countries in Asia.

During the last two decades, significant improvements have been observed in groundnut yield in Asia. During 1991-2013, the groundnut yield grew at annual rate of 2.61% in Asia, which is higher than the world annual growth rate by 1.61% (Table 4). Almost every country in the region, expect Pakistan showed an increasing yield trend. The groundnut yields were doubled in some of the East and Southeast Asian countries, especially in Myanmar the yield grew annually by 2.96% during 1991-2013 which is higher than any other country in the region. Rapid growth in groundnut yield, especially in East and Southeast Asian countries, occurred because of the introduction of high yielding, stress-resistant varieties and improved production practices adapted by farmers.

World groundnut production increased from 24.7 million tons in 1991-93 to 42.1 million tons in 2011-13 at an annual rate of 2.42% (Table 3 and 4) and the increase in production was mainly due to robust growth on Asia and Africa. During this period, groundnut production in Africa increased at annual rate of 3.86% and in Asia at 2.02% (Table 4). Among Asian countries, China groundnut production increased more than double in the last two decades. The groundnut production in China increased from 6.9 million tons in 1991-93 to 16.6 million tons in 2011-13, at an annual rate of 3.74 % (Table 4). The increase in groundnut production in China was mainly due to a technological change and policy support in the form of prices, relaxation of market controls and improvement in marketing facilities. The other promising country in the Asia region in groundnut

production in Myanmar. It tripled groundnut production during 1991-2013 with an annual rate of 6.54% (Table 4).

Table 3. Area, yield and production of groundnut in different regions of the world

Country/Region	Area ('000 ha)			Yield(kg/ha)			Production ('000 tons)		
	1991-93	2001-03	2011-13	1991-93	2001-03	2011-13	1991-93	2001-03	2011-13
World	20,759	23,053	24,931	1,192	1,523	1,689	24,757	35,110	42,119
Developed World	1,214	1,073	1,158	1,642	1,892	2,065	2,620	2,656	3,778
Africa	6,291	9,079	12,034	788	967	921	4,951	8,776	11,085
Asia	13,249	12,897	11,733	1,297	1,835	2,321	17,182	23,674	27,249
South Asia	8,524	6,187	5,247	938	1,059	1,361	7,974	6,568	7,199
India	8,385	6,054	5,110	936	1,059	1,367	7,830	6,425	7,044
Bangladesh	38	26	32	1,046	1,212	1,654	39	32	52
Pakistan	92	96	93	1,063	1,060	850	98	102	79
Southeast Asia	1,528	1,627	1,750	1,342	1,617	1,839	2,050	2,632	3,219
Indonesia	657	662	539	1,806	1,954	2,234	1,187	1,294	1,205
Myanmar	494	603	886	864	1,308	1,560	428	788	1,382
East Asia	3,141	5,030	4,680	2,222	2,849	3,559	7,017	14,319	16,658
China	3,751	4,844	4,624	2,226	2,851	3,562	6,971	14,287	16,630

Table 4. Annual compound growth rates (%) of groundnut area, yield and production, 1991-2013

Region/Country	Area	Yield	Production
World	0.77	1.64	2.42
Developed World	-6.09	-0.30	-5.10
Africa	2.85	0.97	3.86
Asia	-0.58	2.61	2.02
South Asia	-2.16	1.51	-0.68
India	-2.20	1.54	-0.69
Bangladesh	-0.86	2.21	1.33
Pakistan	-0.28	-1.81	-2.09
Southeast Asia	0.89	1.76	2.67
Indonesia	-0.66	1.33	0.66
Myanmar	3.47	2.96	6.54
East Asia	1.57	2.11	3.71
China	1.60	2.10	3.74

Chickpea: Chickpea is the third most important pulse crop in the world after dry beans and dry peas and one of cheapest source of protein (Joshi et al. 2002), minerals and vitamins, fibres and

other important potentially health-beneficial phyto-chemicals. Globally area under chickpea has increased from 10.2 million ha in 1991-93 to 13.1 million ha in 2011-13, at an annual rate of 0.78% (Table 5 and 6). The chickpea area expansion was more pronounced in developed world and Africa at an annual rate of 1.44% and 0.78% respectively during 1991-2013. In the same period, the area expansion was only to 0.65% in Asia, which accounts for 88% of chickpea area in world. India accounts for more than 90% of area in Asia and the area under chickpea grew at an annual rate of 1.22% during 1991-2013. The area expansion in India is mainly due to gradual shift in chickpea area towards semi-arid tropics. The area under chickpea increased by 50% in semi-arid tropics (currently accounts for 61% of chickpea area in India) and decreased by 47% in semi-arid temperate region (Rao et al. 2010). The expansion of chickpea area in semi-arid regions of India can be attributed to availability of short-to-medium duration varieties capable of escaping terminal drought and chickpea's competitive advantage over other crops grown during the same season.

Global chickpea yield increased at an annual rate of 1.31% during 1991-2013, from 699 kg/ha to 931 kg/ha (Tables 5 and 6). Chickpea yield is lower in traditional chickpea growing area like Asia compared to that of non-traditional area like Africa and developed countries like Canada and Australia. During 1991-2013, the chickpea yield in Africa region grew at an annual rate of 3.61% compared to only 1.11% growth in Asia during the same period. In Asia region, Myanmar more than doubled its yield from 658 kg/ha in 1991-03 to 1457 kg/ha in 2001-13. This is mainly due to adoption of improved varieties and crop management practices by the farmers.

Global chickpea production increased from 7.1 million tons in 1991-93 to 12.1 million tons in 2011-13 at an annual rate of 2.1% (Tables 5 and 6). Both area expansion and yield increase contributed to increased production; the contribution of yield to increase in production was more than double the contribution of area. The rapid increase in chickpea production occurred in developed world and African region by an annual rate of 3.3% and 4.4% respectively during 1991-2013. The increased production in these regions was mainly fuelled more by yield increase than by area expansion. Chickpea production in Asia increased from 6.4 million tons in 1991-93 to 10.2 million tons in 2011-13, at an annual rate of 1.7% (Table 6). In India, chickpea production increased at an annual rate of 2.2% during this period. The increase in production of chickpea in India is mainly contributed by area expansion at annual rate of 1.2% during the last two decades. In southeast region, the chickpea production in Myanmar grew at an annual rate of 10.3% (Table 6) which is mainly due to doubling of area and yield during 1991-2013.

Table 5. Area, yield and production of chickpea in different regions of the world

Country/Region	Area ('000 ha)			Yield (kg/ha)			Production ('000 tons)		
	1991-93	2001-03	2011-13	1991-93	2001-03	2011-13	1991-93	2001-03	2011-13
World	10,281	9,847	13,053	699	756	931	7,184	7,456	12,155
Developed World	396	730	932	1,062	1,006	1,427	440	800	1,284
Africa	446	476	556	578	719	1,129	260	342	629
Asia	9,439	8,641	11,565	687	728	885	6,485	6,315	10,241
South Asia	8,327	7,500	10,647	657	705	852	5,471	5,309	9,079
India	6,518	5,836	9,037	712	771	913	4,631	4,522	8,251
Bangladesh	93	16	8	727	758	883	68	12	7
Pakistan	1,032	934	1,034	449	509	501	464	478	513
Iran	656	702	559	444	411	537	292	287	300
Southeast Asia	158	184	335	658	926	1,457	104	172	488
Myanmar	158	184	335	658	926	1,457	104	172	488

Table 6. Annual compound growth rates (%) of chickpea area, yield and production, 1991-2013

Region/Country	Area	Yield	Production
World	0.78	1.31	2.10
Developed World	1.44	2.61	3.30
Africa	0.78	3.61	4.42
Asia	0.65	1.11	1.77
South Asia	0.84	1.05	1.90
India	1.22	0.96	2.20
Bangladesh	-13.09	0.77	-12.42
Pakistan	0.78	0.51	0.48
Iran	-1.31	0.69	-0.63
Southeast Asia	5.11	4.96	10.32
Myanmar	5.11	4.96	10.32

Pigeonpea: Pigeonpea is an important pulse crop grown in the tropics and subtropics lying between 30°S and 30°N. It occupies 6.5% of the world's total pulses area and contributes 5.7% of total pulses production (Rao et al. 2010). Between 1991-93 and 2011-13, the world pigeonpea area expanded from 4.2 million ha to 5.6 million ha, at an annual rate of 1.5% (Tables 7 and 8). It area grew rapidly in Africa and developed world at an annual rate of 2.7% and 5.4% during this period. The pigeonpea area also increased in Asia from 3.7 million ha in 1991-93 to 5.0 million ha in 2011-13, at an annual rate of 1.2% (Table 8). The additional area in Asia during this period is mainly from area expansion under pigeonpea in India and Myanmar. An addition 0.6 million ha in 2011-13 from Myanmar is added to Asia's total area and it grew at an annual rate of 8.7% which is higher among all the countries (Table 8). The increase in pigeonpea area can be attributed to availability of short-to-medium duration wilt-resistant varieties and increase in pigeonpea prices in relation to its competing crops as well as substitute pulse crops (Joshi et al. 2000).

Global pigeonpea yield increased slight from 634 kg/ha in 1991-93 to 764 kg/ha in 2011-13, at an annual rate of 1% (Table 8). The pigeonpea yield increased substantially in Africa at an annual rate of 2.2% which is mainly attributed to increased adoption of high-yielding varieties in Africa especially in Tanzania, Malawi and Kenya. In Asia, there is no significant yield increase during the last two decades and in India the pigeonpea yield was stagnant which grew at annual rate of less than 1% during this period. The stagnation in average pigeonpea yield in India can partly be explained by the shift in area from favourable environment (semi-arid temperate) to marginal environment (semi-arid tropics) where average yields are about 40% (Rao et al. 2010).Yield was higher in Myanmar with an annual increase of 4.4% during 1991-2013.

World pigeonpea production grew at an annual rate of 2.5% from 2.6 million tons in 1991-93 to 4.5 million tons in 2011-13 (Tables 7 and 8). The rate of growth in production was driven largely by area expansion than increase in yield. About 90% of pigeonpea is produced in Asia and specifically in India despite its spread in Africa. The production in Africa increased rapidly from

0.24 million tons in 1991-93 to 0.66 million tons in 2011-13 at an annual rate of 5.0%. India is the single largest producer of pigeonpea which contribute about three-fourth of world production. India pigeonpea production increased from 2.2 million in 1991-93 to 3.7 million at an annual rate of 0.8%. The modest increase in production of pigeonpea in India due stagnant yield increase and shift in pigeonpea area from favourable region to non-favourable regions. Myanmar is the second largest producer of pigeonpea in the world next to India. In the last two decades, the pigeonpea production increased rapidly from 0.08 million tons in 1991-93 to 0.8 million tons in 2011-13 and it grew at an annual rate of 13.6% (Table 8). The rapid production in Myanmar is driven by area expansion and considerably by improvement in yield.

Table 7. Area, yield and production of pigeonpea in different regions of the world

Country/Region	Area ('000 ha)			Yield (kg/ha)			Production ('000 tons)		
	1991-93	2001-03	2011-13	1991-93	2001-03	2011-13	1991-93	2001-03	2011-13
World	4,233	4,524	5,665	634	681	764	2,683	3,081	4,526
Developed World	63	59	137	807	739	853	51	43	117
Africa	419	545	751	576	696	885	241	379	665
Asia	3,750	3,921	5,036	638	679	744	2,390	2,659	3,743
South Asia	3,624	3,470	4,388	638	651	652	2,310	2,256	2,860
India	3,599	3,440	4,370	638	649	651	2,294	2,231	2,844
Bangladesh	6	4	1	513	494	890	3	2	1
Southeast Asia	126	451	648	625	893	1,363	80	403	884
Myanmar	126	451	648	625	893	1,363	80	403	883

Table 8. Annual compound growth rates (%) of pigeonpea area, yield and production, 1991-2013

Region/Country	Area	Yield	Production
World	1.50	1.00	2.52
Developed World	5.42	0.17	5.60
Africa	2.78	2.19	5.03
Asia	1.26	0.86	2.13
South Asia	0.64	0.14	0.79
India	0.66	0.13	0.80
Bangladesh	-11.51	3.34	-8.55
Southeast Asia	8.79	4.43	13.62
Myanmar	8.78	4.43	13.61

Future outlook for food legumes in Asia

Groundnut: Baseline Scenario

The baseline projections of IMPACT model represent the business-as-usual scenario where past trends in per capita income, population growth and area and yield growth rates are assumed to continue to 2050. Table 9 presents the results of the baseline projection for groundnut (in shell equivalent) demand and supply in world and important groundnut growing Asian countries. The demand for groundnut in India will increase to 6.2 million tons in 2050 from 4.8 million tons in 2010. However, production increases are unlikely to catch up with the demand increases, forcing the country to be net importer to meet the increased demand. In contrast, China the largest producer and consumer of groundnut will produce more than the demand and will have a trade surplus of 1.1 million tons in 2050 despite rapid increase in demand from 10.3 million tons in 2010 to 13.8 million tons in 2050 (Table 9). The other countries in Asia like Pakistan and Bangladesh will be importing groundnut to meet more in 2050 than in 2010. On the other hand, Myanmar will produce more than the domestic demand and will have substantial trade surplus for export in 2050. The model results clearly show that Asia will face deficit in groundnut production in the coming years with the current level of area and yield growth of groundnut.

Table 9. Demand and supply projections ('000 tons) for groundnut under baseline scenario

Country/Region	Demand*			Production		
	2010	2020	2050	2010	2020	2050
World	26958.7	30269.6	37188.4	27081.1	30392.0	37310.8
China	10349.3	11392.4	12733.9	10333.0	11416.2	13813.7
India	4818.7	5320.4	6222.8	4685.0	4829.5	4135.5
Myanmar	480.8	519.0	583.7	767.1	806.9	841.4
Pakistan	77.1	86.8	103.5	50.1	49.9	52.6
Bangladesh	26.0	28.5	32.1	27.2	29.1	30.6

Note: * This is total demand includes food, feed and other demand

Chickpea: The baseline scenario projection of chickpea demand and supply for world and important Asian countries is given in the Table 10. The world demand for chickpea will increase from 9.3 million tons in 2010 to 11.3 million tons in 2020 and will increase to 18.2 million tons in 2050. With current level of income and population growth in India, the demand for chickpea will increase from 6.2 million tons in 2010 to 12.1 million tons in 2050. The increase in production in India from 6.0 million tons in 2010 to 10.9 million tons in 2050 will not be sufficient to meet the growing demand. The model results shows that demand-supply gap for chickpea in India will grow over the years. Therefore, India's imports will rise, creating a trade deficit of 1.2 million tons in 2050. The other Asian countries where chickpea is consumed like Pakistan and Bangladesh will also have to import chickpea to meet the growing demand with in sufficient domestic production.

Table 10. Demand and supply projections ('000 tons) for chickpea under baseline scenario

Country/Region	Demand			Production		
	2010	2020	2050	2010	2020	2050
World	9349.6	11397.5	18216.4	9357.0	11405.0	18223.9
India	6278.0	7636.8	12160.1	6050.7	7207.6	10981.5
Pakistan	790.8	1007.9	1752.6	706.9	834.2	1450.6
Myanmar	92.7	104.3	132.4	259.0	282.3	310.5
Bangladesh	61.3	72.3	102.1	14.9	18.9	34.4

Pigeonpea: The IMPACT model results shows that the projected world demand for pigeonpea will be doubled in 2050 (7.6 million tons) compared to the value in 2010 (3.5 million tons). India is the major producer and consumer of pigeonpea in the world, its increase in production of pigeonpea from 2.6 million tons in 2010 to 5.8 million tons in 2050 will not be sufficient to meet increasing domestic demand from 3.0 million tons in 2010 to 6.5 million tons 20150 (Table 11). The other major Asian country producing pigeonpea is Myanmar, its production will increase from 0.6 million tons in 2010 to 0.9 million tons 2050 which higher than the domestic demand and will have sufficient trade surplus position.

Table 11. Demand and supply projections ('000 tons) for pigeonpea under baseline scenario

Country/Region	Demand			Production		
	2010	**2020**	**2050**	**2010**	**2020**	**2050**
World	3512.5	4395	7658.8	3665.7	4548.2	7812
India	3070.9	3829.9	6574.2	2647.2	3308.9	5816.4
Myanmar	144.1	163.9	214.3	605.6	697.9	939.3
Bangladesh	3.2	4.0	6.8	1.8	2.1	3.4

Climate change scenario analysis

Groundnut: The simulations by both climate models project a decline in most of the countries groundnut yield .The decline is much higher in the CSIRO scenarios than MIROC scenarios. The yield levels are projected to increase in India and in China after 2010 in the both the MIROC scenarios. The increases would be much higher in India are 8 and 10 % compared to 5 and 10 % in China relative to baseline by 2050 in B1 and A1B scenarios respectively. The yield levels in Pakistan and Myanmar are seen to progressively decline in both MIROC scenarios to as low as 13% and 7% by 2050 respectively In Indonesia yields are seen to decline in A1B scenario alone. Pakistan would experience the highest decline in Asia. The reduction in Indonesia and Myanmar would be comparatively much lesser than that in Pakistan. However, in the CSIRO scenarios the

yield would decline in all countries except Indonesia where it would marginally increase. India, Myanmar and Pakistan would see declines in yield in both CSIRO scenarios. Pakistan would be worst hit followed by Myanmar and India (Table 12). The yields reduce by 17% in Pakistan 4% in Myanmar and 1% in India. In China yields are seen to decline by as much as 8% only in the B1 scenario and increase by 4% in A1B scenario.

In line with the impact on yield the simulations show a decline in production in both scenarios. As in the case of yield the reductions in production are higher in the CSIRO scenarios than MIROC scenarios. There would be increases in production in India in both MIROC scenarios. The production increases by 13% and 8% in A1B and B1 scenarios respectively. In China productions begin to increase after 2020 MIROC B1 scenario and increase by close to 2% by 2050 and in A1B scenario they increase throughout and by 2050 increase by 3% relative to baseline. In Pakistan it progressively declines in B1 scenario to as low as 10% by 2050. In sharp contrast it increase of 12% by 2050 in the A1B scenario. Indonesia and Myanmar would be the only country which will see its production decline in both MIROC scenarios. On the other hand in the CSIRO scenarios all countries except Indonesia would have reductions in production. China and India would see more or less similar reductions. However, the reductions in India would be highest around 8% in the A1B scenario, while for China it would be 10% reduction in the B1 scenario. Besides Indonesia in Myanmar it increases in the CSIRO B1 scenario it increases by 3% in 2050 relative to baseline (Table 12).

The area under groundnut cultivation is seen to decline in Asian countries except Pakistan and Myanmar in both CSIRO scenarios. The increases in area are much lesser in Myanmar compared to Pakistan. In Pakistan there is rapid area expansion and it is seen to increase by 25 and 12% in B1 and A1B scenarios respectively. In the CSIRO scenarios India, China and Indonesia have reduced area under groundnut. In the MIROC scenarios there is a contrary trend in the two scenarios. In the A1B scenario it increases in all countries with Pakistan having the highest increase of 21% and other countries having increases in the range of 0.5 -3%. In the B1 scenario area under groundnut increases only in Pakistan and India. In the other two countries it declines though to a lesser degree compared to CSIRO scenario (Table 12).

Chickpea: Again the projections are different in case of chickpea also. As in case of groundnut, Pakistan is the country which is worst hit in both scenarios and sees the largest decline in chickpea yield among the Asian countries. As far as India is concerned the yield is projected to decline by 1 and 2 % by 2050 in the CSIRO B1 and A1B scenarios while it is projected to increase by 5% by 2050 in the MIROC scenarios. In Pakistan it declines by 17 and 21 % by 2050 in the CSIRO B1 and A1B scenarios and 14 and 6 % in the MIROC scenarios. In China yield is projected to increase in both CSIRO and MIROC scenarios with higher increases in CSIRO scenarios in 2050 relative to baseline. It increases by 5 and 9% in CSIRO compared to 4 and 6% in MIROC B1 and A1B scenarios respectively. In Iran the yield is projected to increase by 9 % by 2050 in CSIRO A1B scenario. In Myanmar yield is projected to have small increase in the CSIRO B1 scenario alone and is seen to decrease by 4% in MIROC and 2% in CSIRO A1B scenario (Table 13).

The changes in production do not follow the same trend as that of yield. In Pakistan production would decline in CSIRO B1 and MIROC A1B scenarios and increase in CSIRO A1B and MIROC B1 scenarios. Iran would see the highest decline in production in both scenarios despite the increase in yields. It declines by 11 and 21% in B1 scenarios while it increases by 8% in MIROC A1B scenario. In India, China and Myanmar since production is mainly driven by changes in productivity they follow the same trend as that of their yield in respective scenarios. In India it

decreases and increases in the CSIRO and MIROC scenarios respectively. India sees an increase of 6% in the MIROC B1 scenario. In China it increases in both scenarios with relatively higher increases in the CSIRO scenarios. It would have a high increase in the CSIRO A1B scenario by 7% in 2050. In Myanmar it increases in both CSIRO scenarios and decreases in both MIROC scenarios (Table 13).

In both the scenarios there is a reduction in area with a few exceptions. In Pakistan it increases in both scenarios. Myanmar would have higher area under chickpea in the CSIRO scenarios. India would have marginally higher area under chickpea in MIROC B1 scenarios. Pakistan would have more area under chickpea in the CSIRO and MIROC scenarios respectively by 2050 relative to baseline. It expands by 34% in CSIRO B1 scenario and 21% in MIROC A1B scenario by 2050 (Table 13).

Pigeon pea: Pigeon pea yield is projected to decline by around 1% each in both India in the 1 and 2% CSIRO B1 and A1B scenario while in Myanmar it slightly increases in B1 scenario and decreases by 1% in the CSIRO A1B scenario. However, in the MIROC scenarios in India yield is projected to increase by 6% and decline by around 4% in Myanmar by 2050 relative to baseline. Similarly Production decreases in India by 1 to 2% and increase in Myanmar by around 2% in CSIRO scenario. However, in MIROC scenario in India it increases by 6% in India and decreases by 6% in Myanmar by 2050 relative to baseline. Area is seen to decline in India in both scenarios and increase in Myanmar in CSIRO scenario (Table 14).

Conclusion and policy implications

The sustained rise in per capita incomes, growing population and changing lifestyles and dietary consumption, the demand food legumes has been growing rapidly in Asia to the extent that domestic production in most countries in the region is unable to catch up with rising demand. During 1991-2013, Asia's groundnut, chickpea and pigeonpea production grew at a rate of 2.02%, 2.10 and 2.52% a year respectively. Their performance across Asian countries, however, has been mixed. While groundnut production in Myanmar and China grew at an impressive rate of 6.54% and 3.79% respectively, its performance in India has been lacklustre and grew negatively (-0.69%) during 1991-2013. Groundnut yield is higher in China than in any other country in the region, and it is one of the lowest in India. Interestingly, despite differing performances, yield improvements were the main drivers of growth in production in most Asian countries.

In Asia, patterns of production and utilization of chickpea and pigeonpea are overwhelmingly influenced by India because of its status as a dominant producer and consumer in the region. In 2011-13, India accounted for two thirds of the global and three-fourths of Asia's chickpea production. Likewise, it accounted for over 72% of the global and 81% of Asia's pigeonpea production. In the region, Myanmar's chickpea and pigeonpea production grew at an impressive rate at 10.36% and 13.61% respectively during 1991-2013. The growth in production of chickpea and pigeonpea in Myanmar is contributed by both yield growth and area expansion in the last decade.

Table 12: Percentage deviation in groundnut area, yield and production over baseline in climate change scenarios

Country	CSIRO								MIROC							
	B1				**A1B**				**B1**				**A1B**			
	2020	**2030**	**2040**	**2050**	**2020**	**2030**	**2040**	**2050**	**2020**	**2030**	**2040**	**2050**	**2020**	**2030**	**2040**	**2050**
Yield																
India	-0.22	-0.32	-0.44	-0.73	-0.42	-0.65	-0.92	-1.44	3.69	5.38	6.95	8.37	4.17	6.17	8.02	9.75
Pakistan	-5.98	-9.04	-12.44	-15.78	-7.79	-11.11	-14.37	-17.41	-5.43	-7.82	-10.23	-12.75	-2.78	-3.91	-5.47	-7.53
China	-4.23	-5.89	-7.24	-8.02	1.08	2.01	3.19	4.67	1.26	2.21	3.39	4.84	0.07	0.32	0.7	1.12
Indonesia	1.01	1.52	2.02	2.51	1.13	1.71	2.28	2.85	1.53	2.34	3.16	3.99	-2.52	-3.81	-5.1	-6.37
Myanmar	0.05	0.05	0.02	-0.04	-1.63	-2.46	-3.31	-4.18	-2.9	-4.35	-5.78	-7.21	-2.35	-3.52	-4.68	-5.84
Production																
India	-0.86	-1.41	-2.08	-3.03	-2.65	-4.03	-5.46	-7.17	3.73	5.48	7.11	8.5	5.53	8.26	10.87	13.37
Pakistan	2.77	3.93	4.53	5.02	-3.22	-4.49	-5.86	-7.16	-4.48	-6.43	-8.41	-10.52	4.68	7.5	9.96	11.94
China	-5.28	-7.5	-9.43	-10.86	-0.12	0.15	0.62	1.31	-0.06	0.23	0.76	1.56	0.92	1.63	2.5	3.46
Indonesia	1	1.33	1.54	1.61	0.61	0.83	0.95	0.93	-0.17	-0.25	-0.33	-0.44	-1.9	-2.88	-3.84	-4.78
Myanmar	1.36	1.87	2.27	2.53	-0.77	-1.27	-1.86	-2.58	-3.07	-4.62	-6.15	-7.69	-2.13	-3.2	-4.24	-5.28
Area																
India	-0.64	-1.09	-1.64	-2.32	-2.24	-3.4	-4.58	-5.82	0.05	0.09	0.15	0.12	1.31	1.97	2.64	3.29
Pakistan	9.31	14.25	19.38	24.7	4.95	7.45	9.94	12.41	1	1.51	2.03	2.55	7.67	11.88	16.33	21.06
China	-1.09	-1.71	-2.37	-3.08	-1.19	-1.82	-2.49	-3.21	-1.31	-1.94	-2.54	-3.13	0.85	1.3	1.79	2.31
Indonesia	-0.01	-0.19	-0.47	-0.87	-0.51	-0.86	-1.3	-1.86	-1.67	-2.53	-3.38	-4.26	0.64	0.97	1.32	1.69
Myanmar	1.31	1.82	2.25	2.57	0.87	1.23	1.51	1.68	-0.17	-0.29	-0.39	-0.52	0.22	0.33	0.46	0.59

Table 13: Percentage deviation in Chickpea Area, Yield and Production over baseline in climate change scenarios

Country	CSIRO								MIROC							
	B1				A1B				B1				A1B			
	2020	2030	2040	2050	2020	2030	2040	2050	2020	2030	2040	2050	2020	2030	2040	2050
Yield																
India	-0.37	-0.49	-0.63	-0.69	-0.88	-1.34	-1.76	-2.20	2.44	3.52	4.49	5.34	2.35	3.5	4.54	5.45
Pakistan	-5.13	-8.68	-12.83	-17.18	-7.44	-11.68	-16.2	-20.83	-4.78	-7.64	-10.76	-14.2	-1.73	-2.86	-4.42	-6.42
Iraq	-1.64	-2.64	-3.63	-4.53	-1.5	-2.46	-3.46	-4.31	-3.32	-5.31	-7.25	-8.88	-3.89	-6.49	-8.87	-10.9
Iran	-0.42	-0.64	-0.87	-1.18	3.9	5.9	8	9.98	-4.61	-6.92	-9.15	-11.39	5.68	8.82	12.19	15.9
China	1.37	2.29	3.34	4.5	2.99	4.84	6.87	9.08	2.49	3.89	5.35	6.89	1.69	2.52	3.38	4.18
Myanmar	0.06	0.09	0.11	0.11	-0.66	-1	-1.34	-1.71	-1.43	-2.15	-2.88	-3.61	-1.43	-2.17	-2.9	-3.64
Production																
India	-0.82	-1.17	-1.51	-1.84	-1.05	-1.58	-2.08	-2.59	2.66	3.87	4.99	6.03	1.99	2.89	3.73	4.41
Pakistan	6.62	8.82	10.14	10.9	-0.86	-2.06	-3.82	-5.94	-3.4	-5.59	-8.09	-10.93	7.97	11.82	15.32	18.29
Iran	-4.58	-6.81	-9.00	-11.25	-0.06	-0.09	-0.1	-0.21	-9.02	-13.26	-17.26	-21.06	3.78	5.96	8.5	11.37
China	0.01	0.23	0.59	1.00	2.21	3.66	5.25	7.03	1.31	2.16	3.09	4.17	1.54	2.27	3.13	3.92
Myanmar	0.78	1.18	1.57	1.89	0.45	0.70	0.90	1.10	-1.58	-2.34	-3.10	-3.81	-2.91	-4.42	-5.83	-7.28
Area																
India	-0.46	-0.68	-0.89	-1.15	-0.17	-0.25	-0.32	-0.41	0.21	0.34	0.48	0.66	-0.35	-0.59	-0.77	-0.98
Pakistan	12.38	19.16	26.35	33.91	7.11	10.9	14.78	18.8	1.45	2.22	2.99	3.81	9.87	15.1	20.65	26.4
Iran	-4.17	-6.21	-8.2	-10.19	-3.81	-5.66	-7.49	-9.26	-4.63	-6.82	-8.93	-10.91	-1.79	-2.63	-3.29	-3.91
China	-1.34	-2.01	-2.67	-3.35	-0.76	-1.13	-1.52	-1.88	-1.15	-1.66	-2.15	-2.55	-0.15	-0.24	-0.24	-0.25
Myanmar	0.72	1.09	1.46	1.79	1.12	1.71	2.28	2.86	-0.15	-0.20	-0.23	-0.21	-1.49	-2.29	-3.01	-3.77

Table 14: Percentage deviation in pigeon pea area, yield and production over baseline in climate change scenarios

Country	CSIRO								MIROC							
	B1				**A1B**				**B1**				**A1B**			
	2020	**2030**	**2040**	**2050**	**2020**	**2030**	**2040**	**2050**	**2020**	**2030**	**2040**	**2050**	**2020**	**2030**	**2040**	**2050**
Yield																
India	-0.35	-0.49	-0.65	-0.75	-0.84	-1.30	-1.73	-2.15	2.46	3.60	4.65	5.57	2.58	3.92	5.15	6.30
Myanmar	0.07	0.10	0.13	0.14	-0.66	-0.99	-1.34	-1.70	-1.53	-2.30	-3.07	-3.84	-1.40	-2.11	-2.81	-3.52
Production																
India	-0.71	-1.05	-1.42	-1.78	-0.98	-1.49	-1.99	-2.51	2.26	3.28	4.24	5.07	2.50	3.75	4.91	6.00
Myanmar	0.89	1.29	1.67	1.98	0.48	0.74	0.93	1.08	-2.11	-3.20	-4.26	-5.35	-2.63	-3.99	-5.29	-6.60
Area																
India	-0.36	-0.57	-0.77	-1.03	-0.13	-0.19	-0.27	-0.37	-0.20	-0.31	-0.39	-0.47	-0.08	-0.16	-0.22	-0.28
Myanmar	0.81	1.19	1.54	1.85	1.15	1.75	2.30	2.82	-0.59	-0.92	-1.24	-1.56	-1.25	-1.92	-2.55	-3.19

Demand and supply projections for groundnut, chickpea and pigeonpea under the business-as-usual scenario for Asian countries corroborate the fact that in the near future, domestic production is unlikely to catch up with growing demand. If current trends in per capita income and production were to continue, by 2050 India's demand for groundnut, chickpea and pigeonpea in India would increase to 6.2 million tons, 12.1 million tons and 6.5 million tons in 2050 respectively, which is far below the production level. Increasing consumption, coupled with stagnant domestic production and open import policies, will further worsen India's net trade deficit. Demand for chickpea and pigeonpea is also projected to increase in Africa, although increase in production there would more than offset increase in demand, resulting in Africa becoming a net exporter of both crops.

The expanding demand for food legume crops in Asian countries suggests that there are considerable opportunities to expand the food legumes sector in Asia. This can be harnessed by overcoming supply-side constraints through generation and diffusion of appropriate technologies for different production environments, and appropriate market and trade policies.

Developing climate smart crop technologies with traits like drought resistance, heat tolerance, breeding for shorter duration and other crop management practices need to be emphasized. Investment in water efficient technologies, such as mulching, drip irrigation and so on should also be emphasized, in order to optimally utilize scarce resources in uncertain future climate.

Policies to increase competitiveness of food legume crops in India by providing producer subsidies or by strengthening the price support structure would ensure that their area expansion. Coupled with low productivity in general, most food legume crops like chickpea and pigeonpea have lost their competitive edge over other crops grown under similar agro-climatic conditions. Hence, to improve production of these crops, there is a need to improve their profitability by promoting climate smart high yielding varieties and ensuring competitive prices by providing minimum support price.

The environmental benefits and nutritional value of the legumes has been well documented in the literature. Awareness needs to be created about the health and other benefits of consuming legumes so that there is larger acceptance by the public and this in turn would enhance demand in the future. The policies at the national and international levels need to create a conducive policy environment to incentivise and sustain such efforts.

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Targeting and Diffusion of Chickpea improved cultivars in Andhra Pradesh state of India

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ABSTRACT

Chickpea accounts for about 45% of total pulses produced in India, which is the major chickpea producing country, contributing over 75% of world production. Andhra Pradesh is the fifth largest state in chickpea cultivation. In Andhra Pradesh, Kurnool and Prakasam districts were occupying the first and second positions in chickpea production. Tropical Legumes-II (TL-II) project was supported by BMGF and has been promoting chickpea improved cultivars in the state since 2007 improving farmer's livelihood by enhancing chickpea productivity. For this Farmer Participatory Varietal Selection (FPVS) approach was followed. Further a strategic deepening and widening of technology outreach to farmers across all categories was designed by involving farmers in selection of varieties. This demonstrated the performance of improved cultivars over the check cultivars in the two targeted districts. Based on farmers' preference, cultivars were identified, multiplied and distributed to them in small seed pockets. During the first phase of the project (2007-08 to 2010-11), 476 seed pockets were distributed freely in 119 villages of two districts. A real tracking survey was taken up to track these farmers and understand their perceptions on TL-II cultivars. The main objective of the present paper is to trace adoption of chickpea cultivars, drivers of diffusion and innovations in spread of chickpea technology and examine the sustainability. In the real-time survey 487 seed and non-seed beneficiary farmers was included using probability proportionate sampling. TL-II cultivars (JG 11, KAK 2, Vihar, JAKI 9218) have completely replaced the old cultivar (Annigeri). The Logit and Tobit estimation showed that availability of household labour, access to formal seed sources, price information and literacy increased adoption of improved cultivars. Subsidized seed hastened diffusion process. Seed beneficiaries perceived 40-60% yield enhancement through improved cultivars which led to a 'Salient Chickpea Revolution' in the state.

Key words: Diffusion of chickpea improved cultivars, FPVS approach, TL-II project, Chickpea in AP.

Targeting and Diffusion of Chickpea improved cultivars in Andhra Pradesh state of India

Introduction

Chickpea is one of the earliest cultivated legumes has its origin during the mid of 18th century. There are two predominant chickpea types cultivated in India namely, *desi* type is small in size, light to brown seed in colour with a rough coat, cultivated mostly in the India and much of the Indian Subcontinent, as well as in Ethiopia, Mexico, and Iran and *Kabuli*, associated with Kabul in Afghanistan are lighter coloured also whitish, with larger seeds and a smoother coat, mainly grown in Southern Europe, Northern Africa, South America and Indian Subcontinent, having been introduced during the 18th century to India.

In the world major chickpea growing areas are Mediterranean, western Asia, the Indian subcontinent, Australia and the Great Plains. Major countries producing chickpeas are India, Australia, Pakistan, Turkey, Burma Ethiopia and Iran, of all, India produces almost five times more than the second largest producer of chickpea i.e; Australia and contributing over 75% of total world production. Chickpea accounts for about 45% of total pulses produced in the country.

In Andhra Pradesh, Kurnool and Prakasam were the districts occupying one and two positions in Chickpea production. During 2007-08 a baseline survey was conducted in these districts as a bench mark before any intervention. Besides this mother baby trials were introduced in 2007-08 to facilitate participatory varietal trials for selection of suitable varieties involving the farmers as a part of project Tropical Legumes II targeting Kurnool and Prakasam districts.

Before the intervention there were certain chickpea varieties cultivated by the farmers, but those existing varieties were released 30 years back and virtually yielding like local varieties because seed has lost its purity over years. Intermittently, several other varieties were tried but did not like by farmers.

The present paper attempts to give a holistic view result of TL-II intervention targeting adoption by conducting real time tracking survey. The adoption and diffusion pattern is discussed, duly mentioning about the two surveys namely baseline survey and early adoption survey conducted as a part of TL-II project before the real tracking survey, to have clear idea on the technology uptake process.

Baseline survey – lessons learnt

In Kurnool and Prakasam districts, the baseline survey was conducted to serve as a bench mark to study the impact of intervention through TL-II project at a later point of time. Proportionate random sampling technique was adopted to cover all the categories of farmers by drawing a sample of 135 from each district. Together twelve villages were surveyed. In Kurnool district Balapanur, Mitnala and Pulimaddi (3 adopted), Munagala, Rasulpet and Brahmanapally (3 control) and in Prakasam district, adopted villages were Cherukurapadu, Chirvanauppalapadu, Kollavaripalem and control villages Paidipadu, Maddiralapadu and Bodavada were selected. Both adopted (being the villages where

mother baby trials were held in 2007) and control (villages being where there was no deliberate intervention of crop improvement programme under TLII) slightly differ in project treatments, but they have similar agro-climatic conditions.

Baseline survey found that the food crops like jowar and bajra, non food crops like cotton, chillies and tobacco in Prakasam and Sunflower and jowar in Kurnool were traditional crops and these were replaced by chickpea due crop shifts. Chickpea gained prominence as it is a short duration crop, suitable to black soils, less labour intensive, suitable for mechanisation that can be taken up and also due to stable prices realised for chickpeas which lead to stable income. Baseline revealed a striking fact that the old variety Annigeri popularly referred by farmers as Gulabi was the ruling variety and was considered as a local check. The respondents of the survey were ready to buy new seed even at high price if it yields better than Annigeri.

Kumara Charyulu and Bantilan (2011) studied the tracking of Sorghum improved cultivars adoption in India and justified the role of improved cultivars in sustaining the higher yields and reducing yield variability in addition to the biotic and abiotic challenges, presumed climate change also affected sorghum area and its importance globally. The study concluded that climate change will modify length of growing period and increased the predicted temperatures across different regions. It also suggested that more thrust is needed on development of drought resistant and heat tolerant varieties using modern bio-technology tools and also emphasise on development of post-rainy season cultivars and its adoption.

Lessons learnt

- Need for replacement of existng varieties and seed replacement – with high yielding varieties and identified role of gender in chickpea
- Preferences of farmers in any new cultivar were documented and was taken as feedback to the breeders
- Great need for effective seed muliplication and seed delivery systems (formal and informal).

Therefore strategic development of new varieties considering the preferences of the farmers and other players in the market is required to be taken up to have effective crop improvement programmes. Hence the trials were held with the following desi and kabuli varieties along with local checks.

List of released/pre-released cultivars identified for each focal location for FPVS (Farmers' participatory varietal selection) after baseline survey during 2007-08

Country	States/ Divisions	No. of cultivars	Cultivars	
			Desi type	Kabuli type
India	Andhra Pradesh	8	ICCC 37, JG 11, JG 130, JAKI 9218, Annigeri (Check)	Vihar, LBeG7, JGK 2, ICCV 95334, KAK 2 (Check)

The intervention continued the trials moved away from the adopted villages and brought awareness among farmers and within a span of two years ruling variety (Annigeri) started declining and new cultivars introduced were adopted. The FPVS trials data was also analysed for documenting preferences of other farmers visiting the trials.The varieties preferred by farmers were Desi - JG 11, JAKI 9218 and JG 130 and in Kabuli – KAK 2, Vihar.

This led to the initiation of early adoption survey during 2009-10 to ascertain whether there is uptake of the chickpea technology and improved cultivars. Shah *et al.,* (2007) identified the factors accounting for low chickpea production in the year 2005-06. By conducting a survey on 40 farmers from the desert of the Oorpur Thal district Khushab in Pakistan. The results showed that almost two-thirds of the farmers have more than 20 hectares of rainfed land. Eighty-five percent of the growers used their own seed from previous crop. Lack of cleanliness in the marketing of the local landrace is one of the important factors in low productivity and less market prices. The scope for increasing production by adopting drought-resistant high-yielding varieties and improved management practices seems to contribute significantly.

All the 270 baseline survey respondents are revisited to track the early adoption in the two districts i.e., Kurnool and Prakasam. The trend in adoption was similar in all the villages surveyed, the old cultivars disappeared.

Early adoption survey – lessons learnt

The chickpea cropped area increased as a per cent of cropped area of respondents and total cropped area of the district. The varieties adopted by farmers were JG 11 and JAKI 9218 in Kurnool and JG 11 and KAK 2 in Prakasam district.

- JG 11 was adopted by 157 farmers in both districts and was sown in 1330 acres

- KAK 2 was sown by 89 farmers in 1122.5 acres and the price for KAK 2 was greater than JG 11 during this period. The yield levels are improved compared to the old Annigeri.

The adoption of new cultivars has great impact on farmers income and they realised 2.39 benefit cost ratio and where net returns ranged from Rs. 28514 to Rs. 35153 per ha. Due to the distinct performance of the new varieties later the chickpea fitted into cropping patterns in the adjacent districts as a spillover effect of the crop improvement programme under TL II.

Shiyani *et al.,* (2001) assessed the impact of improved chickpea cultivars in the state of Gujarat in India during 1970-95 based on a household survey of chickpea growers in 24 villages of four districts in Gujarat, India. The survey also revealed that improved chickpea cultivars showed distinctly superior performance over local cultivars in terms of yield, net income, and per unit cost of reduction, proving their cost and profit-maximizing characteristics. Tobit model suggested that holding size, crop duration, and yield risk significantly determined the probability, degree of adoption and found the most preferred quality traits of chickpea.

The project continued and the seed multiplication and farmer trials could outreach into new areas where there was already some demand for new seed during the years 2010-11, 2011-

12 and 2012-13.

Real time tracking survey

At this juncture the real time tracking survey was taken up to oversee the process of adoption, diffusion, technology dissemination mechanisms and innovations involved in spread of the improved cultivars introduced under TL-II looking at its sustainability.

This survey was taken up with specific objectives

1. To study adoption and diffusion process, drivers of adoption and preferences of farmers in the real time
2. Track the seed, sources, delivery process and role of various agencies in spread of the technology and to study the various seed channels including the farmer to farmer exchange

Sampling design

To take up an in depth analysis of adoption and trace the movement of seed of improved chickpea cultivars introduced in Kurnool and Prakasam districts the real time tracking survey was conducted. A sample of 487 including seed beneficiary households (2008, 2009 and 2010 and from baseline survey) and non-seed beneficiaries from baseline survey were included (Table 1).

In Andhra Pradesh, sampling details are as follows:

Table 1: List of Seed beneficiaries and sample selected

District	Total seed beneficiaries	Sample allotted included non-seed beneficiaries
Prakasam	140 (29.4)	146 (29.98)
Kurnool	336 (70.6)	341 (70.02)
Total	476 (100.0)	487 (100.00)

* 2008, 2009 and 2010 seed beneficiaries baseline farmers considered
Note: Figure in the parenthesis indicates percentage to column totals

In case of Chickpea, Andhra Pradesh, nearly 70 per cent of sample to be covered from Kurnool district in 19 mandals remaining from the 13 mandals from Prakasam district.

Mowo *et al.*, (2010) reviewed a methodology for tracking the pattern and extent of spillover of introduced technologies, using improved banana germ plasm in Lushoto a case study in Northeast Tanzania which referred to the spontaneous flow, or spread, of technologies between farmers using their social networks without external interference. The study showed that farmers made different modifications to the introduced technologies in order to fit them into the existing farming systems. The pattern of spillover is very much related to existing social networks in the community. The data on adoption parameters

input output costs seed exchange were focussed in the real tracking survey.

Barber (2000) set a pilot benchmark figures to show the true cost of irrigating (real time) an outdoor vegetable crop. The costs taken into account were ownership costs (bore, pump, pipe and irrigator) and operating costs (electricity, diesel, irrigation scheduling service, repairs and maintenance, and labour).

Accordingly, a semi structure questionnaire was designed and all the 487 farmers were interviewed to get the desired information.

Main findings of the real time tracking survey

Sample framework

The real tracking survey was conducted by contacting 330 seed beneficiary farmers and 157 non seed beneficiary farmers in Kurnool and Prakasam districts**.** The survey has widely covered 65 villages in 32 mandals. The data collected was classified and presented in two major seed and non-beneficiary categories. In Kurnool district the total seed beneficiaries are 231 and non-seed beneficiaries are 110 and similarly the seed beneficiaries in Prakasam were 99 while non-seed beneficiaries were 47 as in Table 2.

Table 2: Sample particulars of the real tracking survey, 2013 (no.)

District	Village	Treated /Control	Seed Beneficiaries		Non Seed Beneficiaries		Grand Total
			Baseline Beneficiary HH	Non Baseline Beneficiary HH	Baseline Control HH	Non-Baseline HH	
K U R N O O L	Ahalyapuram	Treated		5			5
	Alluru	Treated		4			4
	Amadagunta	Treated		10			10
	Amadala	Treated		3			3
	Anupuru	Treated		5			5
	Appalapuram	Treated		5			5
	B.Kotukur	Treated		8			8
	Balapanuru	Treated	5			25	30
	Banganipally	Treated		1			1
	Beemuni Padu	Treated		3			3
	Bramhanapalli*	Treated			10		10
	Chamgondla	Treated		4			4
	Govindapalli	Treated		5			5
	Gudipadu	Treated		3			3
	Guduru	Treated		9			9
	Gulamnabipeta	Treated		5			5
	Guttapadu	Treated		3			3

	H.Kottala	Treated		3			3
	Hussaina Puram	Treated		13			13
	K.Nagulapura	Treated		9			9
	Kalluru	Treated		10			10
	Kalugotha	Treated		9			9
	Kasipuram	Treated		6			6
	Kolvmuapalli	Treated		4			4
	Loddipalli	Treated		6			6
	Maddikera	Treated		3			3
	Mandyala	Treated	1				1
	Mitnala	Treated	1			29	30
	Munagala*	Treated			13		13
	Parla	Treated		5			5
	Peddakottla	Treated		6			6
	Pedda marriveedu	Treated		2			2
	Peddamudium	Treated		7			7
	Penchikalapau	Treated		11			11
	Polakollu	Treated		5			5
	Poluru	Treated		3			3
	Pulimaddi	Treated	7			23	30
	R.Kanyapuram	Treated		3			3
	R.Lingamdinne	Treated		6			6
	Rasulpet *	Control			10		10
	Revanuru	Treated		11			11
	Salkapuram	Treated		18			18
	Tangutur	Treated		4			4
	Total Kurnool		**14**	**217**	**33**	**77**	**341**
P R A K A S A M	Anumpalle	Treated		5			5
	Bodavada*	Control			5		5
	Chandulur	Treated		9			9
	Cherukurapadu	Treated				10	10
	Chervanuppalapadu	Treated				9	9
	Chintalagunta	Treated		12			12
	Dyralararuru	Treated		6			6
	Giddalur	Treated		9			9
	J.Pangulur	Treated		2			2
	Janakavarm	Treated		6			6

	Kalagatla	Treated		8			8
	Kollavaripalem	Treated				10	10
	Kongapadu	Treated		17			17
	Kurravanipalem	Treated		4			4
	M.Nidamanury	Treated		8			8
	Maddirala Padu*	Control			7	1	8
	N.Aaraharam	Treated		5			5
	Pedarukatla	Treated		8			8
	Paidipadu*	Control			5		5
	Total Prakasam			**99**	**17**	**30**	**146**
	Grand Total		14	316	50	107	487

- Treated villages of Baseline survey

* - Control villages of baseline survey

The mixed profile of the of sample farmers is presented in Table 3 showing education, caste category, experience in Chickpea cultivation etc for seed beneficiaries and non-seed beneficiaries.

Among the 330 seed and 158 non seed beneficiaries, seed beneficiaries are found to be more educated than non-seed beneficiaries with their mean schooling years being 8.40 years compared 6.96 years. Among the sample 17 members were SCs, 156 are BCs and 303 are OCs, with a coverage of SC beneficiaries is low just 3% but the BC farmers covered were accounting to 32% of the sample. The average experience of chickpea cultivation by seed and non-seed beneficiary farmers is almost the same i.e., 10.98 and 10.25 years confirming that chickpea as crop started only a decade ago.

The extent of own land holding was 14.1 acres in case the entire sample and the mean operational holding was 16 acres corroborates that leasing in land and development in land markets.

It was noteworthy that 98.76% of the sample farmers cultivated chickpea in deep black soils reinforcing the soil suitability for adoption. So diffusion took place in adjacent areas with black soils.

Shiyani *et al.*, (2001) aimed to track adoption of improved chickpea varieties, and assess their on-farm benefits in some remote and backward tribal villages in Gujarat, India, where few newly developed varieties were introduced by a non-government organization. It also determined key factors which were influencing their adoption and found that adoption of improved chickpea varieties was gradually increasing by replacing a prominent local variety. Duration of crop maturity, Suitability of soil, yield risk, and farmers' experience of growing chickpea significantly influenced the adoption.

Area expansion under chickpea

Total area cultivated by sample farmers is 8148 acres in 2013, while it was 4890 acres in 2012-13, showing doubling of the area establishes the tremendous potential for chickpea. Almost 78% of the farmers were stable and want to maintain the same area under chickpea while 13% farmers were decreasing area under chickpea cultivation. Few members, about 22 want to expand the area under chickpea. The decline in area is because prices are being stagnant even after waiting for six to seven months after harvest using the storage facilities. The competitive crops were tobacco and jowar.

As new areas are already gaining (Medak and Guntur) definitely there is scope for increase in the area but depends on market and import export policies.

Table 3: Characteristics of sample farmers

Item	Seed beneficiaries (N=330)	Non Seed beneficiaries (N=157)	Sample Average/ Sample Total (N=487)
Education *(years of schooling completed)*	8.40	6.96	7.94
Caste Category (No.)*			
SC	15	2	17
BC	120	36	156
OC	185	118	303
No. of years of experience in Chickpea cultivation (years)	10.98	10.25	10.74
Extent of own land *(including rain fed and fallow in acres)*	14.10	14.19	14.13
Extent of operational land (in acres)	16.31	17.62	16.73
Chickpea growing plot soil type			
Deep black (No.):	324	157	481
Light black:	6	-	6
Red soil:	-	-	-
Others etc:	-	-	-
Total area (Acres):	5381.5	2766.5	8148
Area under Chickpea cultivation in 2012 -13 *(in acres)*	3346	1544.5	4890.5
Allocation of area under Chickpea cultivation during last three years (No.)			
Increasing:	22	13	35
Decreasing:	49	19	68
Same:	259	125	384
Did you irrigate your Chickpea field (No.)			
Yes:	12	5	17
No:	318	152	470
Distance to regulated market *(km)*	16.30	12.28	15.01
Distance to Research station *(km)*	21.49	12.28	15.01
Distance to Agricultural Office *(km)*	10.07	9.25	9.80

Distance to Storage facility *(km)*	12.75	12.46	12.66
Are you member of any organization/society (No.) **			
Yes:	19	9	28
No:	309	148	457

*11 respondents have not disclosed their caste, **2 HH not responded

The average distance from the seed beneficiary villages to the regulated markets is more 16.3 km and to the Research stations is 21 km when compared to 12.28 km for the non-seed beneficiaries households to the regulated markets and research stations. This reconfirms the effective implementation of the crop improvement programme by TL-II making the improved seed available at far away locations.

Storage facilities like warehouses/cold storage units were in a vicinity of 12 km for all the villages included in the survey a major achievement in the targeted area by mobilising private investment into agriculture.

Seed distribution and implementation

TL II project seed beneficiaries for the past 4 years studied are presented in Table 4, which shows the variety wise seed distributed for the trials of seed beneficiaries from 2008-09 to 2011-12. The seed beneficiaries covered were about 150 during 2008-09, 76 members received JG 11, 45 members got JAKI 9218 seed, 27 members JG 130 seed and 22 members were given with KAK 2 and Vihar seeds. During 2009-10, there were about 127 seed beneficiaries, 52 farmers supplied with JAKI 9218, 23 farmers covered under JG 11 and 22 farmers with JG 130 seed. The trials were taken up in an aggressive way with wide and deep coverage. Besides comprehensive chickpea crop technology is given. Once the farmer is aware of the yield potential of new varieties he would be ready to try the new seed in his field, if seed is available. Therefore, only 20 kg of seed pockets were given to each farmer and thus bringing many farmers into the purview of seed distribution programme/trials. Slowly the withdrawal of the intervention started, thereby creating necessity to farmers to meet the seed demand. This has resulted in development of public and private and farmer to farmer seed networks creating a platform for the exchange of quality seed.

The average quantity of new cultivars seed given for trials and seed multiplication ranged from 17.5 to 25 kg. The judicious use of seed produced by distributing it to many farmers has helped the farmers either their use own seed or exchange seed. This has triggered the demand for quality seed, when there is such a demand for seed of the improved cultivars, even the public channels also responded. Thus, the adoption of the new cultivars hastened.

Implementation of trials

Success rate in sowing the seeds of new cultivars was 95% and just 5% farmers who could not plant the seed.

Table 4: TL-II seed beneficiary details (seed beneficiaries only N =330)

Details	2008-09	2009-10	2010-11	2011-12
HH TL-II project seed beneficiary (no.)	No.	No	No	No
Which Variety seed provided				
JAKI 9218	45	52	11	2
JG 11	76	23	9	-
JG 130	27	22	1	1
KAK 2	10	17	4	-
Vihar	12	13	4	3
Avg. quantity of seed provided (kg)				
Variety	2008-09	2009-10	2010-11	2011-12
JAKI 9218	20.34	19.23	22.27	17.5
JG 11	20.01	18.04	18.33	-
JG 130	18.96	21.36	25	25
KAK 2	19	20.88	21.25	-
Vihar	18.75	21.15	18.75	18.33
Did the household sown this variety (no.) Y: N:	 156 11	 121 6	 28 1	 5 1

Along with seed networks, to restore the germination of seed, scientific seed storage in warehouses and cold storage units also has started. The middle men of the commission agents also were helping the farmers to store their seed and try for loans on the basis of warehouse receipt. Thus the number of warehouses has tremendously increased. Storage also is used to mitigate the price risk.

Seed benefitted year – Area sown by seed beneficiaries

As seen from Table 5, the year before the seed benefitted year 223 acres were cultivated under Annigeri variety during 2006-07 though there was slight awareness of initiation of mother baby trials. But during the seed benefitted year the variety Annigeri disappeared among seed befitted farmers, as it was proven to be a low yielder and there was a latent demand for a new variety.

Table 5: Adoption of improved cultivars (sum of area in acres)

	Seed beneficiary		Non seed beneficiary	
Variety	Previous year of benefitted year	Seed benefitted year	Previous year of benefitted year	Seed benefitted year
Annigeri	223		59	
JAKI 9218	33	624	7	100
JG 11	111	969.25	47	523.5
JG 130	14	367.5	5	33
KAK 2	34	167	4	
Vihar	14	291	6	16
Total Area	445	2444.75	129	688.5

The area under all the new cultivars of chick pea has increased to 2444 acres in the fields of seed beneficiaries and 688.5 acres in the non-seed beneficiaries fields.

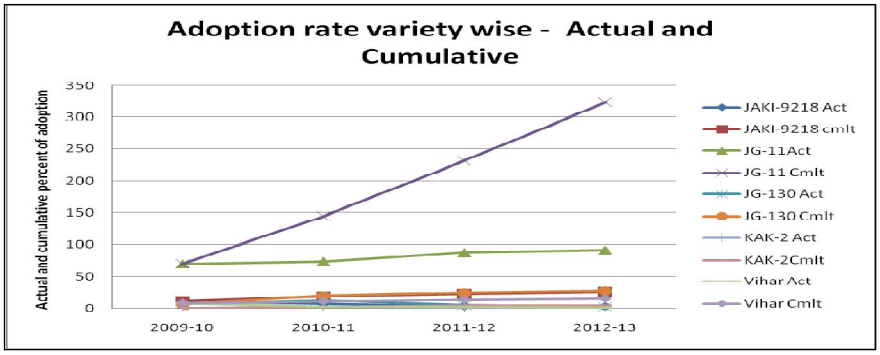
Seed Sources

All the varieties were primarily obtained from PVS trials only (75% farmers) and about 20% of the farmers obtained seed from farmer to farmer exchange, which the second best source of seed. This confirms the strength of informal exchange of seed from farmer to farmer. The third important source of seed on which 11% of farmers depended is the Govt. seed supply.

Varietal adoption and diffusion - 2008-09 onwards

The varietal adoption and diffusion from 2008-09 to 2012-13 was presented in terms of actual and cumulative percentage to total area sown by beneficiaries is presented below which showed that the actual and cumulative adoption rate of JG 11 in 2009-10 is 69.85 which gradually increased to 91.73 in terms of actual percentage and 323.06 as cumulative percentage. In case of JAKI 9218 the actual percent adoption decreased from 2009-10 to 2012-2013 i.e., from 12.17 to 2.88 whereas the cumulative per cent adoption increased from 12.17 in 2009-10 to 26.07 in 2012-13.

Figure 1: Variety wise adoption rate

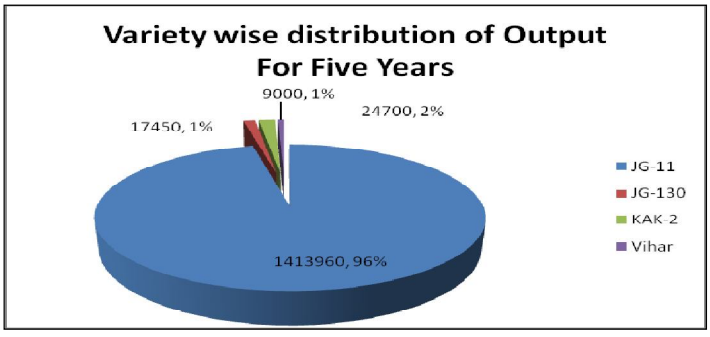


While for other varieties it is not so convincing as shown in Figure 1.

Production – variety wise seed beneficiaries

The total output recorded by seed beneficiaries as an aggregate of the five years variety wise is depicted in Figure 2 which showed JG 11 was occupying 96% of the output produced.

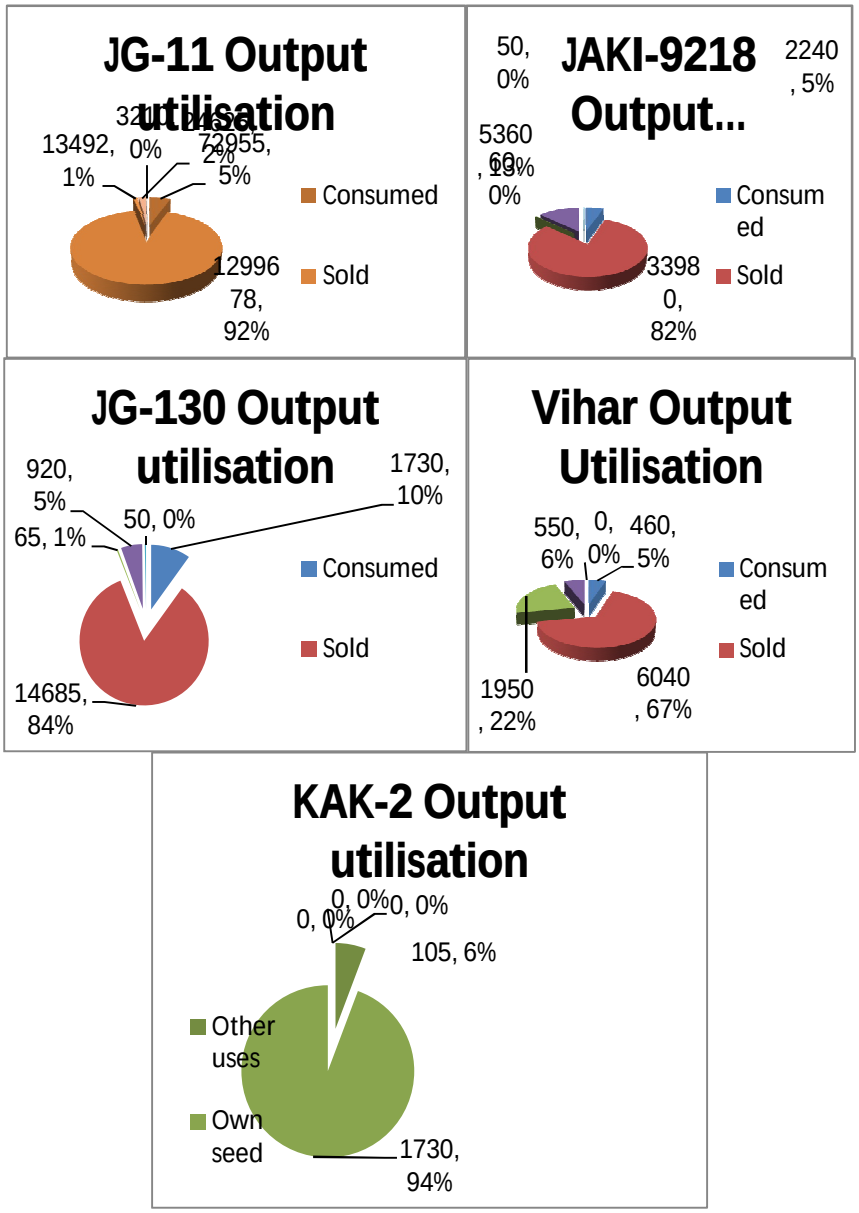
Figure 2: Variety wise output- seed beneficiaries



Output utilisation – Seed beneficiaries variety wise

The farmers were unable to quantify exact quantity of seed exchanged with other farmers, but it was noted that majority of seed also gets exchanged from the storage ware houses. Variety wise output utilisation pattern was depicted in the following Figures 3 to 7. When the output sold was observed variety wise the sold quantity ranged from 67% to 96% of the output. Consumption was around 5% of the output which was definitely used by farmers for day to day consumption; it serves as rich source of protein taking care of nutritional security of the targeted population.

Figures 3, 4, 5, 6 and 7: Variety-wise output utilisation pattern



Costs and return from chickpea cultivation

A year before the seed benefitted year there were about 225 farmers growing Annigeri in 1952.5 acres. Costs and returns obtained from new cultivars JAKI 9218, JG 11, JG 130, KAK 2 and Vihar and Annigeri the old cultivar pertaining to 2012-13 is presented in Table 6.

Table 6: Costs and returns from new cultivars and Annigeri, 2012-13

Operation	Cost of Cultivation`/acre						
	Annigeri	JG 11	JAKI 9218	JG 130	KAK 2	Vihar	Pooled average
No. of farmers	225	382	51	24	13	17	118
Sum of area	1952.5	3145.5	176	152	26	122	929
Land preparation	1093.75	1904.85	2005.55	1956.94	2269.23	2307.27	1922.9
FYM/Compost	0.00	479.51	804.90	450.27	0	194.54	321.5
Seed costs	1000	1863.68	1838.56	1750	2123.07	2072.72	1941.3
Sowing costs	718.75	1145.39	1121.07	997.22	839.56	892.72	952.5
Fertilizer costs	855.62	2339.27	2470.40	2093.61	3092.30	2666.66	2253.0
Micro-nutrient costs	-	9.94	29.41	-	-	-	6.6
Inter-culture costs	93.75	253.97	543.30	539.58	-	31.81	243.7
Weeding costs	406.25	725.31	792.35	727.77	1350	890.90	815.4
Plant protection costs	1250	1828.30	1711.20	1591.59	2619.23	2127.27	1854.6
Watching expenses	56.25	16.75	54.90	3.75	-	-	21.9
Harvesting costs	962.5	1003.28	1120.42	1096.73	1003.84	1141.66	1054.7
Threshing costs	687.5	799.35	899.90	878.12	1830.76	1138.18	1039.0
Marketing costs	82.5	222.67	237.67	213.64	147.69	213.43	186.3
Rental value of land	6000	6115.84	6345.96	6895.83	6192.30	6772.72	6387.1
Others costs if any	-	-	127.45	-	-	-	21.2
Total costs	13206.87	18752.67	20103.11	19195.09	21468.02	20450.70	19029.4
Grain-pod yield (kg)	425	762.66	641.17	695.83	670.83	700	632.6
% increase in grain yield over Annigeri	0	79.44	50.86	63.72	57.84	64.70	48.84
Grain-pod price/kg	34	36.66	33.71	33.25	39.08	38.45	35.9
Gross returns	14450	27959.12	21613.84	23136.35	26216.04	26915	22710.34
BCR	1.09	1.49	1.07	1.20	1.22	1.31	1.19

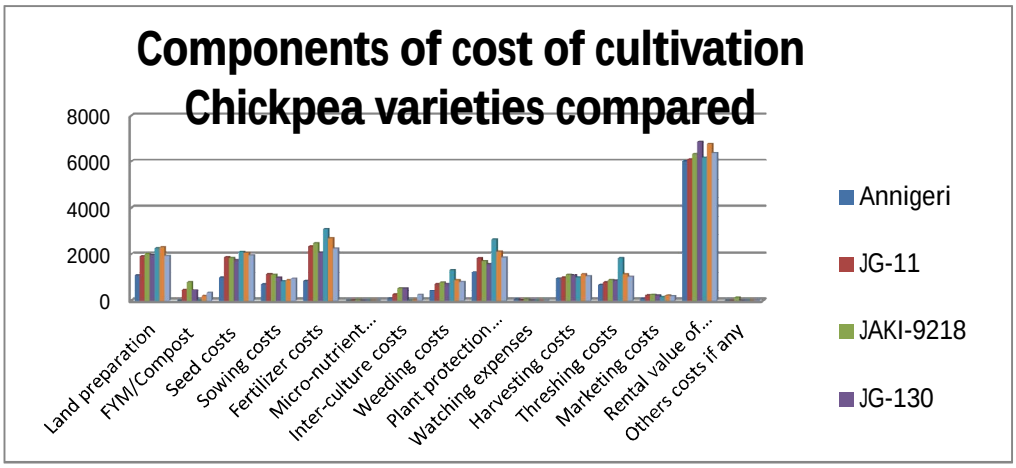
The farmers growing JG 11 are 382 in number planted chickpea in an area of 3145.5 acres, farmers growing JAKI 9218 are 51 in an area of 176 acres. Number of farmers growing JG-130, Vihar and KAK 2 are 24, 17, 13 and acreages are 152, 122 and 26 under each cultivar respectively. The cost of cultivation shows the expenses incurred in each operation for each cultivar.

JG 11 is the most preferred variety among farmers the expenses incurred per acre towards various farm operations are land preparation, FYM/Compost cost, seed cost, sowing cost and fertilizer costs which are 1904.85, 479.51, 1863.68, 1145.39 and 2339.27. Expenditure towards inter cultivation is 253.97, cost for weeding is 725.31, expenses towards plant protection chemicals is 1828.30. The average rental value paid per acre of land is 6115.84.

The cost of cultivation for JAKI 9218 was 20103/acre of which rental value of land is 6345 and fertiliser cost is 2470 per acre. Seed cost was highest for KAK-2 which is 2123/acre followed by Vihar 2072 among the desi varieties JG 11 seed cost was highest 1863 per acre.

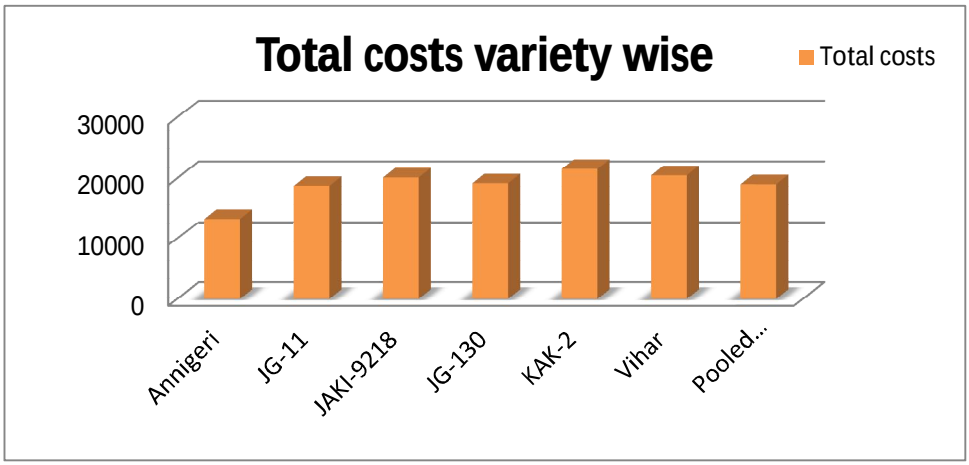
The benefit cost ratio was highest 1.49 for JG 11 clearly endorsing the potential yield and preference by the market and farmers for its higher yields of about 762.66 kg per acre on an average.

Figure 8: Cost components variety wise



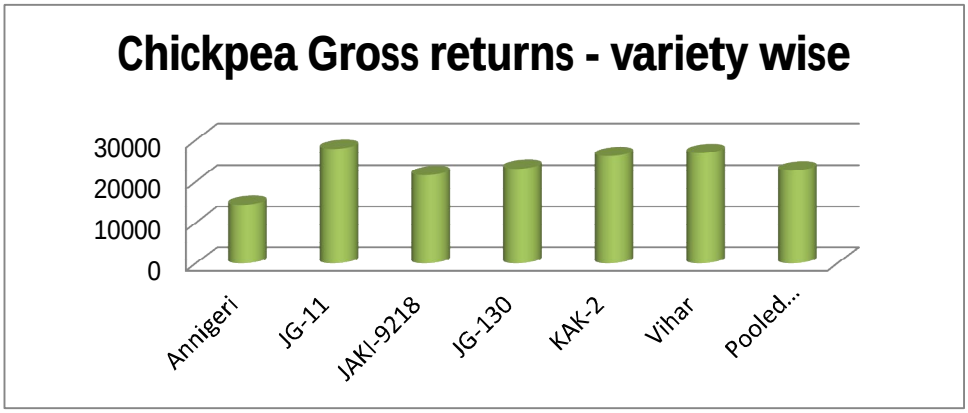
Cost components variety wise are compared in the above figure for all the varieties. Major expenditure in chickpea cultivation is for land preparation, seed cost fertiliser cost and plant protection, but nevertheless the rental value of land is highest among all the cost components.

Figure 9: Cost of cultivation by variety-wise



Variety wise cost of cultivation was more for Kabuli varieties than desi varieties. KAK 2 and Vihar recorded a cost of cultivation of 21468 and 20450 per acre as shown in Figure 9.

Figure 10: Gross returns by variety-wise



Gross returns for the varieties were highest for JG 11, Vihar followed by KAK 2 as depicted in the above figure.

Seed exchange

The quantity of JG 11 shared is 21332 kg between 71 farmers in the seed benefited village and 50 farmers were benefited in other village. 5210 kg of JG 130 is shared by 11 farmers in the same village and 26 other village farmers. 2500 kg of KAK 2 is shared by 3 farmers in the same village and 11 other village farmers. The amount of JAKI 9218 variety shared among 4 farmers of same village and 2 farmers in other village is 2400 kg. One farmer is benefited by Vihar by getting 300 kg seed, he belongs to same village. A total of 31792 kg of chickpea is shared and 112 same village farmers and 99 other village farmers were benefited by this.

Table 7: Seed sharing with other farmers

During the last three years, did you share seeds with any one (No.)?		Yes: 35	
		No: 452	
		Total no. of farmers benefitted	
If yes, what are the varieties?	**Total quantity shared (Kg)**	**SV(No.)**	**OV(No.)**
JAKI-9218	2400	26	10
JG-11	21332	71	50
JG-130	5210	11	26
KAK-2	2500	3	11
NBG-1	50	-	2
Vihar	300	1	-
Grand Total	31792	112	99

Role of institutions in Adoption Process

Role of institutions and their interventions in the targeted area, there where institutes like NSC, A.P. Seed, Department of Agriculture, Agri-biotech foundation, Kurnool seeds and Murali seeds played an important role in seed distribution. The National Seed Corporation distributes JG-11 seed, and High Yielding varieties were distributed by A.P. Seeds.

Department of Agriculture distributes seed on subsidy. Vihar is distributed by Agri-biotech foundation.

Drivers of technology adoption and diffusion

In this study Logit model was employed to examine the incidence of improved chickpea

adoption respectively. The binary Logit model is specified as follows:

$$Y_i = \beta_i X_i + \mu_i \quad \ldots (1)$$

Y_i = 1; if farmer grows improved chickpea varieties;

Y_i = 0; Otherwise

Whereby:

Y = Adoption of improved chickpea varieties

β = Parameters to be estimated

X =Vector of explanatory variables

E_i and μ_i= Random errors.

Therefore to model the adoption of improved chickpea varieties, the following equations were specified:

Logit Model

ADOPCH= NOWFM + TFM+ TOPHL+OTCROP+ GHINCOME+ DITRICT+

FARMSIZE + SECOCCPD+SEEDSOUR +IRRLAND+ NOLITM+SORINFO

In a standard regression model, the dependent variable is generally assumed to take on any value within the set of real numbers and the probability of any particular value is zero. In the dichotomous Logit model, the dependent variable assumes only two values, i.e. 0 and 1, each of which is assigned a probability mass.

Description of variables used in the Logit Model and their expected sign

Dependent variable	
PORPLCH	Proportion of land allocated for improved chickpea
ADOPCH	Improved chickpea adoption 1= adopter 0=otherwise
Explanatory variables	
NOWFM	Number of working family members
TFM	Total family members
CDINDEX	Crop diversification index
NOLITM	Number of literate family members
TOPHL	Total operational landholding (acres)
ATPINF	Access to price information 1=yes 0=no
GHINCOME	Gross household income in thousands (Rupees)
DISTRICT Dummy	District 0=targeted 1=Any other
MARKBEH	Marketing behavior 1=sell immediately after harvest 0=no
NFARMSIZE	Nature of farm size 0=marginal 1=small 2=medium 3=large
SECOCCPD Dummy	Secondary occupation 1=yes 0=no
IRRLAND	Irrigated land in acres
SORINFO	Sources of information 1= combined sources 0=single sources
SEEDSOUR Dummy	Seed source 1=formal 0=informal
VILLAGE	Village type 0=seed benefitted village 1=not benefitted

Table 8: Logit model estimates for household adopted improved chickpea varieties

Adoption of improved chickpea varieties	**Parameter estimate β**	**S. E**
No of working family member s	0.965***	0.292
Total family members	-0.661***	0.211
Total operational land (acres)	0.127	0.137
Gross household income (thousands)	0.014*	0.009
District (dummy)	-0.879*	0.547
Farm size distribution	1.061**	0.541
Secondary occupation (dummy)	-0.674	0.579
Seed sources (dummy)	2.665***	0.901
Irrigated land (acres)	-0.148	0.164
Number of literate family number	0.279	0.252
Source of information	0.682**	0.276
_constant	-0.603	1.003

***=Significant at p<1%; ** = Significant at p <5%; * = Significant at p<10%;

The Logit model was used to investigate factors affecting the adoption of improved chickpea varieties as shown in Table 8. The model is significant at 1% level. The adoption of improved chickpea varieties was increased by 162.5 per cent for a unit increase in working family members. Productive labour is more important than no of men in family in adoption of chickpea varieties. The result also shows gross household income marginally increase adoption of improved chickpea. For a thousand rupees increase in household income the adoption increases by 1.4 per cent. The result implies that the likelihood of adoption was found to be considerably high with the presence of reliable and formal seed source.

Access to diversified information sources increases adoption of improved chickpea adoption by 98 percent. The more information pathways the farmer has, the more the farmer intensifies adoption of technologies. Indeed, studies of innovation adoption and diffusion have long recognized information as a key variable, and its availability is typically found to correlate with adoption (de Harrera and Sain, 1999). Information becomes especially important as the degree of complexity of the technology increases and when the farmers are trial and decision conformation stage (Nowak, 1987). Information sources that positively influence the adoption of technologies can include: other farmers; media; meetings and extension officers.

Although not statistically significant, a unit increase in operational landholding and number of literate household member increase the adoption of improved chickpea varieties by 12 and 32 per cent respectively while an increase in acre of irrigated land in decrease the adoption by 14 per cent that farmer may go for irrigated crops.

The Logit estimation shows that availability of household labour, access to formal seed sources, diversified and reliable information sources, price information and number of literate household member increases the likelihood of adoption. It is therefore important that appropriate seed delivery mechanism should be put in place after an introduction of improved seed for verification. Designing appropriate communication strategy which encompasses traditional communication media is indispensable to hasten adoption of improved chickpea varieties as the majority of farmers' access information from their social network. Providing timely and reliable price information also encourages adoption of chickpea and should get the attention of policy makers to encourage market intelligence networks.

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Targeting and Diffusion of Groundnut improved cultivars in Tamil Nadu state of India

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1. Introduction

India is a major grower and producer of oilseeds as well as a major importer of vegetable oils, ranks fourth among the countries in oilseed economy, next to USA, China and Brazil spending USD 10 billion in 2012-13. Nearly 14 million farmers are involved in oilseed production, mostly in arid and semi-arid regions of the country, whose capacity to adopt modern technology are constrained by poor resource base. This is coupled with aberration in monsoon and market economy presents a formidable challenge to make oilseed production sustainable in the long run. In order to curtail the growing vegetable oil import bills and increase the production and productivity of oilseeds, the Technology Mission on Oilseeds (TMO) was initiated in 1986 with the following objectives; (i) self-reliance in edible oils (ii) reduce imports almost to zero (iii) raise oilseeds production to 18 million tonnes (mt) by 1989-90 and 26 mt of oilseeds and produce 8 mt of vegetable oil by 2000 AD. However, the TMO had unable to create a sustained growth in area under groundnut and the trend was reversed. Before the initiation of TMO (TE 1986-87), the area, production and productivity of groundnut was 7.08 million ha (m ha), 5.81 mt and 795 kg per ha of which, almost 85 per cent as rainfed crop. Implementation of TMO created marked improvement in the first decade and shifted the area, production and productivity to 7.80 ha, 7.84 mt and 993 kg per acre in TE 1995-96 which recorded an increase of 11, 35 and 21 per cent, respectively. Though the irrigated cropped area has increased to 19 per cent, the country production decreased to 6.33 mt from lesser area (5.33 m ha) by shifting its productivity to 1.3 t/ha in 2011-12.

1.1 Performance of groundnut in TLII Targeted districts and in Tamil Nadu

Groundnut is an important oilseed in Tamil Nadu, which constituting 7.51 per cent of area and 13.67 per cent of production with nearly two times higher (2.41 t/ha) than the national productivity (1.3 t/ha) in 2011-12. Though, Tamil Nadu stands better position in productivity, the overall performance needs to be studied by analyzing the changes in area, production and productivity of the selected districts viz., Erode, Namakkal and Thiruvannamalai and which has to be compare with the performance of state during last two decades. This will help in identify the trend in area, production and productivity of groundnut and helps to formulate necessary strategy for its improvement. The results are presented in Table 1-3.

Table 1 Performance of Groundnut area in TLII project districts and Tamil Nadu

District	Area (ha)			Decadal change%			Compound growth rate (%)		
	TE1992 -93	TE2002 - 03	TE2011 - 12	TE1992 to 02	TE2002 to 11	TE1992 to 11	TE 1992 to 01	TE 2002 to 11	TE1992 to 11
Erode	0.79	0.39	0.19	-50.61	-50.86	-75.73	-6.01	-7.14	-6.86
Namakkal	0.75	0.61	0.30	-18.46	-51.76	-60.66	-1.81	-7.61	-6.79
Thriuvannamalai	1.47	0.90	0.62	-38.50	-30.73	-57.40	-7.89	-3.65	-4.57
3Dts total	2.26	1.91	1.11	-15.64	-41.63	-50.76	-1.83	-5.39	-3.85
Tamil Nadu	10.83	6.21	3.95	-42.64	-36.49	-63.57	-5.36	-6.88	-6.32

It could be caution to note from above table in last two decades, area under groundnut has shrink to 3.95 lakh ha in TE 2011-12 from 10.83 ha in 1992-03. The results revealed a huge rate of decline in

area under groundnut was the highest in Namakkal at 7.61 per cent during the last decade (TE2002-03 to TE2011-12) and it was -7.14 per cent in Erode and -3.65 per cent in Thiruvannamalai registering a negative annual growth of -5.39 per cent for the three targeted districts. Erode and Namakkal lost half of its total groundnut area while one third of its area has been fallen in Thiruvannamalai district. It was noticed that in TE1992-93 total area in three selected districts was 2.26 ha has been recorded a sharp fall to 1.9l ha in TE2002-03 hand further declined to 1.11ha in TE 2011-12. In all, the TL II targeted districts lost half of its area under groundnut in last two decades.

Table 2 Performance of Groundnut Production in TLII project districts and Tamil Nadu

District	Production (lt)			Decadal change%			Compound growth rate (%)		
	TE 1992 -93	TE 2002 -03	TE 2011 -12	TE 1992 to 02	TE2002 to 11	TE1992 to 11	TE 1992 to 01	TE 2002 to 11	TE1992 to 11
Erode	1.35	0.63	0.32	-53.31	-49.32	-76.34	-5.63	-5.27	-7.16
Namakkal	1.21	1.13	0.62	-6.83	-44.60	-48.39	3.17	-4.35	-6.46
Thriuvannamalai	1.62	1.39	1.31	-14.12	-5.39	-18.75	-2.95	1.14	-1.77
3Dt total	2.97	3.15	2.26	6.02	-28.24	-23.92	2.36	-1.68	-2.20
Tamil Nadu	14.88	11.08	9.51	-25.49	-14.24	-36.10	-2.72	-0.70	-3.60

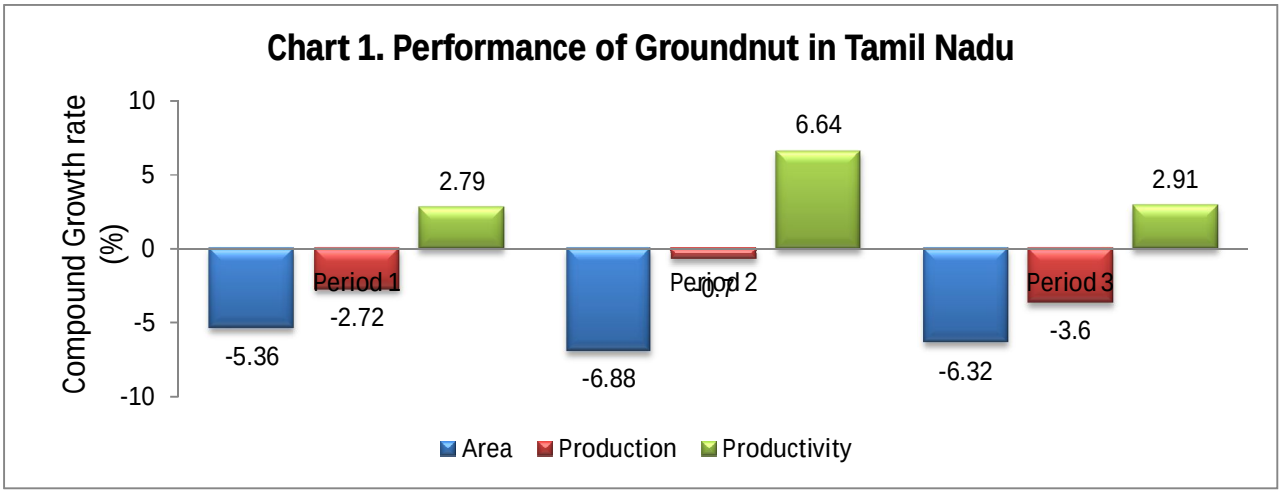
Similar declining trend has been also noticed in production. Tamil Nadu recorded the groundnut pod production of 14.88 lakh tons (lt) in TE1992-93, which has shrunk to 9.51 lt in TE2011-12. Similar sharp declining trend also noticed in Erode and Namakkal from 1.35 and 1.24 lt to 0.32 and 0.62 lt over last two decades which registering a negative growth of -7.16 and -6.46 per cents, respectively. However, Thiruvannamalai recorded relatively lesser negative growth (- 1.77 %) in the above period, this may be due to productivity improvement observed in last two decades.

Table 3 Performance of groundnut productivity in TL II project districts and Tamil Nadu

District	Productivity (lha)			Decadal change%			Compound growth rate (%)		
	TE 1992 -93	TE 2002 -03	TE 2011 -12	TE 1992 to 02	TE2002 to 11	TE1992 to 11	TE1992 to 01	TE 2002 to 11	TE1992 to 11
Erode	1.70	1.61	1.66	-5.46	3.12	-2.51	0.41	2.01	-0.32
Namakkal	1.61	1.84	2.11	14.27	14.83	31.21	5.07	3.53	0.35
Thriuvannamalai	1.10	1.54	2.10	39.65	36.59	90.74	5.37	4.97	2.93
3Dt total	1.31	1.65	2.03	25.68	22.94	54.50	4.26	3.93	1.72
Tamil Nadu	1.37	1.78	2.41	29.90	35.04	75.41	2.79	6.64	2.91

The productivity changes in targeted districts and for Tamil Nadu are analyzed and the results are presented in Table 3. In general, the productivity of groundnut has been improved in all the districts and Tamil Nadu. Particularly, the groundnut productivity has improved from 1.37 tons per ha in TE 1992-93 to 2.41 tons per ha in TE 2011-12, registering 75 per cent increase in the state, while 90 per cent increase was noticed in Thiruvannamalai from 1.1 tons per ha to 2.1 tons per ha in last two decades. Tamil Nadu registered the highest productivity growth in last decade (CGR of 6.64 %) compared to first decade (2.79%), while the TL II targeted districts recorded relatively lesser growth in productivity at 2.01, 3.53 and 4.97 per cent per year for Erode, Namakkal and Thiruvannamalai,

respectively during last decade. While considering last two decades, Erode turned negative productivity growth and Namakkal the productivity growth was stagnated over last decade. The above performance analysis confirmed the negative trend in all the three selected districts and Tamil Nadu for the last two decades which was also confirmed from the downward bars shown in all the charts (Charts 1-4).



Nevertheless, groundnut breeders have conducted research to genetically improved new and better varieties for the bunch and semi spreading types, however, the adoption of these technologies has been limited. The process of social learning involves awareness creation about an innovation hence it falls with the paradigm of the innovation-diffusion model which states that although an innovation may be technically and culturally appropriate, it may not be adopted due to asymmetric information and high search cost (Uaiene et.al., 2009., Smale et al., 1994).Explaining the significance of social learning in the adoption process Foster and Rosenzweig (1995) reported that farmers may initially not adopted a new technology because of imperfect knowledge about its management; however, adoption eventually occurs due to own experience and neighbors' experience.

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), in collaboration with national partners, has developed and released a number of improved groundnut varieties as a way of improving groundnut productivity and competitiveness. In order to address these overlapping constraints and harness the untapped potential in groundnut for poor farmers, ICRISAT has initiated a major legume projects: Tropical Legume II (TLII) supported by the Bill & Melinda Gates Foundation, in 2007-08.The project was designed to increase the legume productivity by 20 per cent, ensure the share of improved varieties to 30 per cent of the cropped area and reaching the benefits to 57 million poor. The project also set short term (3 years) objectives to increase the legume productivity to five per cent, improved varieties to the extent of 10 per cent of cropped area and gaining more than $ 75 million. Groundnut has been selected for Tamil Nadu among six crops covered under TL II. The project has two components; the first one is to identify the best varieties to the locality for up scaling and prioritizing the breeding work and the second component has targeted to assess the present status by baseline and groundnut market surveys with the intention to track the early adoption of improved varieties, mid-term evaluation of the project and focused to draw factors for better efficiency of the project intervention through ex-ante and ex-post evaluation methods.

Based on the distribution of area under rainfed groundnut cultivation in the state, Thiruvannamalai, Erode and Namakkal districts were selected for TLII project in both Phase-I and Phase-II and considering variability in production and budget availability, only Thiruvannamalai and Erode districts were considered forsocio-economic studies under phase I and II of the project.

2. Sampling methodology

The real time tracking (RTT) survey is designed to trace the diffusion of new varieties particularly in the targeted villages in the selected districts such as Namakkal for Co6 and Thiruvannamalai/Erode districts for Co7 variety as a project interventionin TL II phase. The details of the farmers participated or surveyed in the TL II intervention are presented in Table 2.1.

In last 5 years, the project has covered 16 mandals in 213 villages benefiting 2394 farmers through FPVS and PCT activities. More number of farmers (964 from 92 villages) were benefitted from Namakkal followed by Thiruvannamalai 710 farmers for 66 villages and 650 farmers from 55 villages. In the phase I, the baseline survey has been conducted from Erode and Thiruvannamalai districts in 270 farmers including seed benefited and control villages. The paired comparison trails (PCT) were laid in all the three districts and a total of 875 farmers were participated in the trails in last three years.

Table 2.1 Project intervention through FPVS methodology in groundnut production system in Tamil Nadu

Year	Erode (4 Mandals)		Namakkal (5 Mandals)		Thiruvannamalai (7 Mandals)		Tamil Nadu (16 Mandals)	
	Village*	Farmers*	Village	Farmers	Village	Farmers	Village	Farmers
2008	9	107	9	90	9	99	28	296
2009	9	87	8	237	9	81	29	414
2010	8	103	12	196	18	90	38	389
2011	21	202	58	281	18	150	94	633
2012	8	221	18	160	15	290	28	671
5 yrs	55	650	92	964	66	710	213	2394

*numbers

The details of baseline farmer and PCT farmer were participated in 2009, 2010 and 2011 were presented in Table 2.2. Considering the trail intervention, budget and time, 500 farmers were selected from real time tracking (RTT) covering from both baseline (75 farmers) and seed benefited farmers (425) in all the targeted districts. All the basic farmer, crop specific information were collect from the sample farmers, data were computerized and analyzed to track the diffusion of new groundnut cultivars. The results were presented in subsequent section.

The real time Tracking (RTT) survey is designed to track the diffusion of newly distributed improved groundnut cultivators through the paired comparison trial among the trial farmers in the targeted villages of selected districts. The distributions of targeted villages for the paired comparison trial conducted in 2009-11 were shown along with the sample village selected for RTT (Table 2.2). Out of

875 paired comparison trials laid during 2009-11, 500 sample farmers were selected for the survey distributed in all the three districts including 75 farmers from base line farmers contacted in Phase I of the project. The real time tracking survey instrument was designed to track the diffusion pattern of new variety from the targeted area. The sample village distribution clearly confirmed the even distribution of samples from all the blocks and villages from the paired comparison trials conducted in TLII. The major objective of the RTT study is to track the diffusion of new varieties among trial farmers.

Table 2.2 Distribution of sample farmers in real time tracking survey in TLII Phase II

District (1)	Block (2)	Baseline farmers		Paired comparison trials			Total Samples in RTT 4+7=8
		Total BL farmers (3)	sample in RTT (4)	No village (5)	Total (exc BL farmers) (6)	Actual sample in RTT (7)	
Erode	Ammapet	45	15	8	99	45	60
	Nambiur	45	15	10	119	48	63
TV malai	TV malai	45	15	6	45	15	30
	Keelpennathur	45	15	5	45	20	35
	Thandrampet	45	15	4	36	15	30
Namakkal	Elachipalayam			12	220	99	99
	Paramathi			16	145	82	82
	Tiruchangodu			12	166	101	101
		270	**75**	**73**	**875**	**425**	**500**

The further analysis on farm characteristics, varietal distribution, adaption, source of seed before and after the benefited years, diffusion of new varieties, willingness to increase new varieties area, output utilization, cost and return, seed sharing with others were analyzed for two groups via 482 seeds benefited farmers (SBF) and 18 non-benefited farmers (NBF). This total sample represents 500 samples from the selected districts including 425 paired comparison trial farmers and 75 baseline (50 adapted village and 25 non adopted villages) farmers.

2.2 Analytical techniques: In this study tabular analysis was adopted to compile the general characteristics of the sample farmers, the resource structure, cost structure, returns, profits and opinions of farmers regarding the problems in production and marketing. Simple statistics like averages and percentages were used to compare, contrast and interpret results in an appropriate way. To analyse and study the traits preferred in chickpea cultivars by the farmers, weighted average ranking method was used.

3. Results and discussions

3.1 Sample distribution in selected blocks in targeted districts

The distribution of sample among selected blocks are shown in Table 3.1. Among 500 sample farmers surveyed in RTT, it was observed that 96.40 percent of farmers were seed beneficiary (SBF) i.e., who received the improved groundnut seeds identified through the FPVS trials conducted in previous year. While, remaining 18 farmers were non beneficiary (NBF) of improved groundnut seed

varieties were selected as control farmers from the baseline survey who contacted in the RTT survey from same village for comparison.

When compared to three sample districts, trials farmers from Namakkal benefited highly (55.2 per cent sample farms), followed by Erode 25.6 per cent and Thiruvannamalai has constituted 19.2 per cent sample farms in the RTT study. The NBF were 10 per cent of its total sample farm in Tiruvannamalai and only 3.9 per cent in Erode. While, all the sample in Namakkal were benefited by this project. The sample farmers were evenly distributed in all the block.

Table 3.1 Sample distribution of the real time tracking survey, 2013 (no.)

District	Non-BL Beneficiary HH	BL ben. HH**	Baseline HH*	BL Control HH#	BL control HH ben.	All	%	Beneficiary		Non Beneficiary	
								No	%	No	%
1. Erode	98	17	3	5	5	128	25.6	120	93.8	8	3.9
Ammapettai	48	7	3		5	63	12.6	60	95.2	3	4.8
Nambiyur	50	10		5		65	13.0	60	92.3	5	7.7
2. Thiruvannamalai	51	30		10	5	96	19.2	86	89.6	10	10.4
Keelpenathur	20	10			5	35	7.0	35	100	0	0.0
Thandrampet	16	10		5		31	6.2	26	83.9	5	16.1
Thiruvanamalai	15	10		5		30	6.0	25	83.3	5	16.7
3. Namakkal	276					276	55.2	276	100	0	0.0
Elachipalayam	83					83	16.6	83	100	0	0.0
Paramathy	80					80	16.0	80	100	0	0.0
Thiruchengodu	113					113	22.6	113	100	0	0.0
Total	425	47	3	15	10	500	100.0	482	96.4	18	3.6
%	85	9.4	0.6	3	2	100					

3.2 Socio-economic characteristics of sample households

Age,Education,Community,Experience and training attended are the farmer's basic characteristics, which are much influencing in adoption of new technology in general, the farmer and farm characteristics of the SBFs and NBFs were analyzed and the result are presented in Table-3.2.

It could be inferred from the table there is no much difference in (year of schooling) level of education among two farmers' group however, NBFs had 8.4 years schooling compared to 8.1 years of schooling by SBFs.Just like any other activity, experience in farming also expected to provide enhanced farming efficiency. The longer the farming experience would improve the farm efficiency and realize better farm income. Farming experience of sample farmers were reported in Table 3.2. The overall result indicated that the farmers had an average of 23.8 years of farming experience in the study area. The SBFs had 28.2 years of average farming experience while NBFs had 23.6 years of average experience.

From the table it could be interpreted that farmers are marginal to small size of operational holding with the average of 2.39 ha of dry lands. The SBFs farmers had 2.15 ha of operational land and NBFs having 1.9 ha of operational land. In 2012, it extended to 1.09 ha. The NBFs cultivated the groundnut crop relatively more area than NBFs. Non Seed Beneficiary cultivate in 1.16 ha and 1.08 ha by Non Seed Beneficiary farmers, respectively. When comparing the allocation of area under groundnut

cultivation for all samples (500 samples) during last three years, 67.2 per cent of farmers inferred that the area had been decreasing while only for 6.4 per cent of them opinioned that there was an increase in groundnut area. Among seed beneficiary farmers 67 per cent of the farmers concluded that area under groundnut has been decreasing while 25 per cent of the beneficiary sample farmers said that the groundnut cropped area was neither increasing nor decreasing, it left constant and for remaining 8 per cent of the farmers opinioned that the groundnut area showed an increasing trend in last three years. Similarly, among 18 non-beneficiary groundnut farmers, none of them were reported the increasing trend in groundnut area. Half of the NBFs felt that groundnut area showed decreasing trend and the remaining sample farmers reported the groundnut area remained constant in last three years. The decreasing growth rate recorded in selected districts from the performance study results confirmed the sample farmers' opinion.

In case of source of irrigation, it could be interpreted that 99 per cent of groundnut farmers raised the groundnut crops under rainfed condition and all the NBFs groundnut farmers cultivate the groundnut crop under rainfed condition. It could be inferred from the survey that average distance to the regulated market was about 12.2 kms. The SBFs need to travel 12.3 kms and NBFs for 9.1 kms to access the regulated market. Similarly, it could be concluded from the table that average distance to Research Station from farmer's village was about 43.5 kms, for beneficiary farmers it was 57.8 kms, for non-beneficiary farmers it was 42.9 kms.

Average distance to Agricultural Office from the sample farmers village had been calculated, it could be inferred from the result that for SBFs needs to travel 11.3 kms and NBF it was about 10.8 kms to reach the agricultural department office for getting any technology input. Similarly, the average distance to the storage facilities from farmer's village was about 12.1 kms. The storage facility could be reached in 11.4 kms by the SBFs and 12.2 kms by the non-seed beneficiary farmers. Generally, agricultural office, regulated market, regulated market yard are located in the block headquarters.

Table 3.2 Socio-economiccharacteristics of sample HH

Item	Seed beneficiaries (N=482)	Non-seed beneficiaries (N =18)	Sample average (N=500)
Education *(years of schooling completed)*	8.1	8.4	8.2
Caste category (no.)			
MBC	28	2	30
SC:	15		15
ST:	3		3
BC:	430	16	446
OC:	6		6
No. of years of experience in Chickpea cultivation *(years)*	23.6	28.2	23.8
Extent of own land *(including rainfed and fallow in ha)*	2.39	2.15	2.39
Extent of operational land *(in ha)*	2.15	1.90	2.11
Area under Groundnut cultivation in 2012 (in ha)	1.08	1.16	1.09
Allocation of area under Groundnut cultivation during last three years (no.)			
Constant	123	9	132
Decreasing	327	9	336

Increasing	32		32
Did you irrigate your chickpea field (no.)			
NO	481	18	499
YES	1		1
Distance to regulated market *(kms)*	12.3	9.1	12.2
Distance to Research station *(kms)*	57.8	42.9	43.5
Distance to Agricultural Office *(kms)*	11.3	10.8	11.2
Distance to Storage facility *(kms)*	11.4	12.2	12.1
Are you member of any organization/society			
No	248	10	258
Yes	234	8	242

The study results revealed that 51.8 per cent of total sample farmers were not a member in any organization/society while remaining were the members. Among beneficiary framers 49per cent of the farmers were member whereas, remaining 51 per cent of them were not a member of society/organization. Similarly, in case of non-seed beneficiary farmers about 56 per cent of the farmers were not in any organization. Few groundnut production organization like self helps groups and effective function of PACS are village level organization in which most of the sample farmers are members.

3.3 Project beneficiary details

In order to assess the type of cultivars and quality of seed material distributed and status of sowing the given seed in last three years [2009-10, 2010-11 and 2011-12] were analyzed and the results are presented in Table 3.3. This would help to know, how far the project is benefited to farmers, from the result, it could be inferred that most of the farmers (319 samples) got benefited during 2010-2011 whereas, another 74 farmers were received seeds in 2009-10 from Namakkal district**.**

Table 3.3: Project beneficiary details (Seed beneficiary only N =482)

Details	2009-10	2010-11	2011-12
Is this HH TL-II project seed beneficiary (no.)	74	319	108
Which varieties of seed provided(no.)			
1. CO 6	59	168	68
2. CO 7	15	151	40
3 TMV 13*		60	26
Avg. quantity of seed provided (kgs.)			
1. CO 6	8.89	10.00	10.00
2. CO 7	5.00	8.00	7.25
3 TMV 13*		5.00	5.00
Did the house hold sown this variety			
YES	74	319	108
NO	0	0	0
* Newly released variety from Tamil Nadu Agricultural University			

Majority of the beneficiary farmers received Co6 variety seed followed by Co7 due to more number of pared comparison trials were laid in Namakkal district. In 2010-11, 168 BSFs received Co6 (particularly for Namakkal area) followed by Co7 variety seeds to 151 farmers in Erode and Thiruvannamalai districts. An average 10 Kg of Co6 variety was given to Namakkal farmers' in 2010-11 and 2011-12 while Co7 was distributed in Erode and Thiruvannamalai districts around 7 to 8 kg pack. Among the TNAU released groundnut variety, TMVGn13 was distributed in Thiruvannamalai district at 5kg pack to 60 farmers in 2011-12 and 26 farmers in 2011-12 to assess it performance along with ICRISAT varieties. All the sample farmer who received the improved cultivar of Co6, Co7 and TMV13 was taken up sowing at right time in all the three years. This confirms no one wasted the distributed new seed materials. In general, it could be finally interpreted that Co6 variety was provided to majority of the farmers followed by Co7 & newly released variety from TNAU that is TMV13 was least supplied through the TLII project intervention.

3.4 Extent of adoption of improved cultivars

Table 3.4:Extent of adoption of improved cultivars(sum of area in ha)

seed beneficiaries (N= 482)							Non seed beneficiaries (N= 18)						
prevoius year of benefitted year			Seed benefitted year				prevoius year of benefitted year			Seed benefitted year			
Pre_variety	pre_ Area (ha)	%	Ben_Variety	Ben_year	Ben_Area (ha)	%	Pre_variety	pre_Area (ha)	%	Ben_Variety	Ben_year	Ben_Area (ha)	%
CO2	124.7	20.5	Co6	2009-10	2.4	0.5	CO2	1.0	2.8				
MIXED	0.4	0.1		2010-11	7.1	1.5	TMV7	14.2	97.2				
POL2	32.9	5.4		2011-12	6.8	1.4							
TMV1	153.2	25.2											
TMV2	2.6	0.4	Co6 Total		16.3	3.4							
TMV7	103.2	17.0	Co7	2009-10	0.4	0.1							
VRI2	165.4	27.2		2010-11	6.6	1.4							
VRI6	3.4	0.6		2011-12	3.4	0.7							
VRI7	22.1	3.6											
			Co7 Total	10.4	25.6	2.2							
			CO2	95.9	236.9	20.2							
			POL2	130.3	321.95	27.5							
			TMV-13	4.8	11.95	1.0							
			TMV1	90.7	224.1	19.1							
			TMV2	1.2	2.9	0.2							
			TMV7	3.5	8.6	0.7							
			VRI2	101.1	249.65	21.3							
			VRI6	2.9	7.1	0.6							
			VRI7	16.8	41.4	3.5							
			sub Total		447.2	94.4							
Grand Total	607.9	100.0			473.8	100		36.0	100.				

The diffusion of new varieties would be traced by tracking the area expansion by newly distributed groundnut varieties over years among sample farmers.Inorder to assess the status of diffusion of new varieties, year wise and varietal wise area under groundnut crop on benefited and previous year seed distribution was estimated separately among SBFsand NBFs and the results are presented on Table 3.4.

It could be inferred from the table CO2, TMV2, VRI2 and TMV7 are the ruling groundnut varieties, which are released more than two decades ago, still dominated in 90 per cent in groundnut area. TNAU GnCo6 and Co7 groundnut varieties were introduced by this project.In general, the groundnut was cultivated in 607.69 ha in previous year of seed supply but groundnut area has reduced to 473.68 ha during the seed benefited year, in which about 94 per cent groundnut area still occupied by old varieties. The reduction in total groundnut area between previously benefited and benefited year again and indicated declining trend in groundnut area in the study area. The new varieties TNAUGnCo6 occupied 3.4 per cent and Co7 by 2.2 per cent of the total groundnut area 446.96 ha in the sample.

Among beneficiaries farmers, VRI2 occupied 165.35 ha in previous year of seed supply, while the area decreased to 119.29 ha in seed benefited year. Similarly, second highly cultivated variety was TMV1 in previous year which has also decreased to 90.73 ha from 153.24 ha in seed benefitted year. In seed benefitted year majority farmers' cultivated POL2 variety (130.34 ha) followed by VRI2 in 101.07 ha. In case of non-seed beneficiary farmers, they cultivated TMV7 (14.17 ha) at larger extend, whereas only one acre of Co2 was cultivated & no variety was cultivated in seed benefitted year.

3.5 Major source of seed

Source of other than TL-II project supplied varieties

Similarly, major source of seed after initializing TL-II project & other than TL-II supplied varieties are given in Table 3.5

Table 3.5 Source of seed non TLII varieties (No.)

Sources	Very old Variety	Old variety	Recent Variety	Total
Farmer club	30	8	33	71
Farmer to farmer seed exchange (relative, friends *etc*)	30	17	38	85
Govt. agency	44	0	28	72
Inherited from family	23	3	38	64
Local seed producers	41	20	77	138
Local trader or agro-dealers	192	18	202	412
Other farmers	62	0	63	125
Through contact farmer	5	0	15	20
NGO's	11	0	11	22
Grand Total	438	66	505	1009
%	43.41	6.54	50.05	100.00

The varieties are categorized as three different types based on the time of release of varieties. They were very old varieties (includes CO 2, mixed, POL 2, TMV 1 & TMV 2), old varieties (TMV 7 & VRI2) and recent varieties (TMV 13, VR I6 & VR I7). It could be inferred from the table still 43 per

cent of the groundnut area occupied by very old varieties which were released 20 years ago. It could be also noted that another half of the groundnut area occupied by recent new varieties.

Among very old variety the major sources of seed were from local trader or agro dealers. About 43 per cent of the sample farmers received seeds from these sources andthe second highest seed source was other farmerswho supplied to 14 per cent of the sample farmers. It could also be inferred that in old variety, the local seed producers were the major source, whereas local trader or agro dealers were the major suppliers of recent varieties. Local traders and other farmer still meet the around two thirdof the seed supply indicated any program of introduction new varieties could needs to design by integrated the private seed traders in seed distribution chain for sustained seed production.

3.6 Diffusion of new varieties in study area

The diffusion of new varieties were assessed by estimating the allocation of area after supplying the seed from TL-II under different cultivars in three different years (2009-10, 2010-11) are given in Table 3.6 and 3.7 respectively. Seed distributed after 2009-10, the area under new varieties has increased in 1.9 ha in 2010-11 to 13.8 ha in 2011-12. However, the area under new varieties had decreased in 2012. It could be interpreted that majority (i.e., 201.9 ha) of area was allocated under very old varieties like CO 2 and TMV 1 in 2011-12 followed by 146.2 ha under old varieties TMV 7 and VR 12and the under new varieties occupied 3.7 per cent in 2011-12.

Table 3.6 Area allocation under different cultivators

Sum of area after seed supplier(2009-10), ha						
Cultivar name	2010-11	%	2011-12	%	2012-13	%
Very old variety	34.0	53.0	201.9	53.7	40.0	44.9
New variety	1.9	2.9	13.8	3.7	2.8	3.2
Old variety	24.3	37.9	146.2	38.9	46.1	51.9
Recent variety	4.0	6.2	14.2	3.8	0.0	0.0
Grand total	642	100.0	376.0	100.0	88.9	100.0

Table 3.7 Sum of area after seed supplied (2010-11) (ha)

Cultivar name	2011-12	%	2012-13	%
Very old variety	36.11	47.8	190.57	54.9
New variety	1.46	1.9	4.66	1.3
old variety	31.98	42.3	138.22	39.8
recent variety	6.07	8.0	13.77	4.0
Grand total	75.63	100.0	347.33	100.0

Similarly Table 3.9 showed the allocation of area after supplying the seed in 2010-11. It could be highlighted from the table that as same as in previous year major area was allocated for very old varieties 190.57 ha in 2012-13 followed by old varieties 138.22 ha.

It could be inferred from the above two table, the area under newly introduced varieties were increased over years. The change in new varieties was from 1.9 ha to 13.8 ha in 2011-12 after seed

distributed in 2009-10. Similarly, in case of seed distribution in 2010-11, the change in area under new varieties was 1.46 ha to 4.66 ha in 2012-13 confirmed the increasing trend in new varieties area in the sample districts.

3.7 Willingness to increase area under TL -II introduced cultivators

The groundnut farmers reported different reasons for willingness to increase the area under new varieties and same is presented in Table 3.8. Farmers willingness to increase area under TL-II introduced cultivars from the seed benefited farmers, around 36.6 per cent of the farmers willing to take-up the new varieties due to better taste and bigger kernel size followed by 35.89 per cent farmer preferred the varieties for the high price, profit and another 27.6 per cent of farmers for higher yield potential of the new varieties.

Table 3.8 Willingness to increase area under TL -II introduced cultivators

Willingness	Seed Benefited farmers			Non - Seed Benefited farmers		
Yes	482			18		
No	0			0		
If Yes, Reasons	Reason	sum of Reason	%	Reason	sum of Reason	%
	Better taste and bigger size	175	36.31	Better taste and bigger size	5	27.78
	High price and profit	173	35.89	High price and profit	6	33.33
	High Yield	133	27.59	High Yield	7	38.89
	Pest and disease resistance	1	0.21			
	Grand Total	482	100.00	Grand Total	18	100.00

Among the 18 non-seed benefited farmers, about 39, 33 and 27 per cent of farmers preferred the new varieties due to the high yield, high price and better taste as the major reasons for their preference, respectively.

3.8 Output utilization pattern

The output utilization pattern would clearly guide us to understand the path way of varietal diffusion time, and hence the variety wise total groundnut pod produced and its utilization among SBF and NBF were analyzed and the results are presented in Table 3.9. Among the SBF the major ruling varieties much as, TMV1, VRI2, TMV7 and CO2 produced more than 80 per cent total groundnut pod output in last three years. They produced 22.72, 21.15, 18.63 and 17/30 per cent of the total pod (140.26 tons) produced.

While the new varieties Co6 produced 76.7 tons and Co7 produced 26.96 tons contributing 5.47 and 1.92 per cent of the total pod production of the study area, indicated the lower share due to low coverage of new varieties.The analysis of output utilization pattern of groundnut confirmed that, being a commercial crop, around 80 per cent total groundnut output were sold to market, around 14 per cent were kept for own seed use and another one per cent sold for seed purpose.

Table 3.9 Output utilization pattern for Seed benefited farmers (N=482) (Sum of production)

	Grain output		Output utilization (kgs)					Output utilization (%)					
Variety	kgs	%	consumed, kgs	other use, kgs	ownseed, kgs	sold seed, kgs	out_ sold	consumed, kgs	other use, kgs	ownseed, kgs	sold seed, kgs	Output sold	Total output
Seed benefited farmers(N=482)													
Co2	242580	17.30	26865	280	27580	2200	185655	11.07	0.12	11.37	0.91	76.53	100.00
POL2	37140	2.65	1780	710	6280	500	27870	4.79	1.91	16.91	1.35	75.04	100.00
TMV1	318640	22.72	3540	500	49510	800	264290	1.11	0.16	15.54	0.25	82.94	100.00
TMV2	7900	0.56	100	200	1600	200	5800	1.27	2.53	20.25	2.53	73.42	100.00
TMV7	261295	18.63	9850	6400	34500	500	210045	3.77	2.45	13.20	0.19	80.39	100.00
VRI2	296620	21.15	2310	2050	42710	2600	246950	0.78	0.69	14.40	0.88	83.25	100.00
Mixed	63380	4.52	2150	650	11120	700	48760	3.39	1.03	17.54	1.10	76.93	100.00
TMV13	2410	0.17	0	0	0	0	2410	0.00	0.00	0.00	0.00	100.00	100.00
VRI6	12440	0.89	0	0	800	0	11640	0.00	0.00	6.43	0.00	93.57	100.00
VRI7	56520	4.03	0	0	3380	0	53140	0.00	0.00	5.98	0.00	94.02	100.00
Co6	76705	5.47	7323	70	13110	820	55382	9.55	0.09	17.09	1.07	72.20	100.00
Co7	26962	1.92	0	25	4461	5010	17466	0.00	0.09	16.55	18.58	64.78	100.00
All	1402592	100.00	53918.2	10885	195051	13330	1129407.7	3.84	0.78	13.91	0.95	80.52	100.00
Non Seed benefited farmers(N=18)													
CO2	4600	7.89	0	0	400	0	4200	0.00	0.00	8.70	0.00	91.30	100.00
Local	3640	6.24	0	0	400	0	3240	0.00	0.00	10.99	0.00	89.01	100.00
TMV7	39550	67.85	2050	1750	2860	0	32890	5.18	4.42	7.23	0.00	83.16	100.00
VRI2	10500	18.01	0	0	1170	0	9330	0.00	0.00	11.14	0.00	88.86	100.00
All	58290	100.00	2050	1750	4830	0	49660	3.52	3.00	8.29	0.00	85.19	100.00

Among the newly introduced varieties Co 6 and Co 7, output retained for seed purpose was more (17 per cent) in Co 6 and 16.55 per cent in Co 7 varieties. Hence, the new varieties are cultivated as rainfed crop; the output share for seed use was low may be due to poor quantity of production not suitable seed purpose due to occurrence of terminal drought and other biotic stress particularly during the pod maturity stage during 2008-12. This would clearly guide us to change the seed production strategy for new varieties under irrigated condition. Among NBFs, about 85 per cent of total output were sold while, only 8.29 per cent of total production was kept for own seed purpose, indicated that still farmers are largely depended the market or other farmers for groundnut seed. This may be due to high value of output coupled with poor seed retention power and poor quality output from rainfed production system.

3.9 Profitability of new cultivars in Tamil Nadu

The cost and returns analysis always useful in understanding the profitability of new cultivars in Tamil Nadu.The estimated cultivation cost only consider the variable cost excluding land rent, since 99 per cent farmers are own land operators. The total cultivation expense was around 21 thousand per acre for both new and old cultivars. The cost of seed has not been included for new cultivar which was supplied on free of cost to the farmers. Seed cost contributed 8 per cent of total cost Rs. 1400-1800 per acre (see Table 3.10).

Expenditure on land preparation and weeding are the other major cost in groundnut cultivation which costing 3 to 4 thousand per acre, which almost same for old and new varieties. Farmers applied relatively higher dose of fertilizer for new cultivars or varieties, which in-turn respond more when it receive proper rainfall during critical stages of its growth.

The new varieties realized relatively 14 per cent higher pod yield, in Namakkal and five per cent in Erode and Thiruvannamalai, the poor yield advantage may be due to yield loss caused by drought damage in last 3 years. The average productivity Co6 in Namakkal was 941 kg per acre, while the old varieties yield was 823 kg per acre. Whereas in Erode and Thiruvannamalai, the new variety Co7 realized an average 774 kg per acre, which is fiveper cent higher than the ruling varieties (POL 2, TMV 7 and VR I2).

Table 3.10: Profitability of old and new varieties in Tamil Nadu

Operation	Namakkal				Erode &Thiruvannamalai			
	New cultivar		old cultivar		New cultivar		old cultivar	
	Co6	%	TMV1	%	Co7	%	TMV7, POL2 & VRI2	%
Sum of area	**17.3**		**230.0**		**8.7**		**386.8**	
No of farmers	**71**		**63**		**64**		**137**	
Land pre.	3728	17.9	3708	17.7	3057	15.0	3125	14.9
FYM\compost	2943	14.1	2479	11.8	2832	13.9	2853	13.6
seed cost	0	0.0	1620	7.7	0	0.0	1840	8.8
sowing cost	3300	15.8	3324	15.8	3281	16.1	3203	15.3
Fertilizer cost	1692	8.1	1525	7.3	1576	7.7	1545	7.4
Micro nutrient cost	0	0.0	0	0.0	12	0.1	91	0.4
Inter culture cost	0	0.0	0	0.0	24	0.1	0	0.0
weeding cost	3630	17.4	3216	15.3	3738	18.4	3086	14.7
plant protection cost	542	2.6	487	2.3	557	2.7	417	2.0
Irrigation cost	0	0.0	0	0.0	0	0.0	0	0.0
watching expenses	16	0.1	34	0.2	0	0.0	0	0.0
harvesting cost	2295	11.0	2144	10.2	2389	11.7	2246	10.7
Threshing cost	2600	12.5	2339	11.1	2719	13.4	2449	11.7
Marketing cost	103	0.5	110	0.5	119	0.6	121	0.6
Rental value	0	0.0	0	0.0	59	0.3	0	0.0
Total Cost	**20850**	**100.0**	**20986**	**100.0**	**20363**	**100.0**	**20976**	**100.0**
Pod yield (kgs)	941		823		774		738	
fodder yield(kgs)	1344		686		1218		794	
Pod value	26284	93.0	24048	92.5	25141	92.6	25911	93.2
Fodder value	1983	7.0	1949	7.5	1995	7.4	1899	6.8
Total Value(pod & fodder)	**28267**	**100.0**	**25997**	**100.0**	**27136**	**100.0**	**27811**	**100.0**
Net Income (Rs/ac)	7418		5011		6773		6835	
Cost of production (Rs/qtl)	1404		2775		1508		2403	
Benefited cost Ratio	1.4		1.2		1.3		1.3	

In groundnut cultivation, besides the high seed cost, cultivation expenses on harvesting and threshing costing around 23 per cent of total cost in all the old and new varieties, next to that, weeding operation costing 14-15 per cent of total cultivation cost both in old and new varieties. Farmer realized an average pod price of Rs 27.93 for new varieties and 29.22 per kg of dry pod in 2011-12. The gross return (value of pod and fodder) was the highest (Rs. 28267 per acre) in Co6 in Namakkal followed by Rs. 25997 per acre for old varieties. The gross return in Co7 was Rs 27136 per acre and for old varieties it was Rs 27811 per ac in Erode and Thiruvannamalai. However, the net return for new varieties was the highest Rs 7418 per acre in Namakkal and Rs 6773 per acre for new variety and Rs 6835 for old varieties.

The cost of production per quintal of dry pod was Rs.1404 per quintal in Co6 at Namakkal, while it was Rs. 1508 per quintal for Co 7 realized 97 and 59 per cent lesser cost over variable cost in new varieties over ruling varieties in Namakkal and Thiruvannamalai/Erode districts, respectively. It is also note that, the highest benefited cost ratio has recorded at 1.4 in Co 6 indicating return per rupee investment was the highest for Co 6 followed by Co 7, VR I2, POL 2 and TMV 7.

4. Summary and conclusions

India is being a second largest producer of groundnut next to China contributing 14% of world groundnut production (41.269 mt) sharing 19.90% of global groundnut area (24.6mha from world). Next to USA, China and Brazil, India is a fourth largest importer of vegetable oils worth of spending 10 billion USD in 2012-2013. Various programs like Technology mission on oilseeds TMO in 1986, other state and central government programs related to area and technology development programslike ISOPAM, OPDP are creating positive impacts on oil seed production in the country and state. Presently the country producing 4.74mt of groundnut from 4.75 m/ha with an average productivity of 0.996 t/ha of dry pods in 2012-13. Tamil Nadu is one of major groundnut producing state next to Andhra Pradesh, contributing 18.11 per cent country groundnut production from only 7.55 per cent of country's groundnut area with nearly two and half times higher than the national average pods productivity of 2.39 t/ha against the national average productivity of 0.996 t/ha in 2012-2013.

Regardless of the considerable area share, productivity advantage and various development programs, the Tamil Nadu phased unfavorable negative trend in area (-6.88 annual growth) during last decade resulting 50 per cent loss its area from 6.21 lakh ha in TE 2002-2003 to 3.95 lakh ha in TE 2011-2012, however the improvement in production which registered the annual growth of 6.64 per cent between TE 2002-2003 to TE 2011-2012 have minimize the negative growth in production to -0.70 per cent in the above period. This unfavorable trend in groundnut performance need further shift in productivity. The negative trend in area under groundnut may be due to i) low productivity of ruling varieties, ii) low market demand, iii) under developed seed and input delivery system, iv) vulnerability of common variety to biotic and aboitic problems and v) large dependence on monsoon (rainfed production system 64 per cent groundnut area).The cumulative effects of these factors cause low adoption of available improved technologies, low competitive and inability to access high value market to enjoy premium for quality.

In order to address the multi-pronged problems in groundnut production system International Crops Research Institute for Semi-Arid Tropics (ICRISAT), in collaboration with other national partners, has designed a Tropical Legume II (TLII) project in 2007 with the objective to increase the Legume productivity by 15 per cent, ensure the share of improved varieties to 30 per cent of total groundnut area and reaching the benefits to 57 million poor's. Tamil Nadu is one of the major partners in India in TL II and selected the groundnut under this project mainly targeted the major rainfed groundnut production system in Tamil Nadu *viz* Thiruvannamalai, Erode and Namakkal districts. The major objective is to introduce the new cultivar suited for the region by Farmer's Participatory Variety Selection (FPVS) trials' method beside development of new varieties to address above biotic and abiotic impediments in shifting the productivity. This project also tries to document the socio economic profile of the groundnut farmer, identify the role of market institution, availability of infrastructure, fertilizer use, profitability of existing & new varieties and adoption & dis-adoption pattern of new cultivars in the study area. In the first phase of TL II project, besides developing a new cultivar through FPVs method is followed to identify the best suited variety to the region by the

farmer and multiply and distributed through paired comparison field trials (PCT) for fast tracking the adoption process. In the second phase of the TLII project, in order to track the diffusion of new varieties introduced, a Real Time Tracking (RTT) survey was designed and conducted to assess the diffusion pattern, seed storage, output utilization change in some of seed *etc*., to understand the rate adoption and develop strategy for future development. The RTT survey is conducted from 500 farm sample, of which 75 out of 270 from Baseline survey farmers and 475 out of 875 PCT farmers evenly distributed in 82 villages who received seeds during 2009 to 2012. Various information on farm characteristics varietal distribution, adoption, some of seed before and after the seed distribution, diffusion of new varieties, willingness to increase the area under new varieties, output utilization, cost and return, seed sharing pattern and seed storage system were collected in the RTT filed survey from the sample farmers. Out of 500 sample farmers, 482 received seeds through paired comparison called Seeds Benefited Farmers (SBF) and 18 were not received improved seeds (NBF) by this project. The collected information were computerized and processed to draw the meaningful interpretation. The major findings of the RTT survey are summarized as follow;

1) The sample farmers' distribution showed that more than half of them were from Namakkal district, followed by Erode district sharing one fourth and 20 per cent from Thiruvannamalai districts.
2) In the study area, the average schooling years for SBFs was 8.1 years and 8.4 years for the NBFs. They have good farming experience with 23.6 and 28.2 years by the two groups, respectively.
3) The operational holding size was 2.15 ha for SBF and 1.9 ha for NBF, where groundnut crop occupied 1.16 and 1.08 ha, sharing 54 and 57 per cent of the total operational land area, respectively.
4) As confirmed from the groundnut crop performance analysis, about two third groundnut farmers opinioned that groundnut area has been decreased continuously and only one fourth of them reported that there was no change in groundnut area in last three years.
5) Majority of the sample farmers received about 10 kg of Co 7 variety groundnut seeds and 7.8 kg of Co 7 variety seeds were distributed through the paired comparison trials.
6) It was caution to note that still 94 per cent area were occupied by old groundnut varieties while the new variety Co 6 covers 3.4 per cent and Co 7 occupied 2.2 per cent of the total groundnut area.
7) Among old varieties, Co 2 and TMV 1 were dominated in Namakkal district while VRI 2, TMV 7 and POL 2 were dominated in Erode and Thiruvannamalai districts.
8) Among old varieties, more than two fifth of the groundnut area were occupied by very old varieties which were released 20 years ago. The local traders or agro dealers were the major seed source to meet more than two fifth of the total seed demand in the study area.
9) After the seed supplied in 2009-10, the area under new varieties had doubled in 2010-11. The slower rate of diffusion of new varieties may be due to deficit rainfall received during sowing and pod maturity stage. Inadequate and poor distribution of monsoon rainfall during the project period caused a declining trend in rainfed groundnut area particularly in the TL II project study districts.
10) Through unfavorable monsoon has been experienced from the project study area, considering positive trait characteristics like the better taste, bigger size, high price and higher yielding nature of new varieties, most of the sample farmers reported their willingness to take up the new varieties.

11) About one fifth of total output of new varieties were kept for own seed purpose for own farm area expansion and two third of output still sold in the market due to poor quality
12) New variety (Co 6 and Co 7) realized about 14-20 percent high yield than ruling varieties and costing 97 and 59 percent lesser cost of production over the ruling varieties with the cost benefit ratio of 1.4 and 1.3 per rupees of investment compared to 1.2 in case of ruling varieties.
13) The entire sample farmers followed traditional seed storage method and only 3 farmers shared the new seed materials to others due to inadequate surplus over their own seed demand so they sold the poor quality output to market.
14) The agro traders and local dealers are played important role in seed chain, seed to consider in designing the new seed multiplication program.

Way forward

The location specific development programmed for area expansion need to be formulated by removing the production constraints to revert the declining trend in area and production of groundnut particularly in the rainfed production system.There is a need for further intervention in terms of supply of seeds of improved varieties for commercial cultivation in the adopted villages to see the actual demonstration effect.Yield boosting technology needs to be developed to address the drought resistant varieties to overcome the frequently occurring monsoon deficit situations in the study area.Local traders and agro dealers still played important role in the seed supply chain in the study area which necessitate to formulate public-private partnership self-sustained seed multiplication model for fast track diffusion of identified new varieties in the study area.Frequent and severs monsoon deficit particularly during the sowing season and crop maturity was found as major reason for poor quality seed produced thus farmers sold the output to market. This need to identify the irrigated seed production system in Rabi season and used the new seed for next Kharif season for successful and sustained seed multiplication and support for faster expansion of new varieties area in the rainfed groundnut production system. Seed multiplication process in the farmers' field along with buyback arrangement and onward distribution of seeds to the farmers through the institutional agencies like KOF, UASR helps in adoption uptake process.Monsoon deficit and frequent drought occurrence was found as major reason, hence the breeder need to develop drought resistant varieties particulars during terminal crop period.Already half of the farmer are member in any one of the organization in the groundnut production system therefore organizing groundnut producer and marketing organization at village land and link them to groundnut producing consortium help them to realize the premium market advantage through suitable following good production practice and value addition and modern storage system to reap market prize advantage through group approach.There is a need to strengthen seed production, supply and distribution through seed village and seed bank programs where the actual seed supply is only 7 per cent of seed requirement.

Lessons learnt

- Area and production has declined in last two decades even with increasing productivity
- Intermittent drought, rainfall deficit during sowing season drought need for development of tolerant varieties and seed treatment management technologies.

- Increase the seed supply from 2.5 kg to 25-50 kg per farmer in PCT trails would increase the famers attention in seed multiplication' programme. To the cluster of less number of farmers so as to set buy back arrangements for linking the seed chain in up-scaling
- Traders contributed 70% of purchased seeds. PPP concept has to be followed to involve the traders in seed multiplication chain.
- A model of tripod arrangement consisting SAU, DOA, Farmers and Traders need to develop.
- Target the demo area with irrigation for seed multiplication programs in Post rainy season.
- Possible to form seed producer groups/ use available women SHG and NGOs etc. for seed village programs
- More publicity by organizing mega field days and State level Exhibition for larger coverage by inviting farmers of non-targeted area.

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Targeting and Diffusion of Chickpea improved cultivars in Karnataka state of India

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1. Background

In India, Karnataka is fifth largest chickpea growing state next to Madhya Pradesh, Uttar Pradesh, Rajasthan and Maharashtra. Total area under chickpea in Karnataka was 970 thousand ha with a production of 570 thousand tons. Medium range of rainfall, dry and healthy weather conditions are considered to be the ideal for chickpea cultivation in the state. Dharwad and Gulbarga districts of Northern Karnataka have these best conditions for successful chickpea cultivation, which are the major Chickpea growing districts, accounting for 71% of total Karnataka's production. In Karnataka, Gulbarga occupies the first position in chickpea area (1.81 lakh ha), production (1.13 lakh ton), followed by Bijapur, Bidar, Gadag and Dharwad. Hence these districts were selected for targeting the technology under TL II project in the state. Chickpea has become one of the important pulse crops of Karnataka in recent years. The chickpea crop prominently taken earlier as an inter-crop with *rabi* sorghum has increased in its area by 3-fold during the past two decades. However, the productivity continued to remain low (<600 kg/ha) as compared to the national average yield (~800 kg/ha). In Karnataka, it is being grown in an area of 6.5 lakh ha with a production and productivity of 3.10 lakh tons and 473kg/ha, respectively. The main reasons being lack of adoption of high yielding improved cultivars and poor production technologies and yield losses due to various abiotic (terminal drought and heat stress) and biotic stresses (*Fusarium* wilt, dry root rot and *Helicoverpa* pod borer). Some of other major constraints in chickpea are lack of awareness and availability of suitable high yielding varieties of seed material, rainfall variability, lack of area under irrigation and fluctuating marketing prices. Thus, both production and marketing of chickpea is associated with the various technological and economic constraints. The Tropical Legumes-II Project covering leguminous crops was launched simultaneously in South Asia and Sub-Saharan Africa to enhance productivity and incomes among the farmers.

1.1 Major chickpea growing states

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 1.1. Among the states, Madhya Pradesh is the largest chickpea producing state in the country with mean annual area of 25,04,850 ha under the crop for the eleven year period and showed positive (1.14%) but non-significant area growth. Maharashtra state occupied second position with average annual area of10,73,000 ha and a very high annual growth in area by 7.34 percent and it was significant at one per cent level of probability. Karnataka occupied fifth place in respect of chickpea area (5,73,500 ha) followed by Andhra Pradesh (4,55,700ha) and both states witnessed a significant annual growth (6.96% and 14.47% respectively) in area at the one percent level of significance. The estimated growth rates and instability indices for the selected districts in Karnataka with respect to chickpea area, production and productivity for the period from 2000-01 to 2010-11 are presented in Table 1.2.

1.2 Study on tracking of varietal diffusion

The prime objective of real time tracking of varietal diffusion study is to analyze the nature and extent of spread and adoption of improved varieties of chickpea introduced in Dharwad and Gulbarga districts of Karnataka under Tropical Legumes-II project and in-turn the economic impact of such adoption on the farmer's income. This study was under taken for the cropping year 2012-13 in the study districts of the state where the improved chickpea varieties were intervened from 2007-08 to 2012-13. The period of 4 to 5 years during project intervention in the study area is considered adequate to carryout diffusion study to through light on the diffusion process of the technology among the farmers.

Table 1.1: Compound growth rate in area, production and productivity of chickpea and their instability in the major states, 2001-11

Particulars	Area			Productivity			Production		
	Growth rate(%)	Mean ('000/ha)	Instability index(%)	Growth rate(%)	Mean (kg/ha)	Instability index(%)	Growth rate(%)	Mean ('000 tone)	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)	455.70	16.52	2.10** (0.017)	1248.1	14.7	21.18*** (0.19)	553.7	24.8
Karnataka	6.96*** (0.020)	573.50	19.47	3.98*** (0.013)	666	0.11	10.72***	298.1	0.24
Maharashtra	7.34*** (0.012)	1073.00	10.51	5.25*** (0.010)	653.1	0.094	10.64*** (0.026)	525	0.12
Rajasthan	7.92** (0.027)	950.50	19.73	-1.85*** (0.025)	674.7	19.74	1.61 (0.035)	667.4	25.56
Uttar Pradesh	0.08** (0.010)	737.90	8.13	-7.12*** (0.016)	650.8	0.13	-0.68 (0.014)	880.6	0.12
India	1.60 (0.007)	7324.10	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

Table 1.2: Compound growth rate in area, production and productivity of chickpea and their instability in the study districts, 2001-11

District	Area			Productivity			Production		
	Growth rate (%)	Mean(ha)	Instability index (%)	Growth rate (%)	Mean (kg/ha)	Instability index (%)	Growth rate (%)	Mean (ton)	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

The varieties selected by farmers through Mother-Baby trials were tested extensively again on farmers' fields for their acceptability and adoptability through small-scale demonstrations. The seed multiplication was taken up for these selected varieties on large-scale by the breeders under the Tropical Legumes-II project over the years and they were distributed to the farmers for their adoption and to popularize these high yielding varieties among the farmers. The spread of these varieties covered larger area/villages even outside the targeted adopted and control villages chosen earlier (for baseline study) in Dharwad and Gulbarga districts. These varieties were distributed to the farmers during the period from 2008 to 2011. The results on the adoption of the new cultivars were partially documented in the early adoption study conducted during the year 2009-10. Hence, another study on real-time tracking was planned and initiated during the year 2012-13 rabi season. The survey was initiated in the selected districts namely, Dharwad and Gulbarga covering all the villages where improved seeds were distributed in wake of popularizing these varieties.

The present evaluation on adoption enabled to learn the process of early adoption of improved varieties and identify factors for better efficiency of the project interventions. The study focused mainly on the year of seed benefited to the farmers, sources of supply of seed, year wise area allocation under different chickpea cultivars, perception about new cultivars and their preferred traits, cultivar specific constraints by farmers, out-put utilization pattern for different purposes including seed purpose, performance of improved cultivars in terms of cost and returns realized by farmers, role of other institutions and their interventions and the farmers feedback for further diffusion of new cultivars. Thus, the present study aims to know the scaling-up of the new cultivars undertaken in the targeted districts with the following specific objectives.

Objectives of tracking survey:

- To assess the extent of adoption and composition of improved chickpea varieties
- To analyze the sources of seed availability and their share among farmers
- To assess the profitability of different chickpea cultivars
- To analyze the perceptions of farmers about preferred traits in the new chickpea cultivars.
- To analyze specific constraints in the chickpea cultivars
- To assess the chickpea output utilization pattern.

2. Sampling frame and methodology

In Karnataka, two districts namely, Dharwad and Gulbarga (where seeds of improved varieties were distributed among the farmers) were selected to undertake the study to track the nature and extent of adoption of new cultivars. A random sample of 500 farmers across districts was chosen from the total seed beneficiaries in the project. A well structured and pre-tested questionnaire was used to elicit the required primary information from majority beneficiary and few non-beneficiary (control) farmers. The study also covered the control group for better understanding of diffusion patterns:

I. Seed beneficiaries: This sample category includes;

Non-baseline households: Are the seed beneficiary farmers across villages in each district who received seed material of selected improved chickpea cultivars under the project that fall outside the baseline beneficiary households or adopted villages.

Baseline beneficiary households: Are the seed beneficiary farmers across selected villages in each district that got seeds of selected improved chickpea cultivars at one or the other point of time under the project (may be informal source) and belonged to adopted villages covered under baseline survey.

II. Non-seed beneficiaries: This category includes;

Baseline households: These are the non-seed beneficiaries of baseline households that were selected as adopted farmers. Since these farmers of adopted villages in baseline survey were not provided with seeds of improved varieties during the project period and hence they were included under non-seed beneficiary category.

Baseline control households: Are the sample farmers chosen from the control villages of baseline survey. The farmers of these villages did not receive any seeds of improved varieties under the project (formal source). The purpose of inclusion of this sample category was to ascertain the varietal diffusion without the project intervention through informal methods.

2.1 Sampling strategy for real-time tracking survey in Karnataka

Under the present study on real time tracking, a total of at least 500 sample beneficiary households were covered to know about adoption pattern as well as perceptions about TL-II introduced cultivars from both the districts and the same was distributed across different categories of farmers in the state.

The sample was distributed based on the probability proportion to total number of seed beneficiaries across two intervention districts in case of Karnataka, the details as follows (Table 2.1):

Table-2.1: Sampling frame for real time tracking survey

District	Total beneficiaries	Baseline households	Seed beneficiary households	Control households	Total sample allotted
Dharwad	376* (29.5)	30	103	15	148 (29.6)
Gulbarga	896* (70.5)	30	307	15	352 (70.4)
Total	1272 (100.0)	60	410	30	500 (100.0)

Note: Figure in the parenthesis indicates percentage to column totals
* 2008, 2009, 2010 and 2011 seed beneficiaries considered

Out of 500 sample farmers, 30 farmers from each district were selected from baseline adopted villages comprising a total of 60 baseline households for both districts together. Another, 15 farmers from each district was selected from baseline control villages comprising a total of 30 control households for both districts. The remaining 410 sample farmers were chosen from seed beneficiated households of improved chickpea varieties of TL-II project. The final sample selected for the survey was presented in Table 2.2.

Table-2.2: Sample particulars of the tracking survey, 2013 (no.)

District	Village	Treated / Control	Seed beneficiaries		Non-seed beneficiaries		
			Non-baseline HH	Baseline beneficiary HH**	Baseline HH*	Baseline Control HH#	Total sample
Dharwad	Alagawadi		1				
	Amargol		6				
	Amminabavi		3				
	Aratti		6				
	Arekurahatti		12				
	Ballur		13				
	Bennur		3				

	Dandikoppa		1				
	Kadadalli		15				
	Majjigudda		10				
	Navalgund		3				
	Sotakanal		15				
	Yadwad		1				
	Yatinaguda		2				
	Harobelavadi	Treated		10			
	Kumargoppa	Treated		10			
	Shirkol	Treated	12	10			
	Hunsi	Control				5	
	Kabenur	Control				5	
	Yamanur	Control				5	
	TOTAL		**103**	**30**		**15**	**148**
Gulbarga	Allur		1				
	Ambalga		1				
	Astagi		1				
	Aurad		1				
	Aurad(B)		1				
	B Bhosaga		8				
	Babalad		10				
	Bairamudagi		5				
	Belaguppa		2				
	Belur		8				
	Bharatnoor		1				
	Bhimahalli		4				
	Bhopategnur		2				
	Bodan		1				
	Chinamagere		3				
	Chincholi		1				
	Dandoti		3				
	Dangapur		3				
	Dhamapur		1				
	Dixamba		3				
	Gobbur		1				
	Godur		20				
	Gola		3				
	Gudagaon		18				
	Gundgurthi		10				
	Hadgil		4				
	Hagarga		8				
	Harawal		20				
	Hasargundagi		3				
	Hebball		7				
	Hirur		1				
	Jafrabad		1				
	Jambaga		3				
	K bhosaga		8				
	Kalkamba		21				
	Kandagol		4				
	Kanni		2				
	Khazoor		1				
	Kiranagi		8				
	Kogunoor		1				
	Kumsi		8				
	Madyal		1				
	Malgatti		1				
	Narona		3				
	Neelur		1				
	Nimbarga		3				
	Pattan		2				

	Sannur		2				
	Savalagi		9				
	Sindagi		2				
	Sonna		2				
	Station Ganagapur		15				
	Sultanpur		8				
	TajSultanpur		2				
	Tengli		30				
	Tonsali		8				
	V.K.salagar		6				
	Faratabad	Treated		10			
	Gutur	Treated		10			
	Korikota	Treated		10			
	Bennur	Control				5	
	Bhusanagi	Control				5	
	Honnakiranagi	Control				5	
	TOTAL		**307**	**30**		**15**	**352**
	Grand Total		**410**	**60**		**30**	**500**

2.2 Analytical techniques

The data collected from primary sources were computerized for analysis. The data were checked for consistency and completeness and analyzed using different descriptive statistical procedures. The descriptive statistics viz., sample mean, frequency distribution, cross tabulation were used. Tabular analysis was adopted to compile the general characteristics of the sample farmers, determine the resource structure, cost structure, returns, profits and opinion of farmers regarding the problems in production and marketing. Simple statistical tools like averages and percentages were used to compare, contrast and interpret results properly. In order to know the performance of chickpea crop over time, compound growth rates (CGR) 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 study period.

3. Results and discussions

3.1 Socio-economic, natural and institutional factors

The findings of real time tracking of varietal diffusion process of improved chickpea cultivars are presented as follows. The results of the study mainly focus on socio-economic characteristics of farmers such as caste, years of experience in chickpea cultivation, extent of owned and operational area, soil types, area under chickpea cultivation, and status of irrigation to chickpea crop, distance to regulated market, research station, and agricultural office.

Results in Table 3.1 revealed caste composition of sample chickpea farmers and is considered as an important influencing factor for the adoption of new technology. The caste wise distribution was almost on par in both the study districts and showed that in Dharwad district majority (64.86%) of them belonged to backward caste similarly in case of Gulbarga district (77.55 %) followed by scheduled caste (about 10 to 12%) and scheduled tribes (about 6 to 9%). In Dharwad farmers belonged to forward caste accounted 13.51 per cent while in Gulbarga it was 5.68 per cent.

Table-3.1: Caste composition of sample chickpea farmers

Dharwad	Seed beneficiaries	Non-seed beneficiaries	Grand total	Sample Average
SC	18	1	19	12.83
ST	12	1	13	8.78
BC	83	13	96	64.86
FC	20	0	20	13.51
Total	133	15	148	100.00
Gulbarga				
SC	36	0	36	10.22
ST	23	0	23	6.53
BC	260	13	273	77.55
FC	18	2	20	5.68
Total	**337**	**15**	**352**	**100.00**
Sample farmers	**470**	**30**	**500**	

The experience in chickpea cultivation (Table 3.2) by farmers was observed to be 13 years for both districts together and it was almost on part between districts. In case of Dharwad district experience in chickpea cultivation across sample categories was 13 to 14 years while, in case of Gulbarga district it was 12 to 13 years. In the study area the sample farmers had long years of experience in the cultivation of chickpea crop.

Table-3.2: Experience in chickpea cultivation (in years)

District	**Seed beneficiaries**	**Non-seed beneficiaries**	**Grand total**
Dharwad	13.68	12.80	13.59
Gulbarga	12.34	11.47	12.31
Grand total	**12.72**	**12.13**	**12.69**

The extent of owned land by chickpea farmers is presented in Table 3.3 and the results across districts and sample categories (seed beneficiaries and non-beneficiaries) indicated almost similar trend in respect of the extent of owned land. The overall average owned area was 13.13 acres in Dharwad and 12.13 acres in Gulbarga district.

Table-3.3: Extent of own land by chickpea farmers (in acres)

District	**Seed beneficiaries**	**Non-seed beneficiaries**	**Sample average**
Dharwad	12.53	13.20	13.13
Gulbarga	12.80	12.10	12.13
Grand total	**12.67**	**12.41**	**12.42**

The study also showed that a large proportion of land area was operated (Table 3.4) under cultivation by farmers across districts and across sample categories. The land leasing and share cropping practice was not very popularly found among the farmers. The average operational holding was almost on part across districts and sample categories. The same in Dharwad district was 12.98 acres and in Gulbarga district it was 12.05 acres per household.

Table-3.4: Extent of operational land(in acres)

District	Seed Beneficiary	Non-Seed Beneficiary	Sample average
Dharwad	12.30	13.06	12.98
Gulbarga	12.77	12.02	12.05
Grand Total	12.53	12.31	12.33

Table-3.5: Chickpea growing soil types in the study districts

	Seed beneficiaries	Non seed beneficiaries	Sample average
Dharwad			
Deep black soils	15(11.28)	10(66.67)	25(16.89)
Medium black soils	118(88.72)	5(33.33)	123(83.11)
Total	**133 (100.00)**	**15 (100.00)**	**148(100.00)**
Gulbarga			
Deep black soils	166(49.26)	5(33.33)	171(48.58)
Medium black soils	171(50.74)	10(66.67)	181(51.42)
Total	**337(100.00)**	**15(100.00)**	**352(100.00)**
Grand Total	**470**	**30**	**500**

The major soil type where chickpea is cultivated in the study districts and sample categories is presented in Table 3.5. The overall indication across districts showed that 83.11 per cent farmers in Dharwad cultivated chickpea in medium black soils and 16.89 per cent in deep black soils. Whereas, in case of Gulbarga non-seed beneficiary category the proportion of farmers those cultivated chickpea was nearly on par across soil types and its 51.42 per cent in medium black soils and 48.58 per cent in deep black soils.

The results in the Table 3.6 revealed average area under chickpea among sample farmers. The overall average area under chickpea cultivation across both categories of farmers was marginally more at 7.63 acre/farm in Gulbarga when compared to 7.32 acres/farm in Dharwad district and both districts together it was 7.49 acre/farm. The comparison between seed beneficiaries and non-seed beneficiaries across districts indicated that area under chickpea among seed beneficiaries (7.73 acres/farm) was marginally more when compared to non-seed beneficiaries (7.23 acres/farm). Similar trend of higher area among seed beneficiaries over non-seed beneficiaries was observed between districts.

Table-3.6: Average Area under chickpea cultivation in 2012/13 (acre per farm)

District	Seed beneficiaries	Non-seed beneficiaries	Sample average
Dharwad	7.52	7.12	7.32
Gulbarga	7.95	7.32	7.63
Grand total	**7.73**	**7.23**	**7.49**

The allocation of area under chickpea cultivation during last three years (Table 3.7) interestingly indicated that area under chickpea cultivation in Dharwad and Gulbarga districts according to seed beneficiaries (72.93% and 73.89%, respectively) was found to be increasing. Similar, opinion of increasing trend in area under the crop was witnessed by non-seed beneficiaries (73.33% and 66.67%, respectively) in Gulbarga district. While, in case of seed beneficiaries in Dharwad, the chickpea area remained constant as expressed by 15.04 per cent farmers and only 12.03 per cent farmers expressed that the area under chickpea declined in the last three years. Similar trend of increase and decrease (13.33% each) in area under chickpea was opined by non-seed beneficiaries in Dharwad district. In case of Gulbarga district, about 22 per cent of seed beneficiaries and 20 per cent non-seed beneficiaries implied constant area under chickpea and the decrease in area across sample categories in the district was expressed by 4.15 per cent and 13.33 per cent farmers, respectively. The overall average area under chickpea for both sample categories together showed an increase (72.97%) in Dharwad district. Similar trend of increase (73.58%) in area was observed

in Gulbarga district. Thus it implied the importance of the crop in rabi season in both the districts in the recent years. This was mainly attributed to high yielding capacity, resistant nature of cultivars to pests and diseases, their relative drought tolerance capacity and high output price in market and hence offered a high scope for expansion of area under chickpea in the study districts.

Table-3.7: Allocation of area under chickpea cultivation during last three years

District	Seed beneficiaries*	Non-seed beneficiaries*	Grand total
Dharwad			
Constant	20(15.04)	2(13.33)	22(14.86)
Decreasing	16(12.03)	2(13.33)	18(12.16)
Increasing	97(72.93)	11(73.33)	108(72.97)
Grand total	133(100.00)	15(100.00)	148(100.00)
Gulbarga			
Constant	74(21.96)	3(20.00)	77(21.88)
Decreasing	14(4.15)	2(13.33)	16(4.55)
Increasing	249(73.89)	10(66.67)	259(73.58)
Grand total	**337(100.00)**	**15(100.00)**	**352(100.00)**

Note: Figures in parentheses indicates percentage to the total. *no of farmers

Table 3.8 shows the irrigation status of chickpea fields in Dharwad and Gulbarga districts. It was observed from the results that most of seed beneficiaries (84.96%) in Dharwad district had no access to irrigation while only 15.04 per cent of them had irrigation facility. Similarly, among non-seed beneficiaries in Dharwad district, as large as 86.67 per cent of did not have irrigation facility and only 13.33 per cent of them had access to irrigation facility. When seed and non-seed beneficiaries combined together, 85.14 per cent farmers had no irrigation facilities and only 14.86 per cent of them had access to irrigation.

Table-3.8: Irrigation status of Chickpea field(No.of farmers)

	District	Seed beneficiaries	Non-seed beneficiaries	Grand total
Dharwad	No	113(84.96)	13(86.67)	126(85.14)
	Yes	20(15.04)	02(13.33)	22(14.86)
	Total	**133 (100.00)**	**15(100.00)**	**148(100.00)**
Gulbarga	No	314(93.18)	15(100.00)	329(93.47)
	Yes	23(6.82)	00(0.00)	23(6.53)
	Total	**337(100.00)**	**15(100.00)**	**352(100.00)**
Pooled	**Grand total**	**470**	**30**	**500**

Note: Figures in parentheses indicates percentages to the total

3.2 Nature and extent of benefits and technology adoption

The results on project seed beneficiary details in Table 3.9 reveals the preferred chickpea varieties by farmers for which seeds were distributed for adoption was provided in phases over the years from 2008-09 to 2011-12. Out of 470 seed beneficiaries chosen for real time tracking for adoption of improved chickpea cultivars 18.94 per cent of them were given seed material during 2008-09 and subsequently the coverage of farmers increased to 263 (55.96%) farmers during 2009-10, 21.06 per cent during 2010-11 and the remaining 4.04 per cent during 2011-12. Of the seed beneficiaries covered in respective years, 87.64 per cent of them were given JG-11 and 11.36 per cent were provided with BGD-103 varieties during 2008-09 who also cultivated these varieties during the year. During 2009-10, all the (263) seed beneficiaries who were covered under the project found to adopt JG-11 variety for which seed material was distributed. Another 97.98 per cent of them were given JG-11 and 2.02 per cent were provided with BGD-103 varieties during 2010-11. Of the seed beneficiaries during 2011-12, all of the (19 farmers) provided with JG-11 variety. It is very interesting to note that over the last four years, number of seed beneficiaries who cultivated JG-11 increased over the other variety and this indicated the farmer's preference for JG-11.

Table-3.9: Project beneficiary details (seed beneficiaries N=470)

Details	2008-09	2009-10	2010-11	2011-12
Seed beneficiaries of TL-II Project	89	263	99	19
Variety of seed provided 1.JG-11 2.BGD-103	78 (87.64) 11 (12.36)	263 (100.00) 00 (0.00)	97 (97.98) 02 (2.02)	19 (100.00) 00 (0.00)
Average quantity of seed provided(kg) 1.JG-11 2.BGD-103	 20 20	 20 0	 20 20	 20 0
Did the household sown this variety-Yes **Coverage of seed beneficiaries (%)**	**89** **(18.94)**	**263** **(55.96)**	**99** **(21.06)**	**19** **(4.04)**

Note: Figures in parentheses indicates percentage to the total

The extent of adoption of improved cultivars is depicted in Table 3.10. Among the seed beneficiaries in Dharwad district, the extent of area under old variety Annigeri-1 was highest at 1300 acres, 34 acres under JG-11 and 45 acres under local variety in the previous year of benefited year. As against this, the area under JG-11 increased to 137 acres and that of local variety declined to 17 acres during seed benefited year. In case of non-seed beneficiaries in Dharwad district, Annigeri-1 variety alone was cultivated on an area of 193 acres during the previous year of benefited year and an area of 3 acres was brought under JG-11 variety.

Among the seed beneficiaries in Gulbarga district, the extent of area under old variety Annigeri-1 was highest at 2498 acres and was the only variety cultivated by farmers in the previous year of benefited year. As against this, the area under JG-11 witnessed and it increased to 342 acres and that of BGD-103 variety was 11 acres during seed benefited year. In case of non-seed beneficiaries in Gulbarga district, Annigeri-1 was the lone variety cultivated on an area of 106 acres during the previous year of benefited year. As against this, Annnigeri-1 declined marginally and occupied 104 acres and JG-11 was cultivated on an area of 2 acres. Thus, there was adoption of improved cultivar particularly under JG-11 as a result of distribution of seeds material under the project.

Table-3.10: Extent of adoption of improved cultivars (sum of area in acres)

Cultivar Name	Seed beneficiaries (N=470)		Non Seed beneficiaries (N=30)	
Districts	Previous year of benefitted year	Seed benefitted year	Previous year of benefitted year	Seed benefitted year
Dharwad				
Annegiri-1	1300	1235	193	185
JG-11	34	137	0	3.00
Local Variety	45	17	0	0
Gulbarga				
Annegiri -1	2498	2145	106	104
JG-11	0	342	0	2.00
BGD-103	0	11	0	0

The extent of average area under traditional and improved chickpea cultivars over the years from 2009-10 to 2012-13 is presented in Table 3.11. The average area allocated per farm under traditional variety Annegiri-1 declined substantially among Seed Beneficiary (5.30 to 2.35 acres in Dharwad and 5.20 acres to 3.05 acres in Gulbarga) farmers. In case of Non-Seed Beneficiary groups, the there was a marginal reduction in area under Annegiri-1 (reduction from 6.00 to 4.60 acres in Dharwad and 7.73 to 7.67 acres in Gulbarga) after project intervention. The average area allocated per farm increased under JG-11 variety across sample categories and districts. The per farm acreage allocation by Seed Beneficiary across districts increased from little more than one acre

and up to 5.50 acres in three years' time after intervention. It increased from average of 2.50 acres to over 5.50 acres in case of Non-Seed Beneficiary farmers. The average per farm area allocation under BGD-103 variety was between 2.50 and 3.50 acres among Seed Beneficiary farmers in Dharwad while, it ranged between 2.50 to 3.80 acres in Gulbarga.

Table-3.11: Average area allocation under different chickpea cultivars (acre/farm)

District	Sample category	Variety	Year-1 (2009)	Year-2 (2010)	Year-3 (2011)	Year-4 (2012)
			Average/farm (Acre)	Average/ farm (Acre)	Average/farm (Acre)	Average/farm (Acre)
Dharwad	Seed Beneficiary	Annegiri-1		5.30	2.39	2.35
		JG-11		1.47	4.30	5.52
		BGD-103		3.46	2.67	3.00
	Non-Seed Beneficiary (Control)	Annegiri-1		6.00	5.27	4.60
		JG-11		2.50	4.25	5.50
Gulbarga	Seed Beneficiary	Annegiri-1	5.20	2.86	3.05	
		JG-11	1.12	3.63	4.03	
		BGD-103	2.50	3.83	3.25	
	Non-Seed Beneficiary (Control)	Annegiri-1		7.73	7.87	7.67
		JG-11		2.67	4.33	5.67
Total	Seed Beneficiary	Annegiri-1	5.20	3.83	2.78	2.35
		JG-11	1.12	2.79	4.13	5.52
		BGD-103	2.50	3.65	3.00	3.00
	Non-Seed Beneficiary (Control)	Annegiri-1		6.87	6.57	6.13
		JG-11		2.57	4.29	5.57

3.3 Sources of seed

The results on sources of seed during the benefitted year of technology are presented in Table 3.12. It could be implied that both in Dharwad district, almost all farmers depended upon Government agency as a source of seed supply w.r.t. JG-11. However, the project intervention for popularizing improved chickpea varieties was in force in the selected areas/villages from 2008-09 onwards of the district, where about 6.76 per cent farmers depended on farmer to farmer exchange as a source for seed for improved cultivars. In case of Gulbarga district, majority (96.74%) of farmers depended on Government agency as a source of seed supply w.r.t. JG-11. While, about 5.64 per cent relied upon farmer to farmer seed exchange as a source. In case of BGD-103 variety, for 3.26 per cent farmers, the source of seed supply was Government. Thus, it could be inferred that majority of the farmers depended on Government source for supply of seeds.

Table-3.12: Sources of seed during the benefitted year of technology

Cultivar name	Inherited from family	Govt. agency	FF seed exchange	Local seed producers
Dharwad (N=133)				
JG-11	00	133(100.00)	9(6.76)	00
Gulbarga (N=337)				
JG-11	00	326(96.74)	19(5.64)	00
BGD-103	00	11(3.26)	00	00

Note: Figures in parentheses indicates percentages to the total

Sources of seed during previous year of benefitted year are presented in Table-3.13. The farmers in Dharwad depended prominently for seed material on inherited (31.58%) source drawn from the previous harvest followed by farmer to farmer seed exchange (30.08%) , Government seed supply

(26.31%) as another important source through Raitha Samparka Kendra, and state seed corporation. In case of Gulbarga district similar trend was observed w.r.t. seed sources during previous year of benefitted year where inherited from family (38.58 %) was more prominent among the farmers, followed by farmer to farmer seed exchange (32.64%) and local seed producers (21.36 %) as other source of seed material.

Table-3.13: Sources of seed during previous year of benefitted year

Cultivar name	Inherited from family	Govt. agency	FF seed exchange	Local seed producers
Dharwad (N=133)				
Annegiri-1	42(31.58)	35(26.31)	40(30.08)	16(12.03)
Local variety	09(6.76)	-	01(0.75)	-
Gulbarga (N=337)				
Annegiri-1	130(38.58)	25(7.42)	110(32.64)	72(21.36)

Note: Figures in parentheses indicates percentages to the total

Table 3.14 provide information on seed source for other than TL-11 project supplied varieties namely, Annigri-1. The prominent sources of seed for Annigeri-1 variety in Dharwad district were inherited from family (31.58%), followed by farmer to farmer. Similarly in case of Gulbarga district, for majority of the farmers seed source was inherited from family (38.58%). It could be inferred that in the both the districts majority of the farmers depend on own/inherited source and farmer to farmer exchange for seeds.

Table-3.14: Seed source for other than TL-II project supplied varieties (Annigeri-1)

Source	Seed Beneficiary	% farmers
Farmer club	5	3.76
Farmer to farmer seed exchange (relative, friend, etc)	35	26.32
Govt agency	25	18.80
Inherited from family	42	31.58
Local seed producers	10	7.52
Local trader or agro-dealers	6	4.51
Dharwad	**133**	**100.00**
Farmer club	19	5.64
Farmer to farmer seed exchange (relative, friend, etc)	91	27.00
Govt agency	25	7.42
Inherited from family	130	38.58
Local seed producers	31	9.20
Local trader or agro-dealers	34	10.09
NGOs	7	2.08
Gulbarga	**337**	**100.00**
Grand Total	**470**	**100**

3.4 Economic performance of chickpea cultivars

The cost and returns from old cultivar (Annigeri-1) is presented in Table 3.15. The comparative analysis of cost and returns for chickpea crop between Dharwad and Gulbarga districts indicated that the total cost of cultivation of Annigeri-1 variety in Dharwad district was found to be highest at Rs.10,009.50/acre as compared to Gulbarga district at Rs.8502.23/acre. Seed cost accounted was Rs. 683.63/acre and Rs.678.75/acre in Gulbarga and Dharwad districts, respectively. Grain yield was relatively more at 602.02 kg/acre in Dharwad district as compared to Gulbarga district 535.78

kg/acre. Accordingly, the gross returns were found to be more (16266.53 Rs/acre) in Dharwad as compared to Gulbarga (14766.06 Rs/acre). Although the gross returns realized by farmers in Dharwad was more than their counterparts in Gulbarga, the net returns realized on Annegiri-1 variety remained on par across districts and this was mainly attributed to higher cost of cultivation. Thus, the net returns obtained were Rs.6257.03/acre in Dharwad and Rs.6263.83/acre in Gulbarga. The corresponding benefit cost ratio for Annigeri-1 was 1.63 in Dharwad and 1.74 in Gulbarga district representing returns for every rupee invested.

Table-3.15: Cost and returns from old cultivar (Annigeri-1) (Rs/acre)

Input/output	Dharwad	Gulbarga	Pooled
Cost of land preparation	563.29	509.66	544.45
Cost of farm yard manure	357.38	328.71	343.05
Seed cost	678.75	683.63	681.34
Sowing cost	550.00	504.55	532.27
Fertilizer cost	497.04	479.83	488.43
Cost of intercultivation	646.93	612.19	629.56
Cost of weeding	478.68	464.46	471.57
Plant protection cost	753.86	1042.40	898.13
Watch and ward cost	600.35	420.23	424.31
Harvesting cost	428.39	439.94	520.15
Threshing cost	546.78	455.02	500.90
Marketing costs	481.67	430.55	456.11
Rental value of land (Rs.)	3106.20	3184.49	3145.35
Grain yield (Kg.)	602.02	535.78	568.90
Grain Price (Rs.)	26.50	27.00	26.75
Dry fodder yield (Kg.)	313.00	300.00	306.50
Dry fodder Price (Rs/kg.)	1.00	1.00	1.00
Total Cost	10009.50	8502.23	9255.64
Gross return	16266.53	14766.06	15524.58
Net return	6257.03	6263.83	6268.94
BCRatio	1.63	1.74	1.68

The results on cost and returns of improved (Table 3.16) chickpea cultivar, BGD-103 revealed that cost of land preparation, manure, sowing, weeding, watch and ward cost, harvesting, threshing and marketing costs remained almost on par. While, seed, fertilizer and plant protection costs were marginally more in Gulbarga than in Dharwad. The cost of seed incurred by Gulbarga farmers for BGD-103 variety was found to be more (Rs.758.46/acre) than by farmers in Dharwad district (653.63 Rs./acre). The average grain yield realized by Dharwad farmers for BGD-103 variety was found to be 742.72 kg/acre as compared to Gulbarga at 703.84 kg/acre. The total cost of production in Dharwad district was found to be marginally more at Rs.11250 /acre when compared to Gulbarga (Rs.10521/acre) farmers. The gross returns realized by farmers in Dharwad were found to be more at Rs.26063.55/acre than in Gulbarga district (Rs.23731.72/acre). The net returns realized by farmers w.r.t. BGD-103 variety in Dharwad district was more (Rs.14813.55/acre) than in Gulbarga (Rs.13210.72/acre). The benefit cost ratio for BGD-103 across districts ranged between 2.26 to 2.32 indicated returns for every rupee invested in its production.

Table-3.16: Cost and returns of improved cultivar (BGD-103) (Rs/acre)

Input/output	Dharwad	Gulbarga	Pooled
Cost of land preparation	581.81	553.07	567.44
Cost of farm yard manure	374.09	386.92	380.50
Seed cost	653.63	758.46	706.04
Sowing cost	554.54	591.53	573.04
Fertilizer cost	586.36	668.46	627.41
Cost of intercultivation	511.81	361.11	447.16
Cost of weeding	521.42	561.53	530.76
Plant protection cost	658.18	823.07	740.62
Watch and ward cost	439.09	451.53	445.31
Harvesting cost	550.90	523.07	536.99
Threshing cost	527.27	534.61	530.94
Marketing costs	538.18	543.07	540.62
Rental value of land (Rs.)	3118.18	3569.23	3343.70
Grain yield (Kg.)	742.72	703.84	723.28
Grain Price (Rs.)	34.54	33.00	33.77
Dry fodder yield (Kg.)	410.00	505.00	457.50
Dry fodder Price (Rs/kg.)	1.00	1.00	1.00
Total Cost	11250.00	10521.00	10885.50
Gross return	26063.55	23731.72	24882.67
Net return	14813.55	13210.72	13997.17
BC Ratio	2.32	2.26	2.29

The results on the cost of returns for JG-11 (Table 3.17), an improved variety, cultivated on a large area among the farmers under rain fed condition in the study area. The intervention of this high yielder under the project paved way towards greater adoption by farmers compared to any other variety and was preferred by farmers as a substitute for Annigeri-1, a most extensively adopted variety prior to project intervention. Among the costs there was a marginal variation in the cost associated with land preparation, farm yard manure, seed cost, cost of sowing cost, and cost of weeding across districts and were relatively more in Gulbarga over the costs incurred in Dharwad district. While, the cost incurred by farmers on fertilizer (Rs.791.44 and Rs.522.77/acre), plant protection (Rs. 593.84 and Rs.453.44/acre) were relatively more in Gulbarga when compared to Dharwad, respectively in that order.

The average grain yield was found to be more in Dharwad district (732.25 Kg/acre) over Gulbarga (703 kg/acre) with an average grain yield of 717.62 kg/acre for both districts together. Average market price realized by Gulbarga farmers was more (Rs.31.15/kg) over Dharwad (Rs.30/kg) farmers. The comparison of production cost among the districts indicated higher cost in Dharwad (Rs. 9504.25/acre) as compared to Gulbarga (Rs. 8919.29/acre) with overall average for both the district at Rs.9211.77/acre). The gross returns realized by farmers in case of JG-11 were found to be more in Dharwad (Rs.22660.50/acre) as compared to Gulbarga (Rs.22608.45/acre). The net returns were Rs.13689.16/acre in Gulbarga and Rs.13156.25/acre in Dharwad. The benefit cost ratio for JG-11 across districts ranged between 2.38 to 2.53 where the BC ratio in Gulbarga showed relatively higher returns for every rupee invested.

Table-3.17: Cost and returns of improved cultivar (JG-11) (Rs/acre)

Input/output	Dharwad	Gulbarga	Over All
Cost of land preparation	479.79	558.09	518.94
Cost of farm yard manure	468.71	484.77	476.74
Seed cost	749.25	771.95	760.6
Sowing cost	508.87	504.57	500.83
Fertilizer cost	522.77	791.44	657.1
Cost of inter cultivation	490.33	564.58	527.46
Cost of weeding	538.44	586.42	562.43
Plant protection cost	453.44	593.84	548.03
Watch and ward cost	430.81	623.87	527.34
Harvesting cost	441.95	560.39	501.17
Threshing cost	459.45	548.89	504.17
Marketing costs	431.55	567.92	499.74
Rental value of land (Rs.)	3090.87	2955.55	3023.21
Grain yield (Kg.)	732.25	703	717.62
Grain Price (Rs.)	30.00	31.15	30.58
Dry fodder yield (Kg.)	693	710	701.50
Dry fodder Price (Rs/Kg.)	1.00	1.00	1.00
Total Cost	9504.25	8919.29	9211.77
Gross return	22660.50	22608.45	22642.73
Net return	13156.25	13689.16	13430.96
BC Ratio	2.38	2.53	2.46

The increased returns realized on improved chickpea cultivars (JG-11 and BGD-103) proved the hypothesis made before hand with respect to returns among the farmers in the study area over ruling varieties be accepted. The improved variety particularly JG-11 has expanding in its area over the traditional variety, Annigeri-1. The popularization through trials and demonstrations could be continued to appraise the potential of these varieties among the farmers. A comparison of the costs and returns between Annigeri-1 and JG-11 and BGD-103 is furnished in Table 3.18.

Table-3.18: Cost and returns in chickpea cultivars (Rs/acre)

Variety	Particulars	Dharwad	Gulbarga	Over All
Annigeri-1	Total Cost	10009.50	8502.23	9255.64
	Gross return	16266.53	14766.06	15524.58
	Net Return	6257.03	6263.83	6268.94
	BCRatio	1.63	1.74	1.68
JG-11	Total Cost	9504.25	8919.29	9211.77
	Gross return	22660.50	22608.45	22642.73
	Net Return	13156.25	13689.16	13430.96
	BC Ratio	2.38	2.53	2.46
BGD-103	Total Cost	11250	10521	10885.50
	Gross return	26063.55	23731.72	24882.67
	Net Return	14813.55	13210.72	13997.17
	BC Ratio	2.32	2.26	2.29

The comparative results in Table 18 showed cost and returns in the production of chickpea varieties namely, Annigeri-1, JG-11 and BGD-103 across districts. Among the cultivars, the gross returns realized were highest in case of BGD-103 across districts with an overall return of Rs. 24882.67/acre followed by JG-11 (Rs. 22642.73/acre) and Annigeri-1(Rs.15524.58/acre). The corresponding net returns for the varieties were Rs. 13997.17/acre, Rs. 13430.96/acre and Rs. 6268.94/acre, respectively. The overall benefit cost ratio for Annegiri-1 variety across districts was lowest at 1.68 followed by 2.29 for BGD-103 and 2.46 for JG-11. Thus, implied higher returns for every rupee invested in the production of improved varieties over Annigeri-1.

3.5 Role of institutions in technology diffusion

The results from Table 3.19 clearly indicated the role of institutions and their interventions in the targeted sites. It could be seen that University of Agricultural Sciences, Dharwad played important role along with ICRISAT, Hyderabad in taking improved high yielding varieties on mission mode to promote their adoption. The role of UAS Dharwad was significant in organizing village level trainings programs, focused group meetings and organizing farmers clubs, field days and seed melas, field trips, distribution of improved varieties seeds for field trials, large scale demonstrations, and seed production through farmers youth clubs under seed village program. The role of other developmental departments such as the department of agriculture, seed corporations complemented the efforts by way of subsidized distribution of seeds through RSKs are recognized as important interventions in promoting technology spread in targeted sites.

Table-3.19: Role of Institutions and their interventions in the targeted sites

Institute Name	Kind of Information
UAS,Dharwad	Village level trainings programmes Focused group meetings with farmers clubs Field Trials, Field days and melas and field trips, Distribution of improved variety seeds for field trials, Large scale demonstrations Seed production through farmers youth clubs under seed village programme
Department of Agriculture and seeds corporation	Subsidized distribution of seeds through RSKs, Seed Corporation Distribution of agril. inputs through RSKs, Trials and demonstrations

4. Summary and conclusions

Chickpea was a major crop during *rabi* season as it occupied a considerable (over 56 to 60%) proportion of the operational land and predominantly cultivated in black soils in both districts. Average operational farm size per household was 12.98 acres in Dharwad and 12.05 acres in Gulbarga. A comparison between seed beneficiaries and non-seed beneficiaries across districts indicated that area under chickpea among seed beneficiaries (7.73 acres/farm) was marginally more when compared to non-seed beneficiaries (7.23 acres/farm). Most of seed beneficiaries and non-seed beneficiaries in Dharwad (over 84%) and Gulbarga (over 93%) districts had no access to irrigation facility for chickpea crop. Thus, chickpea was largely cultivated under rainfed condition. Seed beneficiary farmers were provided with improved and preferred chickpea cultivars seeds such as JG-11, and BGD-103. All the seed beneficiaries were covered under seed distribution from 2008-09 to 2011-12. Since, JG-11 was most preferred variety where a majority of seed beneficiary farmers were provided with the seed material during the project period and 12 to 13 % per cent were provided with BGD-103. Quantity of seed material supplied was 20 kg per farmer for each variety. Over the years, number of seed beneficiaries who cultivated JG-11 also increased. Annigeri-1 was the most popularly cultivated chickpea variety by seed beneficiary farmers across districts. The farmers depended prominently for seed material on inherited (32% to 39%) and farmer to farmer seed exchange (30% to 33%) sources. Extent of area allocated by farmers for Annigeri-1 declined and that of JG-11 increased over three years period from 2009-10 to 2011-12. The decrease in Annigeri-1 area was from 952 acres in 2009-10, 486 acres in 2010-11 and 437 acres in 2011-12. Area under BGD-103 increased under favorable production conditions. Area under JG-11 increased in the same period from 314 acres in 2010-11 to 1434 acres 2012-13. Gross returns realized were highest in case of BGD-103(Rs.24882.67/acre) followed by JG-11(Rs. 22642.73/acre) and Annigeri-1(Rs.15524.58/acre). The corresponding net returns for the respective varieties were Rs. 13997.17/acre, Rs.13430.96/acre and Rs. 6268.94/acre, respectively. The benefit

cost ratio for Annegiri-1 variety was lowest (1.68) and it was highest at 2.29 for BGD-103 and 2.46 for JG-11. About 55.96% farmers under seed beneficiaries shared seed material of improved cultivars with other fellow farmers in respect of most preferred variety JG-11. There was a tendency of farmers to share seed material (38.72%) within the village and only 17.23% farmers shared with farmers of other villages.Quantity of seeds distributed during project operation period (from 2009-10 to 2012-13) within the same village was higher than in other villages. Hence, village could taken as the appropriate unit to focus intensive extension activities and for the spread of agricultural technology efficiently.Majority of (79%) farmers were disinterested to share seed with other farmers as they needed more time for validation on the true benefits such technology. Government sources comprising Department of Agriculture, Seeds Corporations constituted as major sources of seed supply at lesser cost to (about 80%) farmers followed by the University. According to farmers rapid diffusion of new cultivars could be hastened through measures like organizing intensively crop demonstrations, awareness campaigns using mass media tools, training programs.

The Tropical legumes-II project could make greater impact towards wide spread of improved chickpea cultivars in the study districts. The experiences of the project could be of greater value to promote the technology spread in other crops to enhance productivity and incomes of poor farmers particularly under rain fed conditions.There is need to use existing communication channels for the dissemination of market information. Involve the value chain agents to convince them by organizingfocused meetings with under regulated market mechanism.

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Targeting and introduction of Chickpea improved cultivars in Barind region of Bangladesh

Tropical Legumes II Phase 2 Project

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Targeting and introduction of chickpea improved cultivars in Barind region of Bangladesh

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1. Introduction

Chickpea is one of the important food legumes of Bangladesh. The area and production of chickpea has declined because of high emphasis on enhancing area and production of staple cereals like rice, wheat, maize and other short duration oilseed crops. There is increasing concern about the sustainability of high input, intensively cropped cereal-dominated cropping systems in Bangladesh. Crop diversification with legumes can help in improving soil fertility and system productivity. Chickpea (*Cicerarietinum L.*) is one of the most important pulse crops in Bangladesh considering consumers' choice and consumption. Chickpea has been traditionally cultivated in Bangladesh under rainfed condition. About 85% Chickpea was grown in Jessore, Faridpur, Rajshahi, Kustia, Pabna, ChapaiNawabgonj and Dinajpurdistircts. Most of these areas belong to the Agro ecological zone (AEZ) 11 and 12.

The data on area, production and productivity of chickpea for the period from 1980-2012 is presented below (Table 1.1). The average area under chickpea in Bangladesh for the period from 1980-2012 was 49 thousand hectares. The area coefficient of variation (CV) during the same period was 76 percent. Similarly the average chickpea production during the same period was 35 thousand tonnes and CV was estimated at 75 percent. But, the productivity was increased marginally from 723.58 to 742.57 kg/ha during the same period.

Table 1.1 Area, Production and Productivity of chickpea in Bangladesh, 1980 to 2012

Statistic	Area ('000 ha)	Production ('000 tons)	Productivity (kg/ha)
Mean			
1980-1990	72	52	723.58
1990-2000	74	53	725.62
2000-2012	12	9	770.21
1980-2012	49	35	742.57
CV (Raw data)			
1980-1990	37	36	7
1990-2000	41	41	2
2000-2012	26	23	4
1980-2012	76	75	6

Source: BBS

A baseline survey of chickpea has been taken-up under Tropical Legumes II (TL II) project in drought prone districts of Rajshahi and ChapiNawabgonj of Bangladesh because they were the top producers of chickpea occupying an area of 800 thousand ha during in 2009-10. The baseline survey

aimed at documenting the status of chickpea in terms of production and productivity, ruling varieties, preferences and constraints encountered by the farmers as well as functionaries along the value chain, economics of chickpea, marketing opportunities, marketable surplus and finally to track the supply chain. The analysis of baseline information will serve as a feedback about existing status as prima facie of chickpea. This would redirect the research priorities to enhance breeding programme and also make possible market interventions to enhance the remuneration to the farmers in order to improve livelihoods. However, the specific objectives of this study are:

1. To study the socio economic and environmental factors that influence the adoption of chickpea improved cultivars and also identify the major production constraints for the adoption those.
2. To track the preferred traits along the value chain.
3. To provide preliminary feed back to the crop improvement

2. Methodology

2.1 Sampling framework

The total sample farmers identified from both adopted and control villages of Rajshahi and ChapiNawabgonj districts together constitute about 270. In each district, three treated (adopted) and three control villages have been identified using the FPVS trial locations information. The district wise selection comprised of 90 farmers from adopted area and 45 from control area. The study covers small, medium and large chickpea growers from each location.

2.2 Analytical techniques: Simple tabular analysis was adopted to compile the general characteristics of the sample farmers, the resource structure, cost and returns, profits and opinions of farmers regarding the problems in production and marketing of chickpea. Simple statistics like averages and percentages were used to compare, contrast and interpret results in an appropriate way.To analyseand study the traits preferred in chickpea, weighted average ranking method was used.

3. Results and Discussions

3.1 Socio- economic profile of sample farmers

Socio- economic profile of sample farmers in the study areas were presented in Table 3.1. More than ninety percent of sample farmers were male headed households in the study area. On an average, the household size of the sample farmers were 6 and dependency ratio were 2. The average age of the sample farmers ranges from 43 to 46years. Majority of the sample farmers were falling into the category of middle ages. Educational status of the sample farmers in terms of number of years of education completedwas around 7.

Majority of the sample farmers were not participating in the nominated/elected bodies. Ninety six to ninety seven percent of the sample farmers from both adopted and control villages reported that agriculture as their main occupation followed by business (50-60%). Overall, data showed that

majority percent of the sample farmers had two wheeler/bicycles and television sets indicating that use of these goods had increased in the recent times.

Table 3.1: Socio- economic profile of sample farmers in the study area, 2011-12

Socio-economic Issue	Rajshahi		ChapaiNawabgonj		Pooled	
	A	C	A	C	A	C
Male headed households (%)	97	96	93	91	95	93
Household size (No)	6	6	6	6	6	6
Male workers(no)	2	2	2	2	2	2
Female workers (no)	-	-	-	-	-	-
Dependency ratio*	2	2	2	2	2	2
Age of household head (Years)	43	46	43	45	43	45
Education level of household head (No. of years)	7	6	6	6	7	6
Participation in local bodies (%)	7	7	7	4	7	6
Proportion belonging to forward castes (%)	-	-	-	-	-	-
Proportion belonging to religious minorities (%)	7	2	6	4	7	3
Proportion with agriculture as the main occupation (%)	94	96	97	98	96	97
Proportion with business/service as secondary occupation (%)	67	56	64	49	66	53
Ownership of two wheelers/bicycles (%)	66	69	63	56	64	62
Ownership of television sets (%)	60	64	57	44	59	54
Ownership of radio/tape recorders (%)	4	-	1	2	3	1
* Dependency ratio= (Size of family - Number of workers)/Number of workers						

3.2 Land ownership and operational holding pattern

Land ownership pattern and operational farm size in the study area was presented in Table 3.2. Average operational land holding of Rajshahi sample farmers were 1.40 ha irrigated and 0.20 ha in dryland whereas it was 0.95 ha irrigated and 0.07 ha ofdryland in ChapaiNawabgonj sample farmers.

3.3 Assets and liabilities

Average value of owned land per household in Rajshahi was Tk. 7370/- thousand in adopted villages while it was Tk. 6054/- thousand in control village. In ChapaiNawabgonj, average value of owned land per household had Tk. 6253/- thousand in adopted village and Tk. 4414/- thousand in control villages (Table 3.3).

Table 3.2: Average land holding size across different farm categories (ha)

	Particulars	**Irrig/dry**	Marginal	Small	Large	Pooled
Rajshahi	Own land	*Irrig*	0.30	0.90	3.50	1.10
		Dry	-	0.10	1.00	0.20
	Leased-in land	*Irrig*	0.40	0.30	-	0.30
		Dry	-	-	-	-
	Leased-out land	*Irrig*	-	-	-	-
		Dry	-	-	-	-
	Operated land	*Irrig*	0.70	1.20	3.50	1.40

		Dry	-	0.10	1.00	0.20
ChapaiNawabgonj	Own land	*Irrig*	0.20	0.70	2.40	0.75
		Dry	-	0.10	0.20	0.07
	Leased-in land	*Irrig*	0.20	0.10	0.60	0.20
		Dry	-	-	-	-
	Leased-out land	*Irrig*	-	-	-	-
		Dry	-	-	-	-
	Operated land	*Irrig*	0.40	0.80	3.0	0.95
		Dry	-	0.10	0.20	0.07

Table 3.3: Value of land owned by sample farmers in the study areas, 2011-12 ('000 Tk/Hh)

Type of Land	Rajshahi				ChapaiNababgonj			
	Adopted		Control		Adopted		Control	
	Area (ha)	Value (Tk 000)	Area (ha)	Value (Tk 000)	Area (ha)	Value (Tk 000)	Area (ha)	Value (Tk 000)
Irrigated land	1.20	6358	1.00	5325	1.13	5861	0.80	4150
Rainfed land	0.30	963	0.20	704	0.13	370	0.07	242
Fallow land	0.02	49	0.01	25	0.01	22	0.01	22
Total land	1.52	7370	1.21	6054	1.27	6253	0.89	4414

In the adopted and control villages of Rajshahi district, total livestock accounted for average value of Tk. 156961/- and Tk. 155501/- per household respectively whereas it was Tk. 138169/- for adopted villages and Tk. 157977/- for control villages in ChapaiNawabgonj district (Table 3.4).

Table 3.4: Value of Livestock owned by sample farmers in the study areas,2011-12 ('000 Tk/Hh)

Type of Livestock	Rajshahi				ChapaiNawabgonj			
	Adopted		Control		Adopted		Control	
	Number	Value	Number	Value	Number	Value	Number	Value
Draft animals	2	37.5	2	46.0	2	36.6	2	51.6
Cows	2	50.3	2	50.5	2	37.4	2	53.6
Buffaloes	1	35.0	1	33.0	1	36.0	1	28.0
Young stock	2	24.4	1	13.7	1	13.4	1	10.7
Sheep/goat	4	4.2	2	6.4	3	8.9	3	8.2
Others (Hen,Duck, Pigeon)	-	5.4	-	5.7	-	5.6	-	5.6
Total livestock	11	157	8	156	9	138	9	158

In Rajshahi district, total farm implements had the average value as Tk. 16660/- per household for adopted village and Tk. 13600/- for control villages followed by Tk. 11277/- per household for adopted village and an average value of Tk. 13026/- for control villages in ChapaiNawabgonj district (Table 3.5).

Table 3.5: Value of Farm Implements owned by sample farmers, 2011-12(Tk per Hh)

Type of Implement	Rajshahi		ChapaiNawabgonj	
	Adopted	Control	Adopted	Control
Tractor and accessories	10777	10000	9844	11289
Electrical/diesel pump sets	3611	1689	1089	1111

Bullock drawn tools	166	244	66	70
Others tools (Harvester, Thresher, power sprayers etc.)	2106	1667	278	556
Total farm implements	16660	13600	11277	13026

In the adopted and control villages of Rajshahi district, total consumers durables assets accounted for average value of Tk. 281571/- per household and Tk. 187005/- per household respectively whereas it was Tk. 280401/- per household for adopted villages and Tk. 157138/- per household for control villages in ChapaiNawabgonj district (Table 3.6).

Table 3.6: Value of Consumer durables owned by sample farmers in the study areas, 2011-12(Tk per Hh)

Type of Consumer durables	Rajshahi				ChapaiNawabgonj			
	Adopted		Control		Adopted		Control	
	No.	Value	No.	Value	No.	Value	No.	Value
Residential house	3.1	226278	2.6	140667	2.1	243189	2.6	121667
Cattle shed	1.1	23222	1.0	15300	0.8	17939	0.8	15260
Cycle/two-wheelers	0.8	19644	0.8	20200	0.7	13043	0.7	13689
Others (Television, Fridge, mobile set etc.)	2.4	12427	1.0	10838	1.3	6230	0.8	6522
Total consumer durables	7.4	281571	5.4	187005	4.9	280401	4.9	157138

Farmers of Rajshahi district were obtaining loans from various nationalized banks, NGO's and private banks to the extent of Tk. 36344/- per household for the adopted villages and Tk. 22800/- for the control villages. In ChapaiNawabgonj sample farmers, loans were sanctioned on an average per house hold of Tk. 16806/- for adopted villages and Tk.11911/- for control villages. Farmers ofRajshahi lend to villagers and friends/relatives by extending an amount of Tk. 9916/- per household per year for adopted villages and Tk. 2420/- for the control villages. But in ChapaiNawabgonj farmers were also lending to villagers and friends/relatives (in an informal way) by extending about Tk. 4958/-for adopted villages and Tk. 1210/- for control. Savings in banks, policies, Samitti, NGO's and post office to the extent of Tk. 34144/- per household in adopted villages and Tk. 12149/- per household for control villages in Rajshahi districtwhereas it was Tk. 7011/- for adopted villages and Tk. 4945/- per household for control villages in ChapaiNawabgonj district (Table 3.7).

Table 3.7: Financial Liabilities and Assets of sample farmers in the study areas, 2011-12(Tk per Hh)

Financial Liabilities and Assets	Rajshahi		ChapaiNababgonj	
	Adopted	Control	Adopted	Control
Borrowings (-)	36344	22800	16806	11911
Lending's (+)	9916	2420	4958	1210
Savings (+)	34144	12149	7011	4945
Net Liabilities	7716	-8231	-4837	-5756

The rate of interest for bank loans remained at 12% but the loans from the private financiers, money lenders and finance companies were costing at 20-35% rate of interest for both the districts in studied areas (Table 3.8).

Table 3.8: Source of finance across sample districts (% HH)

Source of laons	**Rajshahi**		Interest rate(%)	**ChapaiNababgonj**		Interest rate(%)
	A	C		A	C	
Loans:						
Nationalized banks	23	20	12	13	13	12
Private banks	4	2	20	8	2	20
NGOs/SHGs	21	22	32	36	24	32
Friends/relatives	4	2	12	4	7	12
Finance companies/samiti	-	9	22	3	2	22
Lending:						
Villagers	3	4	-	3	4	-
Friends/relatives	12	4	-	7	-	-
Savings:						
Banks	27	16	12	3	4	12
LIC/PLI Policies	2	4	12	-	-	-
Samiti	1	2	12	-	-	-
NGOs/SHGs	3	13	12	-	-	-
Post office	3	-	12	4	7	12

Average total assets per household in Rajshahi had Tk. 7826/- thousand in adopted villages and Tk. 6410/- thousand in control village. In ChapaiNawabgonj, average total assets per household had Tk. 6683/- thousand in adopted village and Tk. 4743/- thousand in control villages. Net worth per household in Rajshahi had Tk. 7819/- thousand in adopted villages and Tk. 6402/- thousand in control village. In ChapaiNawabgonj, net worth per household had Tk. 6688/- thousand in adopted village and Tk. 4737/- thousand in control villages (Table 3.9).

Table 3.9: Net worth of sample farmers in the study areas, 2011-12 (Tk '000 per Hh)

Assets and Liabilities	Rajshahi		ChapaiNawabgonj	
	Adopted	Control	Adopted	Control
Value of Land	7370	6054	6254	4414
Value of Livestock	157	156	138	158
Value of Farm Implements	17	13	11	13
Value of Consumer durables	282	187	280	158
Total Assets	7826	6410	6683	4743
Net Liabilities	7	-8	-5	-6
Net worth (Total assets - Net liabilities)	7819	6402	6688	4737

3.4 Cropping pattern and importance of chickpea

The cropping pattern followed by the sample respondents during the year 2011-12 agricultural year is presented in Table 3.10a, 3.10b and 3.10c. The major crops grown during *kharif season* were Paddy (0.21 ha/hh for adopted and control in Rajshahi districts) and mugbean (0.15 ha/hh for adopted and control in both the districts).

Table 3.10a: Average cropping patterns across study districts (ha/hh)-Kharif (Rainy)*

Crops	Rajshahi		ChapaiNawabgonj	
	Adopted	Control	Adopted	Control
Mugbean	0.15	0.15	0.15	0.15
Paddy (T. Aman)	0.21	0.21	0.21	0.20
*(March- June)				

During *rabi season*, since all the respondents were chickpea growers by choice, the area under chickpea was 0.43 ha/hh followed by wheat, potato and mustard (0.12 ha/hh) (Table 3.10b).

Table 3.10b: Average cropping patterns across study districts (ha/hh)-Rabi (Post rainy)*

Crops	Rajshahi		ChapaiNawabgonj	
	Adopted	Control	Adopted	Control
Chickpea	0.43	0.44	0.44	0.41
Wheat	0.12	0.12	0.12	0.12
Potato	0.12	0.12	0.12	0.12
Mustard	0.12	0.12	0.12	0.13
* (Nov-Feb)				

Mainly only one crop grown during summer season (kharif-2) was paddy (0.12 ha/hh) for both adopted and control areas in both the districts (Table 3.10c).

Table 3.10c: Average cropping patterns across study districts (ha/hh)- Summer (kharif-2)

Crops	Rajshahi		ChapaiNawabgonj	
	Adopted	Control	Adopted	Control
Paddy (T. Aus)	0.12	0.12	0.12	0.12
*(July-Oct)				

On an average 56 ha cropped area was under rainy season and 72 ha was under post rainy season and the chickpea area was 35 ha under post rainy season for adopted farmers in the study areas (Table 3.11). Proportion of chickpea area was 49 ha to the total cropped areas for adopted farmers.

Table 3.11: Relative importance of chickpea crop in cropped area of Bangladesh, 2011-12

Cropped area	Rajshahi		ChapaiNawabgonj		Pooled Sample	
	A	C	A	C	A	C
Rainy season cropped area (ha)	54	27	58	28	56	27
Post rainy season cropped area (ha)	62	39	81	46	72	43
Area under rainy season chickpea(ha)	-	-	-	-	-	-
Area under post- rainy season chickpea (ha)	32	18	38	20	35	19
Proportion of chickpea area to total cropped area (%)	52	45	47	44	49	44

Highest productivity level were potato (16-18 t/ha) followed by wheat (3.15 t/ha), mustard (1.3-1.5 t/ha) and chickpea (1.15 t/ha) under *rabi season* in the study areas (Table 3.12).

Table 3.12: Average productivity level across major crops (kg/ha)(source: FGDs)

Crops	Season (K/R/S)	Rajshahi		ChapaiNawabgonj	
		Adopted	Control	Adopted	Control
Chickpea	R	1153	1077	1173	1149
Wheat	R	3105	3157	3158	3135
Potato	R	17800	16600	18377	17191
Mustard	R	1531	1482	1433	1359
Mugbean	K	741	766	766	741
Paddy (T.Aman)	K	4446	4298	4520	4322
Paddy (T.Aus)	S	3835	3779	3927	3853

The chickpea cultivars grown during the last three years from 2009-10 to 2011-12 cropping season in the selected districts was analysed and the results are presented in Table 3.13. Six varieties were grown in the study area, namely BARI Chola-1, BARI Chola-3, BARI Chola-4, BARI Chola-5, BARI Chola-9 and BINA Chola-4. During the year 2011-12 average area of BARI Chola-3, BARI Chola-5 and Chola-9 were 0.27 ha, 0.66 ha and 0.18 ha respectivelyand BINA-4 was0. 05 ha per household adopted farmers whereas it was 0.28 ha of BARI Chola-3, 0.63 ha of BARI Chola-5, 0.06 ha of BARI chola-9 and 0.11 ha of BINA Chola-4 in control farmers in the studied areas. It is very interesting to note that over the last three years, the area under chickpea seemed to increase, irrespective of the variety.

Table 3.13: Allocation of area under different cultivars/varieties in the last three seasons (hh/ha)

Season	Year	Variety	Rajshahi		ChapiNawabgonj		Pooled	
			A	**C**	**A**	**C**	**A**	**C**
Rabi	2009-10	BARI-3	0.11	0.10	0.07	0.11	0.18	0.21
		BARI-5	0.27	0.16	0.32	0.26	0.59	0.42
		BARI-9	0.06	0.02	0.05	0.01	0.11	0.03
		BINA-4	0.02	0.04	0.01	0.04	0.03	0.07
	2010-11	BARI-3	0.11	0.10	0.11	0.12	0.22	0.23
		BARI-5	0.29	0.19	0.42	0.26	0.70	0.45
		BARI-9	0.07	0.03	0.07	0.01	0.14	0.04
		BINA-4	0.02	0.05	0.01	0.04	0.04	0.09
	2011-12	BARI-3	0.11	0.10	0.16	0.17	0.27	0.28
		BARI-5	0.27	0.20	0.39	0.43	0.66	0.63
		BARI-9	0.08	0.03	0.09	0.03	0.18	0.06
		BINA-4	0.03	0.09	0.02	0.02	0.05	0.11
A: Adopted villages; C: Control villages								

On an average the area covered under chickpea was highest BARI Chola-5 (59.24 ha in adopted and 28.23 ha in control farmers) followed by BARI Chola-3, BARI Chola-9 and BINA Chola-4 in the study areas (Table 3.14).

Table 3.14: Composition of chickpea varieties in the study areas, 2011-12 (ha)

Variety	Rajshahi		ChapaiNawabgonj		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
BARI Chola-3	10.06	4.66	14.48	7.75	24.54	12.41
BARI Chola-5	24.45	8.80	34.79	19.43	59.24	28.23
BARI Chola-9	7.38	1.34	8.41	1.45	15.79	2.79
BINA Chola-4	2.58	4.01	1.60	1.08	4.19	5.09
Total	44.48	18.81	59.28	29.71	103.76	48.52

The average of the best yields harvested by the sample respondents was 1576.31 kg/ha for adopted farmers as against 1402.96 kg/ha for control farmers in rain fed situation (Table 3.15). In good years, the average yield was to the tune of 1081.06 kg/ha and 1117.68 kg/ha in rain fed conditions for adopted and control farmers respectively whereas in bad years, the corresponding yield levels were 657.77 kg/ha and 644.76 kg/ha for adopted and control farmers respectively.

Table 3.15: Productivity levels of chickpea (kg/ha) perceived by the sample farmers, 2011-12

Perceived Yield	Rajshahi		ChapaiNawabgonj		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
Rain fed						
Good	1064.93	1116.44	1096.92	1119.36	1081.06	1117.68
Bad	605.64	607.62	719.83	664.30	657.77	644.76
Best	1630.20	1432.60	1545.51	1373.32	1576.31	1402.96
Irrigated						
Good	-	-	-	-	-	-
Bad	-	-	-	-	-	-
Best	-	-	-	-	-	-

On an average the highest yield was BARI Chola-9 (1380 kg/ha for adopted farmers and 1273 kg/ha for control farmers) followed by BARI Chola-5, BARI Chola-3 and BINA Chola-4 (Table 3.16).

Table 3.16: Productivity of chickpea varieties in the study areas, 2011-12 (Kg/ha)

Variety	Rajshahi		ChapaiNawabgonj		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
BARI Chola-3	996	1003	1100	958	1028	981
BARI Chola-5	1123	1115	1145	1040	1136	1063
BARI Chola-9	1375	1264	1384	1282	1380	1273
BINA Chola-4	988	935	951	926	970	931
Source: FGD's						

3.5 Economics of chickpea and other competing crops

It was observed from the financial analysis that among the studied competitive crops, highest gross return (Tk.163 thousand/ha for adopted farmers and Tk. 152 thousand/ha for control farmers) was found for potato followed by mustard (Tk. 89 thousand/ha for adopted and Tk. 85 thousand/ha for control farmers), chickpea (Tk.73 thousand/ha for adopted and Tk.70 thousand/ha for control farmers) and wheat (Tk. 66 thousand/ha for both adopted and control farmers). But highest benefit

cost ratio was calculated for chickpea (2.1 for adopted and 1.9 for control farmers) followed by mustard (1.9 for adopted and 1.8 for control farmers). On the other hand, lowest benefit cost ratio was obtained from potato (1.3 for adopted and 1.2 for control farmers) due to highest production cost obtained from potato (Table.3.17).

The input-output analysis of ruling chickpea cultivars utilization patterns of inputs in the study areas is depicted in Table 3.18 & 3.19. The average output indicated yield level of 1123 kg/ha among adopted and 1115 kg/ha in case of control area for BARI Chola-5 in Rajshahi district whereas it was 1572 kg/ha for adopted and 1347 kg/ha for control area for BARI Chola-5 in ChapaiNawabgonj districts. In case of BARI Chola-3, average yield was 995 kg/ha for adopted and 1003 kg/ha for control area in Rajshahi district. On the other hand, it was 1100 kg/ha for adopted and 1242 kg/ha for control area in ChapaiNawabgonj district. The productivity was more in case of BARI Chola-5 than BARI Chola-3 for both adopted and control situation. The utilization pattern of inputs also showed almost similar trend between varieties and locations.

Table 3.17: Cost and returns from different competing crops grown by sample farmers in thestudy areas, 2011-12

Particulars	Rajshahi		ChapaiNababgonj		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
Gross returns (Tk.'000/ha):						
Chickpea	74	68	73	71	73	70
Wheat	68	69	63	63	66	66
Potato	160	149	165	155	163	152
Mustard	92	89	86	82	89	85
Gross cost (Tk.'000/ha):						
Chickpea	38	39	33	35	36	37
Wheat	51	52	44	45	48	49
Potato	122	126	124	127	123	127
Mustard	46	47	48	50	47	49
Net return (Tk.'000/ha):						
Chickpea	36	29	40	36	38	33
Wheat	17	17	19	18	19	18
Potato	38	23	41	28	40	26
Mustard	46	42	38	32	42	37
BCR:						
Chickpea	1.9	1.7	2.2	2.0	2.1	1.9
Wheat	1.3	1.3	1.4	1.4	1.4	1.4
Potato	1.3	1.2	1.3	1.2	1.3	1.2
Mustard	2.0	1.9	1.8	1.6	1.9	1.8
Source: FGD's						

Table 3.18: Economics of chickpea on sample farms in the study areas, 2011-12 (Tk per ha)

Operations	Rajshahi			
	Adopted		Control	
	BARI Chola-5	BARI Chola-3	BARI Chola-5	BARI Chola-3
Land preparation	8585	10681	8084	9423
FYM/Compost	-	-	-	-

Seed costs	4768	5943	4498	3660
Sowing costs	202	225	202	202
Fertilizer costs	3892	4850	3683	4828
Micro-nutrient costs	-	-	-	-
Inter-culture costs	-	-	-	-
Weeding costs	-	-	-	-
Plant protection costs	524	651	494	389
Irrigation costs	-	-	-	-
Watching expenses	-	-	-	-
Harvesting costs	4768	5943	4498	5951
Threshing costs	3361	3967	3001	3982
Marketing costs	397	352	389	352
Total costs/ha	**26497**	**32612**	**24849**	**28787**
Rental value per season	13121	13121	13121	13121
Grain yield (kgs)	1123	996	1115	1003
Grain price (Tk/kg)	58	57	57	57
Fodder yield (kgs)	636	786	561	449
Fodder price (Tk/kg)	3	3	3	3
Source: FGD's				

Contd.

Operations	ChapaiNawabgonj			
	Adopted		Control	
	BARI Chola-5	BARI Chola-3	BARI Chola-5	BARI Chola-3
Land preparation	7403	9873	6340	9970
FYM/Compost	-	-	-	-
Seed costs	4760	3331	4079	3331
Sowing costs	202	202	202	202
Fertilizer costs	2350	3585	2043	3473
Micro-nutrient costs	-	-	-	-
Inter-culture costs	-	-	-	-
Weeding costs				
Plant protection costs	644	457	524	464
Irrigation costs	-	-	-	-
Watching expenses	-	-	-	-
Harvesting costs	5037	3653	4319	4034
Threshing costs	3361	4034	2882	4004
Marketing costs	554	382	472	434
Total costs/ha	**24311**	**25517**	**20861**	**25912**
Rental value per season	11698	11699	11698	11699
Grain yield (kgs)	1145	1100	1040	958
Grain price (Tk/kg)	58	54	57	54
Fodder yield (kgs)	636	472	524	501
Fodder price (Tk/kg)	3	3	3	3
Source: FGD's				

Higher gross return was found BARI Chola-5 (ranges Tk. 65 thousand to Tk. 68 thousand) followed by BARI Chola-3 (Tk. 53 thousand to Tk. 60 thousand). And benefit cost ratio was also higher for BARI Chola-5 (ranges from 1.70 to 1.90) than BARI Chola-3 (ranges from 1.30 to 1.60) for adopted and control farmers in both the locations (Table.3.19).

Table 3.19: Economics of BARI Chola-3 and BARI Chola-5 cultivars in rain fed condition

Operations	Adopted		Control	
	BARI Chola-5	BARI Chola-3	BARI Chola-5	BARI Chola-3
Rajshahi				
Yield (kg/ha)	1123	995	1115	1003
COC(Tk/ha)	39618	45733	37970	41908
Gross returns(Tk/ha)	67042	59130	65238	58518
Net returns (Tk/ha)	27424	13397	27268	16610
BCR	1.70	1.30	1.70	1.40
ChapaiNababgonj				
Yield (kg/ha)	1144	1100	1040	958
COC(Tk/ha)	36009	37216	32559	37611
Gross returns(Tk/ha)	68318	60816	60852	53235
Net returns (Tk/ha)	32309	23600	28293	15624
BCR	1.90	1.60	1.90	1.40
Source: FGD's				

Table 3.20: Net household income of sample farmers in the study areas,2011-12(Tk/Year/hh)

Source of income	Rajshahi		ChapaiNawabgonj	
	Adopted	Control	Adopted	Control
Income from crops	51322	47856	51344	47578
Farm work (labor earnings)	7138	7956	6022	6800
Non-farm work (labor earnings)	1467	1956	1302	1235
Regular Farm Servant (RFS)	5589	2956	3345	2575
Livestock (milk and milk products selling)	6022	4000	4589	3933
Income from hiring out bullocks	-	-	222	-
Income from selling sheep, goat, chicken, meat, eggs etc.	15822	11078	12522	10044
Selling of water for agriculture purpose	50	11	-	-
Selling CPR (firewood, fruits, stones, and mats etc)	344	467	-	-
Selling handicrafts (specify)	-	-	-	-
Rental income (tractor, auto, sprayer, & truck etc.)	222	160	-	-
Rent from land, building and machinery etc.	6767	4556	5222	3545
Caste occupations (specify)	-	-	-	-
Business (specify)	18278	14600	11233	12444
Regular salaried jobs (Govt./private)	1556	2844	5466	4400
Out migration	7778	1244	3244	1911
Remittances	4444	1156	2345	986
Interest on savings and from money lending	851	111	-	-
Cash and kind gifts including dowry received	1722	378	-	-

Pension from employer	1267	-	-	-
Government welfare/development Programs	-	-	-	-
Grand Total	**139459**	**101329**	**106967**	**95451**

3.6 Income and expenditure of sample farmers

The analysis of the results on annual net household income by sources is presented Table 3.20. The income from crops was a major source among farmers across districts showed that average income from crops contributed respectively in adopted and control areas (Tk. 51322, Tk. 47856) in Rajshahi district was substantially more or less similar than the corresponding incomes from crops (Tk. 51344, Tk. 47578) in ChapaiNawabgonj district. This was mainly attributed to same environment in both the districts. The other sources which contributed to the total household income were business, selling livestock and poultry, labour earnings and income from rent land & farm machinery. The annual total income of the household in the adopted area was Tk. 139459 and that in control area was Tk. 101329 in Rajshahi district and in the adopted area was Tk. 106967 and in control area was Tk. 95451 in ChapaiNawabgonj district.

Table 3.21: Consumption expenditure of sample farmers,2011-12 (Tk/Year/hh)

Food item	Rajshahi		ChapaiNawabgonj	
	Adopted	Control	Adopted	Control
Cereals	26372	18514	20482	21396
Pulses	10560	10996	7793	4504
Milk and Milk products	847	499	589	465
Edible oils	10979	13440	11648	8640
Non-Veg. foods	18555	19392	15878	13333
Fruits and vegetables	4745	4790	2834	2477
Others (Tea/coffee,sugar,gur,spices etc.)	1178	1270	891	971
Total food expenditure	73236	68901	60115	51786
Health	1574	1291	1318	1377
Education	1969	1796	1992	1878
Entertainment and travel	862	642	692	584
Clothing and shoes	4227	3800	2578	2589
Ceremonies	1097	1011	921	876
Alcohol and Cigarettes	726	400	500	643
Cosmetics	581	556	581	436
Others (maintenance, cooking fuel, mobile etc.)	2238	2022	2235	2663
Total Non-food	13274	11518	10817	11046
Total expenditure	86510	80419	70932	62832

The annual food consumption expenditure for various food items (Table 3.21) across districts was found to be more or less similar among the households. The annual food consumption expenditure indicated that cereals food accounted for largest proportion of expenditure (Tk. 26372 adopted and Tk. 18514 control in Rajshahi district and Tk. 20482 adopted and Tk. 21396 control in ChapaiNawabgonj district) by household followed by non-veg. food (Tk. 18555 adopted, Tk. 19392 control in Rajshahi and Tk. 15878 adopted, Tk. 13333 control in ChapaiNawabgonj), edible oils (Tk. 10979 adopted, Tk. 13440 control in Rajshahi and Tk. 11648 adopted, Tk. 8640 control in

ChapaiNawabgonj) and pulses (Tk. 10560 adopted, Tk. 10996 control in Rajshahi and Tk. 7793 adopted, Tk. 4404 control in ChapaiNawabgonj). The remaining food expenditure incurred was on fruits and vegetables and spices. The annual total food expenditure per household was Tk. 73236 for adopted and Tk 68901 for control in Rajshahi and Tk. 60115 for adopted and Tk. 51786 for control in ChapaiNawabgonj district.

The annual non-food expenditure showed that the proportion of expenditure incurred by households indicated almost similar trend in pattern of expenditure across districts and among adopted and control areas.

The proportion of utilization pattern of output to the total production by households across districts and areas (adopted and control) are presented in Table 3.22.Marketable surplus is grain output available to be sold after meeting the requirement of own consumption, other uses like kind wages gifts and as own seed. The results showed that a large proportion of the total output produced by households in case of adopted 160/161 kg and 120 kg of control was sold in the market in both the district. The adopted and control households retained respectively a considerable quantity of output for consumption.

Table 3.22: Crop utilization (main product) per HH (kgs) (BARI Chola-5)

Particulars	Rajshahi		ChapiNababgonj	
	Adopted	Control	Adopted	Control
Grain output (Kg)	1059.36	1099.15	1081.86	1278.91
Consumed (Kg)	133.11	118.56	111.15	69.16
Other uses*	24.70	18.11	28.82	12.35
Kept as own seed (Kg)	60.24	49.40	54.29	49.40
Sold as seed (Kg)	384.91	290.91	384.99	296.40
Seed sale price (Tk/kg)	92.00	92.00	90.00	90.00
By-product (Kg)	958.91	454.48	261.55	313.69
By-product sale price (Tk/Kg)	3.00	3.00	3.00	3.00
Qty sold in the market (kg)	456.40	622.17	491.04	851.60
Market Price (Tk/Kg)	57	57	57	57
Marketing cost (Tk/q)	86.45	86.45	118.56	111.15
*Includes kind wages, gifts and fed to cattle etc				

The study results showed that distance to regulated market and storage centrefrom the study areas were 2.5 to 3.0 km and 35 to 40 km respectively (Table 3.23).

Table 3.23: Access to market and storage facilities

Dist.	A/C	Village name	Distance to regulated market (km)	Distance to storage facilities (km)
Rajshahi	**A**	Bijoynagor, Kadomshohor and Kakonhut	2.5	35
	C	Deopara, Saroil and Nazirpur	3.0	35
Chapai Nabab gonj	**A**	Manikara, Bahoroil and laxmipur	2.5	35
	C	Amnura, Dheenagor and Kanpara	3.5	40

3.7 Sources of information

The results on important sources of information on technology of the produce to the farmers showed that they depended on more than one source of information. Main sources of information about new cultivar, fertilizer management, pest and diseases management with ranked out and presented in Table 3.24. In both the districts the main sources of information about new cultivars, were obtained to the sample farmer from research institute (Rank-1), agricultural extension worker (Rank-2) and input-suppliers (Rank-3) and about fertilizer management were obtained from input-dealers (rank-1), research station (rank-2) and extension staff (rank-3) in the study areas.

Table 3.24: Sources of information to sample farmers in the study areas, 2011-12 (Wt. scale)

Sources of information	New seed/cultivar		Fertilizer management		Pest management		Disease management	
	A	C	A	C	A	C	A	C
Rajshahi								
Input-dealers	6.0(3)	6.0 (3)	8.0(1)	8.0(1)	8.0(1)	8.0(1)	6.0(3)	6.0(3)
Research station	8.0(1)	8.0(1)	7.0(2)	7.0(2)	7.0(2)	7.0(2)	8.0(1)	8.0(1)
Extension staff	7.0(2)	7.0(2)	6.0(3)	6.0(3)	6.0(3)	6.0(3)	7.0(2)	7.0(2)
T.V/Radio	-	-	-	-	-	-	-	-
Magazines/News paper	-	-	-	-	-	-	-	-
Fellow farmers	5.0(4)	5.0(4)	5.0(4)	5.0(4)	5.0(4)	5.0(4)	5.0(4)	5.0(4)
Friends/relatives	4.0(5)	4.0(5)	4.0(5)	4.0(5)	4.0(5)	4.0(5)	4.0(5)	4.0(5)
NGOs	3.0(6)	3.0(6)	3.0(6)	3.0(6)	3.0(6)	3.0(6)	3.0(6)	3.0(6)
ChapaiNababgonj								
Input-dealers	6.0(3)	6.0(3)	8.0(1)	8.0(1)	8.0(1)	8.0(1)	6.0(3)	6.0(3)
Research station	8.0(1)	8.0(1)	7.0(2)	7.0(2)	7.0(2)	7.0(2)	8.0(1)	8.0(1)
Extension staff	7.0(2)	7.0(2)	6.0(3)	6.0(3)	6.0(3)	6.0(3)	7.0(2)	7.0(2)
T.V/Radio	-	-	-	-	-	-	-	-
Magazines/News paper	-	-	-	-	-	-	-	-
Fellow farmers	5.0(4)	5.0(4)	5.0(4)	5.0(4)	5.0(4)	5.0(4)	5.0(4)	5.0 (4)
Friends/relatives	4.0(5)	4.0(5)	4.0(5)	4.0(5)	4.0(5)	4.0(5)	4.0(5)	4.0(5)
NGOs	3.0(6)	3.0(6)	3.0(6)	3.0(6)	3.0(6)	3.0(6)	3.0(6)	3.0(6)

(Figures in the parentheses indicate rank of importance as source of information)

3.8 Preferred traits of chickpea and price premiums for traits

To analyse the study the traits preferred in chickpea cultivars by the farmers, weighted average Ranking Method was used.Having observed the constraints in all the existing varieties the preferences for in the studied cultivars were presented in Table 3.25a. In both the districts farmers preferred BARI Chola-5 forhigh yield (Rank-1)followed by fit into existing cropping patterns (Rank-2) and disease resistance (Rank-3) and BARI Chola-9 for also high yield in Rajshahi rank-1 and ChapaiNababgonj rank-3, disease resistance in Rajshahi rank-2 and ChapaiNababgonj rank-1 and pod borer resistance in Rajshahirank-3 whereas it was rank-2 in ChapaiNababgonj. The other preferred traits, in general were attractive grain colour and grain size across varieties and locations.

Table 3.25 a: Preferred traits for chickpea production among cultivars (Wt. scale)

	Rajshahi		ChapaiNababgonj	
	BARI Chola-5	BARI Chola-9	BARI Chola-5	BARI Chola-9
High yield	9.9(1)	10.0(1)	10.0(1)	8.0(3)
Short duration	-	-	-	
Drought tolerance	-	-	-	
Cold tolerance	-	-	-	
Attractive grain colour		7.0(4)	8.0(4)	7.0(4)
Heat tolerance		-	-	
Pod borer resistance		8.0(3)	-	9.0(2)
Disease resistance	8.0(3)	9.0(2)	8.9(3)	10.0(1)
Fit into existing cropping system	7.0(2)	-	9.0(2)	
Higher recovery of dal (%)	6.0(4)	-	7.0(5)	
Figures in parentheses represent ranks in descending order of importance				

Consumption preferred traits for both the districts,better taste for BARI Chola-5 and BARI Chola-9 were ranked-1 (Table 3.25b).

Table 3.25 b: Preferred traits for chickpea consumption among cultivars (Wt. scale)

Consumption Preferred Traits	Rajshahi		ChapaiNababgonj	
	BARI Chola-5	BARI Chola-9	BARI Chola-5	BARI Chola-9
Better taste	2.0(1)	2.0(1)	2.0(1)	2.0(1)
Less cooking time	-	-	-	-
High keeping quality	-	-	-	
Figures in parentheses represent ranks in descending order of importance				

Market preferences as observed by farmers both BARI Chola-5 and BARI Chola-9 were high demanded (ranked-1) cultivars by marketing agents and fetching high price (ranked-2) (Table 3.25c).

Table 3.25c: Preferred traits for chickpea marketing among cultivars (Wt. scale)

Marketing Preferred Traits	Rajshahi		ChapaiNababgonj	
	BARI Chola-5	BARI Chola-9	BARI Chola-5	BARI Chola-9
High demand	3.0(1)	3.0(1)	3.0(1)	3.0(1)
Fetches higher price	2.0(2)	2.0(2)	2.0(2)	2.0(2)
Low price fluctuations	1.0(3)	1.0(3)	1.0(3)	1.0(3)
Figures in parentheses represent ranks in descending order of importance				

The major constraints in the existing cultivars as expressed by the farmers that high diseases incidence for BARI Chola-5 in Rajshahi district was ranked-1whereas high pod borerincidence for BARI Chola-5 in ChapaiNababgonj district was ranked-1. In both the district for BARI Chola-9, not fit into cropping system was ranked-2 followed by low germination rate was ranked-3 to the sample farmers (Table 3.26).

Table 3.26: Major constraints among chickpea cultivars (Ranking by wt. Scale)

Constraints	Rajshahi		ChapaiNababgonj	
	BARI Chola-5	BARI Chola-9	BARI Chola-5	BARI Chola-9
Low yield	-	-	-	-
High pod borer incidence	2	-	1	-
High disease incidence	1	4	2	4
Long duration	3	1	4	1
Low germination rate	4	3	3	3
Small grain size	-	-	-	-
Not attractive colour	-	-	-	-
Poor taste	-	-	-	-
Low recovery of dal (%)	-	-	-	-
Low market price	-	-		-
Not fit into cropping system	-	2	-	2
Poor fodder quality	-	-	-	-
Susceptible to storage pest	-	-	-	-

3.9 Marketing Channel/Marketing chain

In the study areas chickpea are moved from producer to consumer in the different market through different intermediaries, such as bepari, wholesaler, retailer and processors. According to the transacted volume of the chickpea and participations of the intermediaries in the channel, seven major channels were identified as a dominant in the study areas.

Chan.no.	**Major marketing channels**	**% marketed**
As grain directly		
1	Producer→Bepari→Wholesaler→Retailer→Consumer	20
2	Producer → Wholesaler→ Retailer →Consumer	10
3	Producer → Retailer →Consumer	5
4	Producer → Consumer	5
As dal/flour		
5	Producer→Bepari→ Processor→Wholesaler→Retailer → Consumer ▸	45
6	Producer → Processor → Wholesaler → Retailer → Consumer	10
7	Producer → Processor → Consumer	5

Summary and conclusions

On an average the household size of the sample farmers were 6 and dependency ratio were 2. Educational status of the sample farmers in terms of the number of years of education in the adopted villages of Rajshahi district had maximum years of schooling of 8 years followed by adopted farmers of ChapaiNawabgonj district of 6 years. Ninety six to ninety seven percent of the sample farmers of both adopted and control villages in both the district reported that agriculture as their main occupation. Overall data showed that majority percent of the sample farmers had two wheeler/bicycles and television sets indicates that use of this type of goods had increased which increases the cost of living. Average operational land holding of Rajshahi sample farmers were 1.40 ha cultivated in irrigated whereas it was 0.95 ha in ChapaiNawabgonj sample farmers. During *rabi season*, since all the respondents were chickpea growers by choice, the area under chickpea was 0.40 ha/hh followed by wheat, potato and mustard (0.12 ha/hh). On an average the area covered under chickpea was highest BARI Chola-5 (29.70 ha in adopted and 14.10 in control farmers) followed by BARI Chola-3, BARI Chola-9 and BINA Chola-4 in the study areas. Among the studied competitive crops, highest benefit cost ratio was calculated for chickpea (2.1 for adopted and 1.9 for control farmers) followed by mustard (1.9 for adopted and 1.8 for control farmers). The income from crops was a major source among farmers across districts. In both the districts farmers preferred BARI Chola-5 for high yield (Rank-1) followed by fit into existing cropping patterns (Rank-2) and disease resistance (Rank-3). The major constraints in the existing cultivars as expressed by the farmers that high diseases incidence (ranked-1) followed by high pod borer incidence (ranked-2) and long duration (ranked-3) for BARI Chola-5 in Rajshahi district. The gender wise ownership of the resources in the adopted and control areas showed that male members of the family had complete access (100%) to the ownership of different assets. The major activities performed by male (100%) in the adopted and control areas of both the districts.

The study clearly indicates huge potential for chickpea in the targeted sites as they are highly competitive when compared with other post-rainy season crops grown. Chickpea yielded high net benefits per ha and high benefit-cost ratio than the others. So, the targeting of chickpea in rice-fallows increases not only the incomes but also enhances the sustainability of cropping systems. Ultimately, the viability of small and marginal farmers' agriculture will be increased in South Asia.

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Targeting and introduction of Chickpea improved cultivars in Bihar state of India

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ABSTRACT

Chickpea is one of the major pulses in Bihar, with crop yield of 1000 kg/ha, which is higher than the national average of crop yield (841 kg/ha). Despite of huge potential and comparative advantage, the crop acreage and production of chickpea in Bihar has been in declining trend. Lack of availability of seed of improved varieties, problems in marketing the produces, and insecurity and/or widespread theft of crop from the field are some of the prominent reasons. A base line survey was conducted in selected eight villages in two districts of Bihar, which was with an aim of increasing the area and production of chickpea through adoption and diffusion of improved crop varieties. This was also associated with improved management practices in target districts of Bihar. The objective of this socio-economic study on chickpeas was to appraise the existing situation of production and marketing of chickpeas in selected districts/villages of Bihar, and with respect to adoption of alternate technologies, and its impacts on crop productivity. This includes also estimation of farmers' profitability in growing the crop. This is based on survey of sample of 135 farmers from each of the two districts; which were further divided into control and treatment groups. In 2012/13, the average yield of improved variety in adopted villages was 9.5 quintal /ha and the yield of local variety was 8.5 q/ha. The per capita income of farmers in the adopted village was more than that of control village, even though only about 54% of total household income was derived from the crop enterprise. However, the chickpea alone contributes to about Rs 9000 to 15000 per ha in the sample villages surveyed. Our study also suggests that chickpeas have a comparative advantage in Bihar than several other crops; and they are financially highly profitable in the study sites. Data pertaining to preferred traits for production, consumption and marketing indicated that those introduced varieties have been given higher yield, having better taste along with good keeping, and with better cooking quality, followed by fetching high price in the market are most preferred by all the respondents of study. Involvement of women in chickpeas production is very high, especially for harvesting and threshing activities. Major constraints in cultivation of chickpeas in the studied sites are high pod borer incidence, shortage of seed of HYV, lack of crop type suitable for flood receding agro-ecology, and lack of marketing infrastructures and storage of crops after harvest

***Key words**: chickpeas, Bihar, Bhagalpur; Banka, socio-economic analyses, production constraints*

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1. Introduction

Chickpea is one of the major pulses in Bihar, with crop yield of 1000 kg/ha, which is higher than the national average of crop yield (841 kg/ha). Despite of huge potential and comparative advantage, the crop acreage and production of chickpea in Bihar has been in declining trend. In this study, we assess the present socioeconomic condition of production of chickpeas in this state of Bihar, and farmers' constraints and opportunities in production and marketing of Chickpeas in Bihar. This is done based on primary survey in 8 villages in two districts of southern and eastern Bihar, that is in Bhagalpur and Banka district of Bihar.

Chickpea crop areas and production have increasing trend in India during the last 10 years, the crop acreage in India has increased by over 20% during the last one decade, with an over 8.75 million ha of acreage in 2010 (DES, Govt. of India, 2012). Not only crop acreage, but also crop yield, and total production have also increased during the same period. The increased on crop production is more in states like Maharashtra, M.P., Rajasthan, Andhra Pradesh, Karnataka and Gujarat (Table 1) than other states of India.

Table.1 Grouping of states by increasing and decreasing trend of chickpeas acreage

State	Area	Production
Sates where Area and Production of chickpea is in increasing trend	Andhra Pradesh	Andhra Pradesh
	Karnataka	Karnataka
	Madhya Pradesh	Madhya Pradesh
	Maharashtra	Maharashtra
Sates where Area and Production is in decreasing trend	Assam	Assam
	Bihar	Bihar
	Haryana	Haryana
	Punjab	Punjab
	Uttar Pradesh	Uttar Pradesh
	Himachal Pradesh	Himachal Pradesh
	Orissa	Orissa

Note: Some of states presented in Table 1 are denoted as losing state with respect to area and production (Fertilizer News 2012, Govt. of India).The assessment data by each state suggest that Gujarat state followed by Maharashtra recorded highest growth in crop yield, likewise, instability on crop acreage and yield was recorded highest in Rajasthan followed by Maharashtra and Haryana.

Likewise, assessment of the crop acreage trend by states reveal that there has been a gradual shift in crop acreage across the states in India, and the crop acreage has sharply declined in states like Punjab and other northern states, but during the same period, the crop acreage has been increased in southern India states like Andhra Pradesh.

Study objectives

The main purpose of the study is to assess socioeconomic aspects of chickpeas growers in Bihar state, in relation to a project on adoption and dissemination of improved cultivar of chickpeas in selected parts of Bihar. Keeping in the view of this context, the study has following specific objectives:

1) To carry out socioeconomic assessment of chickpeas cultivation in selected districts of Bihar;
2) To assess farmers level constraints and opportunities in cultivation of chickpeas in the study areas;
3) To identify and evaluate farmers' preferences over different traits of chickpeas
4) To assess gender roles and functions in cultivation of chickpeas in the study sites; and
5) To suggest policy implications on constraints and opportunities of chickpeas production in the study sites

With this background, the paper has been structured following way. The second chapter describes chickpeas production in Bihar state, its overall historical trend, and production status in the districts selected for the field study. Then, the third

2. Chickpea production in Bihar

In Bihar, agriculture sector has experienced a considerable growth during the past three decades. The progress has been spectacular in 1980's when state recorded agriculture growth of 2.50 percent per annum, which has been however could not been sustained during nineties. This same pace of growth is not there in pulses and other minor crops, for example, Pulse crops got major setback; the total pulse crop acreage has declined from 1.63 million ha in 1970-71 to 0.53million ha in the year 2011-12. Some part of this declined is also due to bifurcation of state in early 2002; however, within the present days Bihar state, there has been continues declining on crop acreage and production of pulses.

Moreover, about 520 thousand metric tons of pulse was produced in the state in 2011-12, which is about 4% of total production of pulse in the country. The percentage area under pulses to gross cropped area has in declining trend in Bihar, especially in the region where gross irrigated area expanded (Chopra, 1982). Considering rising demand of pulses in the country, and Bihar a traditionally pulse production belt of India, this is an alarming situation. Among pulse crops grown in Bihar, only crop acreage of Lentil has increased recently, with crop acreage of about 20,000 hectares in 2010. Likewise, the crop yield (991kg/ha)of Lentil is also higher in Bihar than that of the all India level average.

Area under pulses has experienced not only a declining trend, but also pulse acreage was most instable during the last two and half decades. However, variability of crop area of total pulse is comparatively lower, however, in case of individual pulse crops; chickpea has highest variability in area and production; whereas productivity of lentil shows lowest variability. Consultation with farmers reveals that rainfall during late kharif season has positive impact on increase in pulse area in the state. In case of Bihar, the crop yield has increased from 550 kg/ha in 1975/76 to 1000 kg/ha, in 2010-11, however, the chickpeas acreage cannot be compared for Bihar for the same period due to bifurcation of the state in early 2000. Even after 2003, after bifurcation of the state of Bihar, the chickpea area has been in declining trend in the new state of Bihar, due to profitability and growing popularity (and public policy emphases) on Rice-Wheat system and other competing cropping patterns. It has been noticed that as irrigation facilities developed, chickpea crop area in the state gradually has been converted to rice and wheat system (also confirmed in authors' discussion with the farmers group in visit to site Sept 2013). There is a huge variability in area and production of chickpeas from 2000 to 2009; however, the productivity during the same period is more stable. This

indicates that there is a scope to increase production potential of chickpea in the state if the state government adopts adequate policy measures.

Table 2. Dynamics of changes on annual crop area, production, and yield of chickpeas in Bihar

Period	Annual average crop area(in 1000 ha)	Annual average Production (in 1000 tons)	Average Productivity (kg/ha)
Mean			
1990-2000	130.94	117.41	893.07
2000-2009	70.35	65.81	933.11
1990-2009	100.65	91.61	913.09
CV (Raw data)			
1990-2000	13.44	23.02	15.96
2000-2009	23.46	25.60	7.8
1990-2009	35.06	37.52	12.23

Chickpeas production in the districts selected for the study

For this study, two leading chickpeas production districts of Bihar were selected for farmer's level survey, therefore, a brief description on area and production of chickpeas and general feature of farming in the two districts are provided below:

Bhagalpur

In Bhagalpur district, the average area under chickpea in triennium ending 2000 was 5,042 hectare producing 4,416 tons with productivity of crop yield of 872 kg per hectare. It is endowed with congenial climate condition for cultivation of wide varieties of crops and trees. However, the periodic distribution of rainfall during the season is not uniform. Dry and wet spell are commonly experienced resulting in water stress. Rice is still a most important crop, which covered 41 to 46 percent of gross cropped area, but area under rice has also been declined now. However, area under maize has increased due to adoption of winter maize at large scale especially in Bihpur subdivision of Bhagalpur districts. Wheat is the main competing crop during the post rainy season followed by chickpea and oilseed crops. Relative importance of pulses in the districts is 23.09 percent of total gross cropped area. Among pulses chickpea accounts 60 percent of area to total pulses area in the districts. Since the last triennium ending, the area under chickpea has been increased but average productivity declined from 872 kg/ha to 744 kg/ha (2000-2009).

Banka

Banka is also located in Zone-3A having same climatic condition, rainfall but irrigation structure is different from Bhagalpur. Chickpea is one of the major pulse crops in Banka district with an area of 3873ha during 2000 after that it has declined to 2477ha until 2009 triennium ending however, average production has been stagnated over the same period. However, productivity level has shown an increasing trend as rises from716 kg/ha to1057 kg/ha. Wheat is the main competing crop during the post rainy season followed by chickpea and oilseed crops. Relative importance of chickpea to total cropped area is about 14 percent and average productivity across all other major crop is

comparatively higher than Bhagalpur. However, 90% of farmers continue to use local variety for chickpea cultivation.

Among selected sample district, the variability in area and production was found more in Bhagalpur as indicated by having higher CV value. However, Productivity was found less stable in Banka as indicated by having higher value.

Table 3: Crop area, production and yield of chickpeas in two districts in Bihar and instability (1997 to 2012).

Year	Bhagalpur			Banka		
	Area (ha)	Production (t)	Yield (kg/ha)	Area (ha)	Production (t)	Yield (kg/ha)
1997-2000	5042	4416	872	3873	2703	-716
2003	3619	3012	823	3008	1836	745
2006	3144	2126	663	3561	2680	745
2009	6162	4619	744	2477	2783	1057
Instability measure (CV)						
Raw data						
1997-2000	0.23	0.02	0.14	0.03	0.05	0.22
2000-2003	0.23	0.02	0.1	0.04	0.04	0.01
2003-2006	0.24	0.02	0.09	0.03	0.05	0.18
2006-2009	0.85	0.03	0.19	0.05	0.09	0.18
De-trended Data						
1997-2000	0.01	0.02	0.14	0.03	0.05	0.22
2000-2003	0.02	0.02	0.1	0.04	0.04	0.1
2003-2006	0.03	0.02	0.09	0.03	0.05	0.18
2006-2009	0.02	0.03	0.19	0.05	0.09	0.18

3 Field study sites and insights from the survey

Cropping patterns and major crop varieties in the study area

Major crops grown in the studied districts are presented in Table 4.Chickpea, lentil and wheat, are the major Rabi crops grown in the region. Data clearly indicates that in adopted village of Bhagalpur district, wheat was the major Rabi crop followed by chickpea. On the contrary in control villages where chickpea was the major Rabi crop followed by wheat (0.06 ha/household). At Banka, the major Rabi crop was chickpea (0.58 ha/household) followed by Wheat and Mustard in their cropping patterns. Major crops cultivated in the study districts are presented in Table 5.

In summary, average cropping pattern across study districts indicated that cereal crop dominates the cropping pattern in the state followed by pulses. Among the pulses, chickpea and lentil are the two major crops cultivated in both the districts surveyed.

Table 4. Average cropping patterns across study districts (% of crop area)

Kharif (Rainy season)

Crops	Bhagalpur		Banka		Pooled	
	Adopted	Control	Adopted	Control	Adopted	Control
Paddy	0.61	0.28	0.78	0.71	0.695	0.495
Maize	0	0.06	0.01	0	0.005	0.03

Post rainy (Rabi)

Crops	Bhagalpur		Banka		Pooled	
	Adopted	Control	Adopted	Control	Adopted	Control
Chickpea	0.66	0.36	0.50	0.48	0.58	0.42
Wheat	2.31	0.06	0.42	0.29	1.365	0.175
Mustard	0.55	0	0	0	0.275	0
Lentil	0	0.01	0.02	0.004	0.01	0.007

Summer

Crops	Bhagalpur		Banka		Pooled	
	Adopted	Control	Adopted	Control	Adopted	Control
Maize	0.01	0.18	0.13	0.13	0.07	0.155
Mung	0.004	0.24	0.10	0.07	0.052	0.155

Relative importance of chickpea crop in cropped area of Bihar sample, 2011-12

The relative importance of chickpea crop in total cropped area is shown in Table 5. Chickpea was accounted nearly about 20 per cent in adopted village and to 36 percent in control village s respectively.

Table 5. Land allocation for growing chickpeas in the study sites in Bihar

Cropped area	Bhagalpur		Banka		Pooled Sample	
	A	C	A	C	A	C
Rainy season cropped area (ha)	55.6	16.4	73.5	32.2	129.1	48.5
Post rainy season cropped area (ha)	321.4	20.1	82.9	36.8	404.3	56.9
Area under post- rainy season chickpea area post rainy area (ha)	60.1	16.5	45.9	21.9	106.1	38.4
Proportion of chickpea area to total cropped area (%)	16	45	29	32	20	36
A: Adopted village; C: Control village						

Productivity of major crops

Average productivity of major crops such as wheat, and chickpea was comparatively higher in Banka than that of Bhagalpur district (Table 6). Average Yield of chickpea in adopted villages were comparatively higher (754.5kg/ha) than control village (689kg/ha) as indicated in Table 6.Crop yield

of some other crops like paddy, mung and lentil were also higher in control villages than that of the adopted.

Table 6: Average productivity levels across major crops (Kg per ha)

Crops	Season (K/R/S)	Bhagalpur		Banka		Pooled	
		Adopted	Control	Adopted	Control	Adopted	Control
Chickpea	R	711	616	798	762	754.5	689
Mustard	R	630	0	0	0	315	0
Wheat	R	2408	2250	3440	2503	2914	2376.5
Paddy	K	2238	4006	3210	1979	2724	2992.5
Maize	K	0	4183	3593	0	1796.5	2091.5
Maize	S	2499	3618	3624	2118	3061.5	2868
Mung	S	624.5	1206	840	1666	792.25	1436
Lentil	R	0	1000	704	1000	352	1000

However, data pertaining to composition of different varieties indicated that traditional variety still playing an important role in their chickpea cropped area. Local varieties accounted nearly 90-95 percent of total chickpea area cultivated in the surveyed sites (Table-7). Among traditional verities cultivated, *Desla Plain* was accounting about 69% in adopted villages and 47% in control villages respectively followed by *Desla Roon* and Radha. Among improved cultivars of chickpeas, JG 14 was accounted highest share, i.e., 2.3% followed by KAK 2 (2.1%) on the plot areas of the sample farmers surveyed.

Deshla plain is popular variety which is generally used by many of the farmers (49.2 ha) in the adopted villages of Bhagalpur followed by 23.3 ha in Banka district. However, its share was much less in control village of Banka than other places.

Table 7. Crop acreage by variety grown (%)

Variety	Bhagalpur		Banka		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
DESLA PLAIN	81.70	96.90	51.80	9.70	68.80	47.10
DESHLAROON	6.90	1.20	32.50	68.20	17.90	39.50
JG 14	0.10	0.00	5.20	0.00	2.30	0.00
KAK 2	0.70	0.00	4.00	0.00	2.10	0.00
Radha	1.00	1.90	6.30	14.70	3.30	9.20
Subhara	1.50	0.00	0.20	7.40	1.00	4.20
Vaibhav	8.10	0.00	0.00	0.00	4.60	0.00
Sub-total	100	100	100	100	100	100
Total area	60.2	16.5	45.0	22.0	105.2	38.5

4. Study framework and methodology

4.1 Sampling framework

The target districts and communities for conducting baseline survey on "chickpea cultivation in Bihar" under TL-II project was mainly based on the technology intervention (PVST of chickpea on farmer field) under the collaborative efforts of ICRISAT and Bihar Agricultural University (BAU), Sabour during the year 2010-11. In this regard, two districts of Bihar were selected purposively for the socioeconomic analyses. These two districts are also the project target districts where breeders and other scientists of the project have a plan to disseminate the improved variety of chickpeas more widespread in the near future; and also have distributed improved variety of chickpeas seed to over 100 farmers in the previous years.

In each district a cluster of 3 villages from two different blocks were selected as adopted villages and 3 villages from surrounding areas with comparable agro ecological and market condition were chosen to serve as control villages. Selection of control village would enable the team to do a comparable counter factual analysis in impact evaluation. In total, a cluster of three villages each from adopted and control villages i.e.,six villages in each district were identified for conducting base line survey.

The Two districts selected for the study are: Banka and Bhagalpur. The, three villages each from Bhagalpur districts i.e., Khankitta, Rajpur, and Pipra, were selected as adopted; and the control villages in the district were: Kurpat, Lailakh, and Jicho. The adopted villages were relatively close to Bihar Agricultural University, Sabour or research station.The adopted villages in the Banka district were Kotwal, Kotwali, and Simaria, and the villages those served as control were Gurudwara, Padampur and Babura.

To select households for the survey, stratified Random Sampling technique based on probability proportion to size method to farm size was used for selection of farmers. From each of the adopted villages a sample of 30 farmers were interviewed and from each control villages a sample of 15 farmers were interviewed. Thus, 135 from each district totaling to 270 farmers were interviewed. In this way a total of 180 beneficiaries from the six adopted villages to whom the technology was provided and 90 non-beneficiaries from the control village to whom the technology was not provided were randomly selected and surveyed. The detailed sampling framework is shown below.

Table 8.Selection of sample among selected districts and the study sites

District	Treatment/ Adopted village	No. of farmers	Control village	No. of farmers	Total
Bhagalpur	Khankitta	30	Kurpat	15	
	Rajpur	30	Lailakh	15	
	Pipara	30	Jichho	15	135
Bhanka	Kotwal	30	Gurudwar	15	
	Simaria	30	Padmpur	15	
	Kotwali	30	Babura	15	135
Grand Total	6	180	6	90	270

4.2 Methodology

Growth rate analysis

For assessing the trends in area, production and productivity of chickpea in different states and the study districts of Bhagalpur and Banka, the following growth rate formula was employed.

$$^{YT} = ab^{t}u^{t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, ^{YT} = area/production/productivity in the year's'

a = intercept indicating Y in the base period (t = 0)

b = Regression coefficient

^{t} = Time period in years

Ut = Disturbance term for the year 't'.

Garrett's ranking technique

Each of 135 respondents selected in each district were asked to rank the preferences based on their priorities using ranks from 1 to 10. In this analysis, rank 1 means most important problem and rank 10 means least important problem. In the next stage rank assigned to each reason by each individual was converted into per cent position using the following formula:

Per cent position = 100 (Rij – 0.5) / NJ
Where,

Rij stands for rank given for the ith factor (i= 1, 2….5) by the jth individual
(j = 1, 2……., n)

Nj stands for number of factors ranked by jth individual.

Once the per cent positions were found, scores were determined for each per cent position by referring Garrett's table. Then, the scores for each problem were summed over the number of respondents who ranked that factor. In this way, the number of respondents who gave ranks arrived at total scores for each of the factors and mean scores were calculated by dividing the total score. Final overall ranking of the factors was carried out by assigning rank 1, 2, 3… etc, in the descending order of the mean scores.

5 Characteristics of chickpea growing farmers

Post stratification of sample farmers (Table 9) indicated that about 40 percent of sample farmers were of large categories followed by small (32.77%) and (27.77 %) marginal farmers in adopted

villages. However, in control villages43 percent were having large size of holdings followed by marginal farmers (37.77) and only18.88percent were having small size of holdings respectively.

Table 9.Distribution of sample farmers in studiedtwo districts in Bihar, 2012-13

Category	Bhagalpur		Banka		Pooled sample	
	Adopted	Control	Adopted	Control	Adopted	Control
Marginal	15(16.66)	30(66.66)	35(38.88)	4(8.88)	50(27.77)	34(37.77)
Small	29(32.22)	7(15.55)	30(33.33)	10(22.22)	59(32.77)	17(18.88)
Large	46(51.11)	8(17.77)	25(27.77)	31(68.88)	71(39.44)	39(43.33)
Total	90(100)	45(100)	90(100)	45(100)	180(100)	90(100)

Land owned by sample households has been classified on the basis of their uses and categorized as cultivable land (irrigated, dry) fallow land, leased in land and leased out land as below .it may further be categorized as marginal ,small and large farm according to size of holding.

Table 10.Average land holding size across farm categories (ha/household)

	Particulars	Irrig/dry	Marginal	Small	Large	Pooled
Bhagalpur	Own land	Irrig	0.69	1.36	4.02	2.19
		Dry	0.00	0.25	2.60	0.76
		Total	0.69	1.61	6.62	2.95
	Leased-in land	Irrig	0.05	0.03	0.01	0.03
		Dry	0.00	0.00	0.01	0.00
		Total	0.05	0.03	0.02	0.03
	Leased-out land	Irrig	0.00	0.00	0.09	0.04
		Dry	0.00	0.00	0.00	0.00
		Total	0.00	0.00	0.09	0.04
	Operated land	Irrig	0.74	1.39	3.95	2.22
		Dry	0.00	0.25	2.60	0.76
		Total	0.74	1.64	6.55	2.98
	Particulars	Irrig/dry	Marginal	Small	Large	Pooled
Banka	Own land	Irrig	0.58	1.45	4.35	1.64
		Dry	0.01	0.07	0.49	0.13
		Total	0.59	1.52	4.84	1.77
	Leased-in land	Irrig	0.11	0.05	0.05	0.07
		Dry	0.06	0.02	0.00	0.03
		Total	0.17	0.07	0.05	0.11
	Leased-out land	Irrig	0	0	0	0
		Dry	0	0	0	0
		Total	0	0	0	0
	Operated land	Irrig	0.69	1.49	4.4	1.71
		Dry	0.07	0.08	0.49	0.16
		Total	0.76	1.57	4.89	1.88

Pooled analysis indicated that average operational land holdings across differentcategories for Banka was about 1.88 ha/household out of that 1.71 ha was irrigated and remain were dry land. Where as in Bhagalpur it was estimated about 2.98ha/ households in which 2.22 ha was irrigated. Apart from these, on an average 0.11ha/household area was leased inland andno area was leased out to the other

farmers in Banka, where as in Bhagalpur it was estimated approximately about0.04 haof land was leased-in and leased-out to the others under study.

Socio economic profile of sample farmer indicated that100% households of sample villages headed by male. On an average, the proportion of male and female in sample households were found to be nearly 52.5 percent and 47.5 percent respectively. Further, it was observed from the table that out of total population nearly 53percent of population had agriculture as main occupation in adopted villages. However, for control villages it was 54.4 percent, followed by business and services, respectively. Based on dependency ratio, it may be said that although the majority of female workers were found engaged in household works, but a substantial proportion was also engaged in agriculture, however, their involvement in non-agriculture occupation was very limited as compared to their counterparts. Educations is considered as one of the most important indicators for development and have a look on data that levels of education for selected household head were lagged much behind as indicated by having only middle level i.e., 9.88and8.49 respectively for both of the district. One remarkable point has been observed during the survey that each household of both the district had nearly 100% of mobile ownership followed by ownership of two wheeler and television set.

Table: 11 Socio-economic profile of sample farmers in Bihar, 2011-12

	Bhagalpur		Banka		Pooled	
	A	**C**	**A**	**C**	**A**	**C**
Male headed households (%)	100.0	100.0	100.0	100.0	100.0	100.0
2Household size (No)	7.4	7.9	6.8	7.1	7.1	7.5
Male Workers(no)	2.8	2.9	2.7	3.3	2.8	3.1
Female Workers (no)	0.8	1.7	1.6	1.5	1.2	1.6
Dependency Ratio*	1.1	0.7	0.6	0.5	0.8	0.6
Age of Household head (Years)	51.0	53.0	51.0	45.0	51.0	49.0
Education Level of household head (No. of years)	10.5	8.5	9.3	8.5	9.9	8.5
Participation in local bodies (%)	0.0	0.0	0.0	0.0	0.0	0.0
Proportion belonging to forward castes (%)	62.2	0.0	0.0	4.4	31.1	2.2
Proportion belonging to religious minorities (%)	33.3	0.0	0.0	13.3	16.7	6.7
Proportion with agriculture as the main occupation (%)	51.1	42.2	54.4	66.7	52.8	54.4
Proportion with business/service as secondary occupation (%)	44.4	48.9	45.6	33.3	45.0	41.1
Ownership of two wheelers/bicycles (%)	96.7	75.5	96.0	100.0	96.3	87.8
Ownership of television sets (%)	100.0	66.0	83.0	100.0	91.5	83.0
Ownership of mobile (%)	100.0	95.5	100.0	100.0	100.0	97.8
* Dependency ratio= (Size of family-Number of workers)/Number of workers A: Adopted village; C: Control village						

Household Income by Sources: - Total household income has been derived by summing up of total farm income and total non-farm income. Total farm income comprises of income obtained from crop production, livestock, etc. While on-form income includes income derived from business, salary, remittances etc. Net household income of sample farmers in selected districts during 2011-12 by source in Rs./Year/Household has been presented below.

It may be observed that total household income on an average was worked out to be Rs.250782 for adopted villages of Bhagalpur which was found to be highest followed by adopted village of Banka district (Rs.169839). Among control villages, it was comparatively higher for Banka district than that of Bhagalpur and was estimated to be Rs.130629 and Rs.113407 respectively. Data pertaining to table indicated that majority of part of population of selected districts i.e. 53 % of total population mainly depend upon agriculture followed by business and services. Regular salaried Job figured to be the second major source of income in both the districts i.e. contribution of non-farm income was estimated about 82061 for adopted villages of Bhagalpur and Rs.82167/Year for adopted villages of Banka. Earning from business figured out to be the third most important source of income and accounted for about Rs.2277 out of Rs.130629 followed (Rs.12222) and (Rs.9967) respectively by adopted and control villages of Bhagalpur.

Table 12.Net household income of sample farmers, 2011-12 (Rs/Year)

Source of income	Bhagalpur		Banka		Pooled	
	A	C	A	C	A	C
Income from crops	92717	27544	49250	26267	70983.5	26905.5
Farm work (labor earnings)	28367	11156	15744	12311	22055.5	11733.5
Non-farm work (labor earnings)	11222	7089	7000	7667	9111	7378
Regular Farm Servant (RFS)	622	1556	0	444	311	1000
Livestock (milk and milk products selling)	3611	2844	611	21111	2111	2477.5
Income from hiring out bullocks	0	222	0	0	0	111
Income from selling sheep, goat, chicken, meat, eggs etc.	1172	729	378	4356	775	2542.5
Selling of water for agriculture purpose	0	0	0	67	0	33.5
Selling CPR (firewood, fruits, stones, and mats etc)	0	0	0	0	0	0
Selling handicrafts (specify)	0	0	0	0	0	0
Rental income (tractor, auto, sprayer, & truck etc.)	2444	133	1600	0	2022	66.5
Rent from land, building and machinery etc.	0	0	0	0	0	0
Caste occupations (specify)	0	0	0	0	0	0
Business (specify)	12222	9667	5667	23295	8944.5	16481
Regular salaried jobs (Govt./private)	82061	39956	82167	35111	82114	37533.5
Out migration	6111	5000	0	0	3055.5	2500
Remittances	0	0	0	0	0	0
Interest on savings and from money lending	0	0	0	0	0	0
Cash and kind gifts including dowry received	0	0	0	0	0	0
Pension from employer	10233	7511	7422	0	8827.5	3755.5
Government welfare/development Programs	0	0	0	0	0	0
Grand Total	2,50782	1,13407	1,69839	1,30629	2,10310.5	1,12518

Consumption expenditure of sample farmers, 2011-12 (Rs/Year)

Among Non-food items, the people of Bhagalpur district were found to have lowest expenditure in both control (42020.0**)** compared to adopted villages (55477.9) Whereas data pertaining to expenditure on total Non-food items by samples of Banka districts was comparatively higher (88688.4)in both adopted and control village(58609.1).Among food items, expenditure on cereal was found highest in control villages while the expenditure on milk and milk products, fruits and vegetables and pulses was higher in adopted villages. It may further be observed that income and expenditure of adopted villages as whole was comparatively higher than control village. The people

of adopted villages are more prosperous than control villages, which is in line with the fact that they were found to have better equity or net worth and less liability and more profit oriented.

Table13.Consumption expenditure of sample farmers, 2011-12 (Rs/Year)

Food item	Bhagalpur		Banka		pooled	
	Adopted	Control	Adopted	Control	Adopted	Control
Cereals	16949.4	18594.4	17619.7	18511.1	17284.6	18552.8
Pulses	6607.2	6343.3	7181.0	7053.8	6894.1	6698.6
Milk and Milk products	9408.3	10425.6	14180.1	6850.0	11794.2	8637.8
Edible oils	3570.0	3653.3	4913.3	4511.1	4241.7	4082.2
Non-Veg. foods	4793.3	6477.8	8110.0	1306.7	6451.7	3892.2
Fruits and vegetables	4097.6	5780.1	7026.2	1282.2	5561.9	3531.1
Others	4895.1	5441.9	6606.8	1316.9	5750.9	3379.4
Total food expenditure	**50321.0**	**56716.4**	**65637.2**	**40831.8**	**57979.1**	**48774.1**
Health	5656.7	9055.6	21450.0	14266.7	13553.3	11661.1
Education	29437.8	15315.6	40802.2	23822.2	35120.0	19568.9
Entertainment and travel	1873.3	1191.1	2184.4	1244.4	2028.9	1217.8
Clothing and shoes	9012.2	9022.2	14583.3	11500.0	11797.8	10261.1
Ceremonies	0.0	11.1	0.0	322.2	0.0	166.7
Alcohol and Cigarettes	602.2	1006.7	302.4	394.4	452.3	700.6
Cosmetics	3242.2	2760.0	3918.9	3217.8	3580.6	2988.9
Others	5653.4	3657.8	5447.1	3841.3	5550.3	3749.6
Total Non-food	**55477.9**	**42020.0**	**88688.4**	**58609.1**	**72083.2**	**50314.6**
Total expenditure	**105798.9**	**98736.4**	**154325.6**	**99440.9**	**130062.2**	**99088.6**

Source of Information for adoption of pulse technology

We tried here to analyze the source of information for adoption of new seed, fertilizer management, pest management and disease management in pulse crop, because it involves different kinds of operation which is required to be performed for getting optimum yield. However, the farmers do not carry out the operations uniformly because different farmers have different level of technical knowledge and resources in possession and have different needs. Therefore adopting these practices may invariably be different from farmer to farmer. To analyze the sources of information for different purpose, the proportion of sample farmers who adopted a particular operation by getting knowledge from above mentioned operations has been worked out and presented below

Table 14.Sources of information to sample farmers in 2011-12								
Sources of information	New seed/cultivar		Fertilizer management		Pest management		Disease management	
	A	**C**	**A**	**C**	**A**	**C**	**A**	**C**
Input-dealers	3	2	3	3	4	3	4	3
Research station	2	5	2	2	2	1	2	1
Extension staff	6	7	4	7	3	4	3	4
T.V/Radio	5	4	6	4	5	5	5	5
Magazines/News paper	7	6	7	6	7	7	6	7
Fellow farmers	1	1	1	1	1	2	1	2
Friends/relatives	4	3	5	5	6	6	6	6

Note: 1 means highest importance and larger the number least important it is in terms of farmers consultation for the source of information of cultivars and agriculturalpractices related information.

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As shown in table 14, despite of the KVK research station being located nearby from the farmers' settlement, The surveyed farmers have not given top priority to the research station for agricultural related information and chickpeas cultivar choices; but they have given top priority to fellow farmers (highest rank), followed by friend and relatives (2nd highest rank), and then to input dealers (3rdrank).

Table 15. Sources of information in Banka district, 2011-12 (Wt.scale)

Sources of information	New seed/cultivar		Fertilizer management		Pest management		Disease management	
	A	C	A	C	A	C	A	C
Input-dealers	2	4	3	4	4	4	4	4
Research station	4	2	4	3	3	2	3	1
Extension staff	3	3	2	2	2	3	2	3
T.V/Radio	6	6		6	6	6	6	5
Magazines/News paper	7	7	6		5	5	5	
Fellow farmers	1	1	1	1	1	1	1	2
Friends/relatives	5	5	5	5	7		7	

For Banka, almost similar pattern had been followed as fellow farmers has been ranked 1st followed by research station and extension staff for New seed except control village for pest management, they were found to give top priority to the research station.

It may be concluded that majority of farmer's rely on fellow farmers for getting any information or package of practices for raising the crop. This finding clearly indicates that proportion of farmers approaching research station to meet their seed requirement was quite low for chickpea production, which also indicates the poor extension service in this respect.

Crop yield of chickpea

Productivity of chickpea by varieties in sample districts during the year 2011-12 kg/ha has been presented in the following table.

Table: 16. Productivity of Chickpea by varieties in Bihar sample, 2011-12 (kgper ha)

Variety	Bhagalpur		Banka		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
Deshla Roon	732.77	741.00	946.83	900.35	848.03	890.70
Desla Plain	668.66	626.32	776.09	638.08	702.53	627.11
JG 14	790.40		1042.34		1000.35	
KAK 2	988.00		806.87		832.74	
Radha	864.50	494.00		671.84	1010.45	630.80
Subhara	839.80			370.50	790.40	370.50
Vaibhav	699.83				699.83	

Economic analysis of chickpea cultivation

An economic analysis of an activity provides rich information on farmers' intensions and incentives pursued for using particular activity. Economic analysis of cultivation of crops thus provides vital information on why farmers grow particular crop and which crop is most remunerative in a location. A summary version of information pertaining to cost of cultivation and input output ratio associated with growing chickpea at different locations has been presented in Table 17 below. The net return obtained from chickpea was estimated as Rs 6000 to 20,000 /ha in the sample surveyed village among the sample farmers. This indicates that the comparative advantage from chickpea was better than many of the competing crop like wheat, as indicated in table (returns from different crops), especially with the environment of in adequate irrigated areas. By and large, pulses crop are more remunerative crop for Banka rather than Bhagalpur, however there is no distinct different across the farmers. Due to low crop yield, and even some of the farmers from control village growing improved cultivar of chickpeas due to farmers to farmers transfer of knowledge, and seeds in the area.

Table 17.Economic costs for growing cultivar types in the sample farms, 2011-12 (Rs per ha)

Factors					Sample Average (Pool Data)		Average of all 4 sample (Adopter + Control)
	Bhagalpur District		Banka District				
	A 1	C1	A2	C2	Adopter	Control	All Sample
1. Total production cost/ha	17042	14132	11721	14774	14382	14453	14417
2. Grain yield (kg/ha)	978	596	595	1006	787	801	794
3. Grain price/kg	30	30	30	30	30	30	30
4. **Value of Grain**	29340	17880	17850	30180	23595	24030	23813
5. Fodder yield (kg/ha)	978	596	595	1006	787	801	794
6.Fodder price/kg	5	5	5	5	5	5	5
7 Value of fodder	4890	2980	2975	5030	3933	4005	3969
8. Gross Income per ha	34230	20860	20825	35210	27528	28035	27781
9. Net profit per hectare	17188	6728	9104	20436	13146	13582	13364
10. Benefit cost raio	1.72	1.27	1.52	2.04	1.62	1.65	1.64

Overall, when the benefits from all of the farmers' types and location are combined, then the overall benefit and cost ratio of chickpeas in the survey site is 1.64. This is fairly higer than many of other crops cultivated in the areas. Detailed results are in Tables 17.

8 Constrains and prospects of chickpea production

Many problems or constraints were observed on sample farms, which were pooled into fallowing categories namely, low yield, pest and disease, long duration, small grain size, lack of technical knowledge, low market price or pulse production being not profitable etc. The constraints involved in chickpea production were identified and ranked according to weighted mean scale or in form of proportion of farmers who given priority for that observed occurrence of the problem on their farm and the results have been presented below.

Table 18. Major Constraints among cultivars (Wt. Scale)

Constraints	Bhagalpur		Banka	
	Local(d.p)	Local(d.r)	Local	Improved
Low yield	1st		1st	2nd
High pod borer incidence	2nd	1st	2nd	1st
High disease incidence		3rd	3rd	3rd
Long duration				4th
Small grain size	5th		4th	
Not attractive colour	4th	2nd		
Poor taste		5th		
Low recovery of dal (%)				
Low market price	3th			
Not fit into cropping system		4th	5th	
Poor fodder quality				
Susceptible to storage pest				5th

The findings clearly indicate that major constraints among cultivar in Bhagalpur for local variety was low yield followed by high pod borer incidence, low market price, having no attractive color and small grain size was ranked 1st, 2nd 3rd, 4th and 5th respectively. As far as the improved varieties were concerned high pod borer incidence followed by not having attractive color, High disease incidence, not fitting into cropping system and poor taste were given the 1st 2nd, 3rd, 4th and 5th accordingly.

In Banka district, the major constrains in order of importance were low yield, high pod borer incidence, high disease incidence, small grain size and low recovery of dhal percentage as 1st, 2nd, 3rd, and 5th rank respectively for local variety and high pod borer incidence followed by low yield, high disease incidence, long duration& not fitting into cropping system as 1st, 2nd, 3rd, 4th, and 5th accordingly for improved variety by the respondents.

Thus it may be concluded that major constraints among cultivar was the pest and disease for improved variety and Low yield was the main problem for local varieties of chickpea production among selected farmers of both districts in Bihar.

9 Conclusions and Implications

Chickpea is one of the major pulse crops in Bihar. The area under chickpea has declined from 2.45 lakh hectare in 1975-76 to 0.56 lakh hectare in 2011-12, although productivity has increased from 550 kg/ha to 1000 kg/ha during the same period. Decline in area of chickpea was mainly due to insecure harvest of crop in isolated pockets due to social factor. Heavy losses in production of chickpea due to insect's infestation mainly pod borer, socio-economic constraints, problems of market, lack of improved varieties etc. Among variety distributed to the farmers JG 14, KAK 2 and Subhra are most acceptable variety in the farmer's field in both of the districts in Bihar. However poor germination, non-suitability into cropping pattern, post-harvest losses due to rat attack, etc., are some of the major farmers' level problems which hinders them for expansion of its crop acreages.

The productivity of improved variety ranged in between 850 kg to 1000kg/ha in selected district under study. However the cost of cultivation/ha has been estimated Rs. 18280to 19200/ha. Relative importance of chickpea in the total cropped area has also been declined. However, profitability of chickpea is comparatively more than others Rabi crop. Regarding local variety, one of the major setbacks is that the farmer from 20 to 25 years has not replaced it. Most preferred traits for production consumption and marketing in Bihar is that those varieties which gives higher yield ranked 1st for production and fetching high price along with having high demand and better taste with good keeping quality ranked accordingly for consumption and marketing purpose. Local variety is the only reliable for consumption and production purpose.

Major constraints for growing chickpea in Bihar are unavailability of suitable HYV of crop, erratic rainfall causes moisture stress in the post monsoon season, increasing incidence of disease and insect infestation, etc. Recently, consumption of chickpeas has gone up but this has not been reflected in the wholesale prices in the local communities. To increase area and production of chickpea in the study locations in Bihar, region specific approaches and prioritization may need be give, and chickpea adoption needs to be considered within the farming systems of the crop choices of the farmers. Since, recently the rice and wheat crop acreage have been in increasing trend, and majority of farmers opt for cultivation of wheat in the post-monsoon season after rice; instead of chickpeas and other crops, especially when the irrigation is available at assured source. This is due to relatively low level of crop yield of chickpeas than wheat and other crops.

Policy implications

Following policy recommendations have emerged out of the empirical analyses carried out above.

(i) Replacement of traditionally grown varieties with high yielding varieties.
(ii) Inclusion of short duration varieties of chickpea as catch crop.
(iii) Improving market information system and infrastructure.
(iv) Linking MSP to market price can bridge the gap between demand and supply.
(v) Co-ordination of research extension and farmers to encourage farmer's participatory research etc.

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Tropical Legumes II Phase 2 Project

Targeting and introduction of Groundnut improved cultivars in Odisha state of India

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Targeting and introduction of Groundnut improved cultivars in Odisha state of India

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1. Introduction

Groundnut is the major oilseed crop in India grown in an area of 4.93 m ha during 2010 (FAOSTAT, 2012). It contributes about 30% to the edible oil basket of the country. The South Asia has more than 7 million ha (31% of world total) under groundnut, roughly 83% of this is in India. The country has lost 4.62 m ha of groundnut area to other competing crops like soybean, maize and Bt. cotton during the last decade at an annual rate of 3.48% mainly because of cheaper imports of other edible oils, which depressed groundnut prices. Though productivity of groundnut was increased by 2.14% during the period, production declined at the rate of 1.14% annually.About 85% of the total groundnut area in the country is sown in the rainy season. Being a rainfed crop, the yield variability across both, growing regions and years is high. The instability measure (CV) was higher in the case of productivity than in the case of area in all the sub-periods (Table-1.1).

Table 1.1 Area, Production and productivity of groundnut in India, 1981-2010

Statistics	Area ('000 ha)	Production ('000 tons)	Productivity (kg/ha)
Mean			
1981-1990	7585	6815	898
1991-2000	7605	7578	996
2001-2010	6096	6894	1131
1981-2010	7095	7095	1000
CV (Raw data)			
1981-1990	8.96	20.54	13.24
1991-2000	8.75	14.83	13.44
2001-2010	6.63	23.64	21.54
1981-2010	12.97	19.66	19.48

Source : Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India

1.1 Status of groundnut in major producing states

Andhra Pradesh, Karnataka and Maharashtra states produce more than 75 % of the total groundnut output in the country.Gujarat ranks first as far as area under groundnut is concerned in the country. Though productivity of groundnut in Gujarat increased from 750 kg/ha during 1980-89 to 1219 kg/ha in 2000-09, the area remained stagnant (Table 1.2). In Andhra Pradesh, groundnut area fluctuated during the different decades. However, productivity remained almost stagnant over the three decade period. Karnataka also exhibited a similar trend with regard to the total cultivated area of groundnut and declining productivity. Tamil Nadu and Maharashtra also suffered erosion of area under groundnut during the last decade, despite increasing productivity. It is observed that the productivity varies widely among the states and is dependent on factors like soil fertility, coverage

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of irrigation under the crop and the season when it is grown. The instability indices computed for decadal sub-periods at the state level implied that the variability is greater in case of productivity than in case of the area and is mainly because of majority of the area under groundnut being rainfed.

Table 1.2 Area, production and productivity of groundnut in major states (1980-2009) and instability measures (Area in '000 ha and productivity in kg/ha).

Year	Gujarat		AP		Karnataka		Tamil Nadu		Maharashtra		Rajasthan	
	Area	Pdty	Area	Pdty	Area	Pdty	Area	Pdty	Area	Pdty	Area	Pdty
1980-89	1916	750	1736	855	951	820	968	1105	766	889	218	691
1990-99	1900	920	2182	892	1213	835	988	1529	622	1101	266	952
2000-09	1898	1219	1645	838	893	680	563	1830	409	1072	273	1329
1980-09	1905	963	1854	862	1019	778	840	1488	599	1021	252	991
CV (Raw data)												
1980-89	18	53	20	14	21	12	10	12	12	19	16	36
1990-99	5	45	11	22	7	16	13	16	19	14	15	30
2000-09	5	48	14	33	11	22	16	13	14	9	17	15
1980-09	11	52	19	23	19	25	27	24	29	17	19	26

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India

1.2 Groundnut in the state of Odisha

Groundnut constituted 33% of the total oilseed acreage in the state of Odisha contributing more than 65% of the total oilseeds produced in the state during the triennium ending 2011-12.In Odisha, groundnut is grown both in rainy as well as post rainy seasons. Area under rainy season groundnut comprises 34 % as compared to 66% post rainy season and is mostly rainfed.

Table 1.3 Area, Production and Productivity of groundnut in Odisha, 1980 to 2012

Statistic	Area ('000 ha)	Production ('000 tons)	Productivity (kg/ha)
Mean			
1980-1990	302.2	398.3	1318
1990-2000	312.3	412.0	1319
2000-2012	236.1	368.7	1562
1980-2012	279.2	390.8	1400
CV (Raw data)			
1980-1990	15.1	15.7	7.9
1990-2000	9.3	22.0	14.8
2000-2012	9.1	21.5	14.2
1980-2012	12.7	19.3	14.8

Source: Odisha Agricultural Statistics

Area under groundnut during the period 1980-90 was 302.23 thousand ha which declined by almost 22% to 236.11 thousand ha during 2000-12 (Table 1.3). Production however, declines only by 7% from 398.31 thousand tons to 368.75 thousand tons during the period mainly because of increase in yield from 1318 kg/ha to 1562 kg/ha. Decline in area is mainly attributed to climatic aberrations and early cessation of rainfall and non availability of groundnut seeds immediately after harvest of autumn rice. Nineties and the last decade experience slight higher yield variability mainly because

of higher frequency of drought during the post rainy season.The groundnut productivity in Orissa is quite high as compared to national average but there is scope for further increase. The climate of Orissa is conducive for groundnut. The availability of seed in Rabi(post rainy season) is the major hindrance for the farmers.

Majority of the groundnut varieties being grown in the country are quite old and are susceptible to both biotic and abiotic stresses. The TL-II program is targeting the popularization of newly released stress tolerant varieties and efficient seed delivery mechanism so as to enable the groundnut farmers to raise the yield at a higher front. ICRISAT initiated TL-II project in Odisha during 2012-13 to take concrete steps in releasing some promising groundnut varieties conducive to growing conditions in the state. A baseline survey was undertaken in this project with the following objectives: 1. To study the current status of groundnut crop in the state of Odisha; 2. To examine the socio-economic profile of the groundnut farmers in the studied area; 3.To find out the importance of groundnut in the area allocation by farmers; and 4. To investigate the level of adoption of modern varieties, productivity level, profitability, preferred traits of groundnut crop etc.

2. Methodology

2.1 Sample framework

In Odisha, two districts were selected by the breeders to implement the TL-II project. One was based on highest area during post-rainy season (Jajpur) and another having substantial area both under rainy as well as post-rainy season i.e., Dhenkanal. There are hardly any competing crops in Jajpur for groundnut during post-rainy season. In Dhenkanal, similar observation is also made. Area under groundnut in Jajpur is hovering around 32 thousand ha (Table 2.1). Production increase was observed mainly because of yield increase. In contrast to Jajpur, area under groundnut in Dhenkanal district declined sharply from 20.55 thousand ha during the triennium ending 1998 to 11.63 thousand ha during the last triennium though production remains same around 20 thousand tons because of increased productivity from 974 to 1725 kg/ha.

Table 2.1: Area, production and productivity and instability indices of Groundnut in sample districts of Jajpur and Dhenkanal

Triennium ending	Jajpur			Dhenkanal		
	Area ('000 Ha)	Production ('000 tons)	Yield (kg/ha)	Area ('000 Ha)	Production ('000 tons)	Yield (kg/ha)
1998	31.18	33.62	1078	20.55	20.02	974
2003	33.21	46.62	1404	16.06	17.58	1095
2009	31.92	59.58	1867	12.07	18.42	1525
2012	32.04	56.33	1758	11.63	20.06	1725
CV(Raw data)						
1995-2000	8.72	46.38	43.56	2.18	24.60	25.16
2000-2012	2.58	19.28	19.57	16.66	15.75	21.71
1995-2012	4.98	29.70	28.80	24.14	19.16	25.74

High groundnut yield variability was observed in case of Jajpur during the period 1995-2000 because of severe drought in 1996 and also due to super cyclone in 1999. In Dhenkanal, area variability was substantially high during the period 2000-12 (Table 2.1)

Table 2.2 lists the sampling design which depicts the villages where TL-II program was implemented. In each of these two districts, three villages were selected for intervention and were designated as 'adopted' villages and three control villages where no such intervention was made. All together 180 groundnut farmers were selected randomly from among the groundnut growers in the treated villages at the rate of 30 respondents per village. Similarly 90 farmers were selected from among the control villages @ 15 farmers per village.

Table-2.2: Sample villages for baseline survey under TL-II Project in Odisha

Districts	Treatment/ Adopted village	No. of farmers	Control village	No. of farmers	Total
Jajpur	Nosta	30	Swainsahi	15	135
	Udaynagar	30	Bhagwanpur	15	
	Radhadeipur	30	Saboo	15	
Dhenkanal	Nuagaon	30	Kotpala	15	135
	Mandapal	30	Sananagana	15	
	Thakurpala	30	Kaluriapatna	15	
Grand Total		180		90	270

In Jajpur district, among the respondent farmers, 90% belongs to marginal and small in the adopted villages whereas, in Dhenkanal district, these categories constituted 71%. In case of control villages, 84% of the farmers are from the marginal and small categories in Jajpur whereas, these categories together represented 87% in Dhenkanal district (Table 2.3).

Table 2.3: Distribution of groundnut sample farmers among different categories, 2011-12

Category	Jajpur		Dhenkanal		Pooled sample	
	Adopted	Control	Adopted	Control	Adopted	Control
Marginal	42 (46.67)	20(44)	23(25.56)	12(27)	65(36.12)	32(36)
Small	39(43.33)	18(40)	41(45.56)	27(60)	80(44.44)	45(50)
Large	9(10)	7(16))	26(28.88)	6(13)	35(19.44)	13(14)
Total	90(100)	45(100)	90(100)	45(100)	180(100)	90(100)

(Figures in the parentheses represent percentages to the column total)

2.2 Analytical techniques: In this study, tabular analysis was adopted to compile the general characteristics of the sample farmers, the resource structure, cost structure, returns, profits and opinions of farmers regarding the problems in production and marketing. Simple statistics like averages and percentages were used to compare, contrast and interpret results in an appropriate way. To analyze and study the traits preferred in chickpea cultivars by the farmers, weighted average ranking method was used.

3. Results and discussions

3.1 Socio-economic profile of sample farmers

The survey was conducted immediately after the cropping season of 2011-12 to minimize recall bias. The baseline survey dealt with several findings: the socioeconomic profile, assets and liabilities, sources of income and details of consumption expenditure, cropping pattern, varietal composition, yield levels and economics of groundnut cultivation, sources of information about technology, trait preferences and gender issues.

Table 3.1: Socio-economic profile of sample farmers in groundnut, 2011-12

Socio-economic Issue	Jajpur		Dhenkanal		Pooled	
	A	C	A	C	A	C
Male headed households (%)	100	100	100	100	100	100
Household size (No)	6.06	8.82	6.07	6.18	6.06	7.5
Male workers(no)	2.2	4.7	2.5	3.4	2.4	2.7
Female workers (no)	0.3	0.3	0.1	0.4	0.2	0.2
Dependency ratio*	1.38	1.66	1.33	1.46	1.36	1.58
Age of household head (years)	52	57	52	48	52	53
Education Level of household head (no. of years)	6	7	6	5	6	6
Participation in local bodies (%)	1.11	6.67	5.56	4.44	3.33	5.56
Proportion belonging to forward castes (%)	56	40	4	Nil	30	20
Proportion belonging to religious minorities (%)	Nil	Nil	Nil	Nil	Nil	Nil
Proportion with agriculture as the main occupation (%)	35.6	42	48	78	41.8	60
Proportion with business/service as secondary occupation (%)	6.7	11.1	12.2	20.0	9.5	15.5
Ownership of two wheelers/bicycles (%)	91	96	96	93	93	94
Ownership of television sets (%)	61	73	44	60	53	67
Ownership of mobilephones(%)	87	91	84	98	86	94
* Dependency ratio= (Size of family-Number of workers)/Number of workers A: Adopted village; C: Control village						

All the sample households are patriarchal, irrespective of adopted or control villages in both the districts. Average household size was 6 in case of adopted villages whereas it stood at 7.5 in case of control villages. Farming activities are highly dominated by male workers in both the districts. Dependency ratio in case of adopted villages was estimated at 1.36 whereas, for control villages it was found to be 1.58. Average age of the household head was about 52 to 53 years in the studied villages and the education level was up to the 6^{th} level. Among the respondent farmers, poor participation in the local bodies was observed. About 42and 60 % of the farmers had farming as their main profession in adopted and control villages respectively. Majority of the groundnut farmers in the adopted and control villages owned two wheelers/bicycles and mobile sets.

3.1.1 Land holding size

Average land holding was found to be higher among Dhenkanal farmers than that of Jajpur district (Table 3.2). In Jajpur, marginal, small and large farmers had operated lands of 0.67, 1.38 and 2.86 ha respectively whereas, for Dhenkanal, the land holding sizes were found to be 0.71, 1.41 and 2.53 ha respectively for marginal, small and large farmers.

Table 3.2 Average land holding size across different farm categories (ha)

District	Particulars	Irrig/dry	Marginal	Small	Large	Pooled
Jajpur	Own land	Irrigated	0.10	0.20	0.40	0.17
		Dry	0.41	0.80	1.86	0.75
		Fallow	0.00	0.00	0.03	0.01
		Total	0.51	1.00	2.29	0.93
	Leased-in land	Irrigated	0.00	0.02	0.09	0.02
		Dry	0.18	0.37	0.51	0.30
		Fallow	0.00	0.00	0.00	0.00
		Total	0.19	0.39	0.59	0.32
	Leased-out land	Irrigated	0.01	0.00	0.00	0.00
		Dry	0.01	0.00	0.00	0.01
		Fallow	0.00	0.00	0.00	0.00
		Total	0.02	0.00	0.00	0.01
	Operated land	Irrigated	0.09	0.21	0.49	0.19

		Dry	0.58	1.17	2.37	1.04
		Fallow	0.00	0.00	0.00	0.00
		Total	0.67	1.38	2.86	1.23
Dhenkanal	Own land	Irrigated	0.15	0.24	0.43	0.26
		Dry	0.52	0.82	1.53	0.91
		Fallow	0.02	0.06	0.03	0.04
		Total	0.69	1.13	2.05	1.23
	Leased-in land	Irrigated	0.02	0.05	0.16	0.07
		Dry	0.10	0.30	0.56	0.31
		Fallow	0.00	0.00	0.08	0.02
		Total	0.12	0.36	0.72	0.38
	Leased-out land	Irrigated	0.00	0.00	0.03	0.01
		Dry	0.08	0.00	0.12	0.05
		Fallow	0.00	0.01	0.03	0.00
		Total	0.08	0.00	0.17	0.06
	Operated land	Irrigated	0.17	0.29	0.56	0.32
		Dry	0.54	1.12	1.97	1.17
		Fallow	0.00	0.00	0.00	0.00
		Total	0.71	1.41	2.53	1.49

3.1.2Assets and liabilities

Land owned by the respondent farmers in Jajpur was comparatively lower than that of Dhenkanal district(Table 3.3). Higher land value in case of adopted villages in Dhenkanal district compared to that of Jajpur was mainly because of irrigated land discriminating between the two districts. Same is true for control villages, where land value of Jajpur district exceeds that of Dhenkanal district.

Table 3.3: Value of land owned by sample farmers, 2011-12 ('000 Rs/Hh)

Type of land	Jajpur				Dhenkanal			
	Adopted		Control		Adopted		Control	
	Area (ha)	Value	Area (ha)	Value	Area (ha)	Value	Area (ha)	Value
Irrigated land	0.09	57.61	0.34	258.11	0.31	326.78	0.15	121.89
Rainfed land	0.77	313.77	0.70	459.33	0.91	496.03	1.09	579.00
Others	0.01	1.83	0.01	1.56	0.01	2.50	0.00	0.00
Total land	0.86	373.22	1.05	719.00	1.22	825.31	1.24	700.90

Overall value of livestock owned by respondent farmers were found to be Rs 23900 and Rs 30100 per Hh respectively for adopted villages of Jajpur and Dhenkanal and were Rs 26200 and Rs 27900 respectively for the control villages of these districts as depicted in Table 3.4.

Table 3.4: Value of Livestock owned by sample farmers, 2011-12 ('000Rs/Hh)

Type of Livestock	Jajpur				Dhenkanal			
	Adopted		Control		Adopted		Control	
	No.	Value	No.	Value	No.	Value	No.	Value
Draft animals	0.8	12.9	1	12.9	1.9	23.3	1.51	18.0
Cows	1.02	7.8	1.22	9.5	0.84	4.6	1.07	6.0
Buffaloes	0	0	0	0	0.02	0.4	0.00	0.00
Young stock	0.87	2.9	1.09	3.4	0.98	1.8	1.11	2.1
Sheep/goat	0.37	0.4	0.13	0.4	0.04	0.1	0.89	1.7
Others	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total livestock	3.16	23.9	3.4	26.2	3.89	30.1	4.58	27.9

Value of farm implements were Rs 26820 and Rs 31170 per Hh respectively for the farmers belonging to adopted villages of Jajpur and Dhenkanal while for the control villages, the values were Rs 25860 and Rs 26180 per Hh respectively for the two types of villages(Table 3.5). Ownership of mechanized implements was found to be low among the respondent groundnut farmers irrespective of the districts.

Table 3.5: Value of farm implements owned by sample farmers, 2011-12 ('000 Rs/Hh)

Type of Implement	Jajpur				Dhenkanal			
	Adopted		Control		Adopted		Control	
	No.	Value	No.	Value	No.	Value	No.	Value
Tractor, harvesters, threshers and accessories	0.04	10.5	0.14	16.56	0.05	17.77	0.04	15.56
Electrical/diesel pump sets	0.12	1.38	0.35	2.55	0.23	3.37	0.09	1.44
Bullock drawn tools	3.68	3.81	4.24	3.82	4.31	9.92	3.73	9.18
Trucks & others	0.01	11.11	0.02	2.67	0	0	0	0
Others tools	0.03	0.024	0.38	0.24	0.12	0.099	0	0
Total farm implements	3.88	26.82	5.13	25.86	4.71	31.17	3.86	26.18

Value of consumer durables owned by respondent farmers was found to be higher in case of Dhenkanal than that of Jajpur irrespective of adopted and control villages as observed in Table 3.6.

Table 3.6: Value of Consumer durables owned by sample farmers, 2011-12 ('000 Rs/Hh)

Type of Consumer durables	Jajpur				Dhenkanal			
	Adopted		Control		Adopted		Control	
	No.	Value	No.	Value	No.	Value	No.	Value
Residential house	-	184.47	-	263.00	-	270.56	-	277.89
Cattle shed	-	7.40	-	6.68	-	7.15	-	5.12
Cycle/two-wheelers	1	9.86	1.13	18.84	1.15	12.54	1.07	9.27
Others	2	6.88	2.4	8.73	1.81	6.08	2.35	9.05
Total consumer durables	3	208.60	3.53	297.26	2.96	296.32	3.42	301.33

3.1.3 Source of finance among the respondent farmers of sample districts

Multiple sources of finance are available to the farmers in both the districts and farmers avail finance from these sources which and when becomes more conducive. In case of Jajpur district, input traders were found to be major source of financing farming with high interest rate of 34.5% and about 73% of the farmers availed this opportunity followed by cooperative banks and nationalized banks, both of which are available at low interest ranging from 5 to 12% as seen in Table 3.7. In case of Dhenkanal, cooperatives loan are availed mostly by the groundnut farmers constituting about 74% of the farmers followed by moneylenders, from whom, around 64% of the farmers borrowed at exorbitant interest rate of 36%. Also about 31% of the farmers in Dhenkanal took loan from nationalized banks.

Table 3.7 Source of finance across sample districts (% Hh availed)

Source of loans	Jajpur	Interest rate (%)	Dhenkanal	Interest rate (%)
Co-operatives	35.0	5	74.1	5
Nationalized banks	15.00	12	31.1	12.3
Private banks			0.74	15
NGOs/SHGs	1.5	30	5.1	24
Friends/relatives	4.4	10	4	12
Input Traders	72.6	34.5	4	36
Moneylenders	8.1	35.54	64	36

3.1.4 Financial liabilities and assets of sample farmers

Overall it is observed in Table 3.8 that net liabilities were higher in case of Dhenkanal than that of Jajpur district. It was found to be Rs 26000 and Rs 43540 respectively for adopted villages of Jajpur and Dhenkanal districts whereas, for control villages the values were Rs 34000 and Rs 41000 respectively for the two districts. Though savings was found to be much more in case of farmers of the adopted villages of Dhenkanal district, the borrowings was higher at Rs 54000 per Hh.

Table 3.8: Financial liabilities and assets of sample farmers, 2011-12(Rs '000 per Hh)

Financial Liabilities and Assets	Jajpur		Dhenkanal	
	Adopted	Control	Adopted	Control
Borrowings (-)	29.009	38.133	54.072	46.822
Lending's (+)	0	0	0	0
Savings (+)	2.9956	4.111	10.532	5.709
Net Liabilities	26.03	34.022	43.54	41.179

3.1.5 Net worth of sample groundnut farmers

Net worth of sample farmers of adopted villages of Jajpur district was found to be low at Rs 606.54 thousand per Hh as compared to its control villages mainly due to lower land area i.e., 0.86 ha which these farmers possess and consequently low value of land and thus low net worth(Table 3.9).

Table 3.9: Net worth of sample farmers, 2011-12 (Rs '000 per Hh)

Assets and Liabilities	Jajpur		Dhenkanal	
	Adopted	Control	Adopted	Control
Value of Land	373.22	719.00	825.31	700.9
Value of Livestock	23.93	26.19	30.14	27.91
Value of Farm Implements	26.82	25.86	31.17	26.18
Value of Consumer durables	208.6	297.26	296.32	301.33
Total Assets	632.57	1068.31	1182.94	1056.32
Net Liabilities	26.03	34.02	43.54	41.18
Net worth	606.54	1034.29	1139.4	1015.14

3.1.6 Income and expenditure of sample farmers

3.1.6.1 Net household income

In case of adopted villages of Jajpur district, bulk of the income came from farming which stood at Rs. 48580 per Hh (Table 3.10) followed by salaried job (Rs. 28160), non-farm labour income(Rs.10220), remittances (Rs. 10000), business(Rs. 8400) and farm labour income(Rs.6010) . However, in case of adopted villages of Dhenkanal, though still farming contributed the major chunk of the income which stood at Rs. 44320, nonfarm farm labour income was the second most important source of income at Rs. 20600 followed by salaried job (Rs.13270), business(Rs.7940) and farm labour income(Rs.5340). Among all the categories of respondent farmers, highest net household income of Rs 166160 was observed to be with the farmers of control villages in Jajpur district.

Table 3.10: Net household income of sample farmers, 2011-12 (Rs '000 per Hh)

Source of income	Jajpur		Dhenkanal	
	Adopted	**Control**	**Adopted**	**Control**
Income from crops	48.58	65.07	44.32	48.66
Farm work (labor earnings)	6.01	4.60	5.34	5.34
Non-farm work (labor earnings)	10.22	4.64	20.60	17.51
Regular Farm Servant (RFS)	0.00	0.00	0.00	0.00
Livestock (milk and milk products selling)	2.03	3.27	1.19	0.67
Income from hiring out bullocks	0.00	0.00	0.00	0.40
Income from selling sheep, goat, chicken, meat, eggs etc.	0.06	0.00	2.23	1.42
Selling of water for agriculture purpose	0.00	0.00	0.08	0.00
Selling CPR (firewood, fruits, stones, mats etc)	0.00	0.00	0.00	0.04
Selling handicrafts	0.00	0.00	0.00	0.00
Rental income (tractor, auto, sprayer, truck etc.)	0.00	0.00	1.50	2.67
Rent from land, building and machinery etc.	0.00	0.00	0.00	0.00
Caste occupations	0.00	0.00	0.00	0.00
Business	8.40	13.93	7.94	4.07
Regular salaried jobs (Govt./private)	28.16	54.53	13.27	17.04
Out migration	0.67	0.00	1.33	0.00
Remittances	10.00	10.09	1.92	8.44
Interest on savings and from money lending	0.00	0.00	0.00	0.00
Cash and kind gifts including dowry received	0.00	0.00	0.00	0.00
Pension from employer	2.19	7.56	0.67	0.08
Government welfare/development Programs	1.97	2.07	1.34	1.42
Others 1	1.03	0.40	2.56	1.40
Grand Total	119.31	166.16	104.30	109.17

3.1.6.2 Consumption expenditure of respondent groundnut farmers

Expenditure on food items was lower among the groundnut farmers in the adopted villages of Jajpur district than that of Dhenkanal district though both had the same household size as observed in Table 3.11. However, in case of control villages of Jajpur, food item expenses surpassed that of Dhenkanal because of higher household size. As incase of food item expenses, non food item expenditure was also in higher side in the adopted villages of Dhenkanal than that of Jajpur. Overall, the total consumption expenditure for adopted villages was Rs. 71583 and Rs. 85910 respectively for Jajpur and Dhenkanal and Rs. 100240 and Rs. 92345 respectively for the control villages of the two districts.

Table 3.11: Consumption expenditure of sample farmers, 2011-12 (Rs/Hh/Year)

Food item	Jajpur		Dhenkanal	
	Adopted	Control	Adopted	Control
Cereals	14107	21505	17120	17810
Pulses	2537	3786	3519	3708
Milk and Milk products	4286	5752	4016	3167
Edible oils	1731	2187	1875	1966
Non-Veg. foods	3223	4904	4288	4476
Fruits and vegetables	5876	6474	6728	6322
Others	5685	6789	7338	6646
Total food expenditure	37445	51398	44883	44095
Health	4778	6956	6000	10100
Education	4528	10644	7939	11144
Entertainment and travel	5080	8016	4211	4644
Clothing and shoes	5500	7100	5239	5678
Ceremonies	7544	8222	10128	9711

Alcohol and Cigarettes	267	0	200	67
Cosmetics	2429	2311	1723	1700
Others	4013	5593	5588	5206
Total Non-food	34138	48842	41027	48250
Total expenditure	71583	100240	85910	92345

3.2 Cropping pattern and importance of groundnut

The relative importance of groundnut in the cropping pattern among the sample farms is presented in Tables 3.12.

3.2.1 Kharif area allocation

Kharif season is dominated by rice crop in both the districts. The rice area per household among the farmers in the adopted villages varied between 1.15 ha for Jajpur district to 1.26 ha for Dhenkanal, whereas, for control groups, it was 1.18 and 1.02 ha respectively for Jajpur and Dhenkanal. However, a very little area allocation was observed for kharif groundnut in Dhenkanal district which varied between 0.08 ha in case of adopted villages to 0.05 ha in case of control villages.

3.2.2 Rabi area allocation

During rabi, area allocation under groundnut was higher in Jajpur both in case of adopted as well as control villages which stood roughly at 0.9 ha per Hh. Apart from mung bean, all other crops like black gram, horse gram, vegetables were minor crops in Jajpur. In Dhenkanal, though groundnut is the main crop among the groundnut farmers, area allocation is low at around 0.6 ha per Hh as compared to Jajpur. Mung bean was the second most important crop during the Rabi season. However, it is not a competing crop with groundnut as it requires heavier soil than that of groundnut.

Table 3.12 Average cropping patterns across study districts (ha per Hh)

Crops	Jajpur		Dhenkanal	
	Adopted	Control	Adopted	Control
Kharif (Rainy) season area allocation				
Rice	1.15	1.18	1.26	1.02
Jute	0.01	0.07	0	0
Groundnut	0	0	0.08	0.05
Pigeon pea	0	0	0.02	0.00
Vegetables	0.001	0.071	0.01	0
Rabi(post-rainy) season area allocation				
Groundnut	0.90	0.91	0.61	0.59
Mung	0.08	0.31	0.28	0.06
Blackgram	0.14	0.02	0.03	0.09
Horsegram	0.02	0.04	0.01	0.04
Gram	0	0	0	0.0007
Vegetables	0.003	0.04	0.0004	0.0007
Rice	-	-	0.0007	-
Summer season area allocation				
Mung	0.02	-	-	-
Vegetables	0.0009	0.004	-	-
Annual crops				
Sugarcane	0.01	0	0.02	0.16
Banana	-	0.0001	-	-

Apart from kharif and Rabi area allocation, few farmers in adopted villages of Jajpur had mung bean and vegetables during summer. Also farmers in Dhenkanal district had grown sugarcane both in adopted as well as in control villages. Sugarcane area allocation was highest at 0.16 ha per Hh in case of control villages of Dhenkanal district.

3.1.8 Importance of groundnut in sample farmers

Groundnut is grown in both kharif and rabi season in Dhenkanal district irrespective of adopted and control villages. However, during kharif season, groundnut is planted in the uplands and is highly infested with weeds and has very low yield. In Jajpur, groundnut is solely grown in post rainy season with available moisture in the soil. It is mostly planted after the harvest of autumn paddy during 4th week of October to 1st week of December in Jajpur whereas, in Dhenkanal, post-rainy season groundnut is planted during 1st week of December to the last week of December. In Jajpur, 38.5% of the total cropped area was under groundnut crop in the adopted villages while, it was 29.69% in case of Dhenkanal. In the control villages, groundnut cropped area were 34.34 % and 31.45 % respectively for Jajpur and Dhenkanal districts. Overall, groundnut cropped area were 34.11% and 33.09% respectively for adopted and control villages under study (Table 3.13).

Table 3.13: Relative importance of groundnut crop in the cropped area, 2011-12

Cropped area	Jajpur		Dhenkanal		Pooled Sample	
	A	C	A	C	A	C
Rainy season cropped area (ha)	104	59.25	123.07	48.09	227.07	107.34
Post rainy season cropped area (ha)	102.87	59.57	84.05	35.97	186.91	95.54
Annual and Summer crops	3.08	0.251	1.92	7.13	5.00	7.38
Area under rainy season groundnut (ha)	0	0	6.93	2.07	6.93	2.07
Area under post- rainy season groundnut area post rainy area (ha)	80.84	40.89	55.08	26.50	135.92	67.39
Proportion of groundnut area to total cropped area (%)	38.50	34.34	29.69	31.45	34.11	33.09

3.3 Productivity levels of major crops

Among the crops grown in the studied villages, sugarcane yield was 91884 kg/ha in the adopted villages of Jajpur district whereas, its yield ranged between 73889 kg/ha in case of control villages in Dhenkanal district to 87284 kg/ha in case of adopted villages. Rice is the most important crop in the kharif season in both the district. However, the crop is subjected to frequent flooding during the crop growth stage. During kharif, 2011, massive flood washed away the rice crop in Jajpur district irrespective of adopted and control villages. So the yield was too low at 262 kg/ha and 576 kg/ha respectively for adopted and control villages. However, for Dhenkanal district, yield of rice varied from 2673 kg/ha in case of control villages to 2895 kg/ha for adopted villages. During kharif, groundnut is grown only in the Dhenkanal district and its yield varied between 873 kg/ha for adopted villages to 941 kg/ha in case of control villages. Pigeon pea is grown in uplands in Dhenkanal district both in the adopted villages as well as in control villages. However, pigeon pea yield varied widely from only 325 kg/ha in case of adopted villages to 926 kg/ha for control villages.

In case of Rabi rice, yield was found to be 4250 kg/ha in the adopted village of Dhenkanal district. Groundnut yield found to be 2516 kg/ha and 2186 kg/ha respectively for the adopted villages of Jajpur and Dhenkanal district, whereas for control villages, yield remained 2417 kg/ha and 1985 kg/ha respectively for the Jajpur and Dhenkanal district (Table 3.14). Jajpur district yield

outweighed the state and district average yield among the studied villages. So also was the case with Dhenkanal district. Other major pulses grown in the studied villages were horsegram, mung bean, black gram and gram. These crops are not competing crops with groundnut and also yield was also found to be too low excepting in case of horse gram in control villages of Jajpur where, it was observed to be 942 kg/ha. Rabi season vegetables yield was comparatively higher than that of kharif season.

Table 3.14Average productivity levels across major crops (Kgs per ha)

Crops	Season (K/R/S)	Jajpur		Dhenkanal	
		Adopted	Control	Adopted	Control
Sugarcane	Annual	91884	-	87284	73889
Banana	Annual	-	30875	-	-
Rice	Kharif	261	576	2894.75	2673.33
Groundnut	Kharif	-	-	872.87	940.72
Jute	Kharif	1290	1970	-	-
Pigeon pea	Kharif	-	-	324.69	926.25
Vegetables	Kharif	8645	14722.80	11527	-
Rice	Rabi	-	-	4250	-
Groundnut	Rabi	2516	2417	2186	1985
Horsegram	Rabi	265	942	420	525
Mung	Rabi	405	464	365	322
Black gram	Rabi	428	299	387	399
Gram	Rabi	-	-	-	463
Vegetables	Rabi	14786	17989	14820	12350
Mung	Summer	263	-	-	-

3.4 Area allocation to different ground varieties during the last three post-rainy seasons

In Jajpur district, majority of the farmers use purchased seeds from seed dealers who in turn brought it from major groundnut growing states during kharif season like Gujarat, Karnataka, Andhra Pradesh, Maharashtra and even from the Baragarh district of Odisha where groundnut has the highest area during kharif season in the state. However, farmers have scant idea about the varieties being grown by them and typically groundnut varieties are named as per the states from where the seed is procured by the agents from the respective state mandis. So typical groundnut varieties were found to be Gujarati, Amravati, Padmapurietc. as is seen in Table 3.15. During 2009-10, in the adopted villages of Jajpur district, area under Amravati variety was 48.38% which reduced to 38.05% during 2011-12 whereas, Gujarati variety increased from 41.46% to 60.80% during the same period because of bold grain and higher shelling percentage and also yield is relatively better. Padmapuri variety declined from 8.38% to 1.15% during the period. Smruti variety was found to be also very popular in the control villages of Jajpur district and it constituted 47% of the total groundnut area over all these years. In control villages, Amravati and TMV 2 hardly occupied any major area.

In Dhenkanal district, the old AK 12-24 variety still occupies more than 50% of the groundnut area in the adopted vilages. Area under Gujarati slightly increased from 33.21% to 35.72% during the period. Other varieties like Amravati, TMV-2, Smruti were found to be of little significance. In control villages of Dhenkanal district, AK 12-24 was found to be most dominant which occupied more than 90% of the area allocated to groundnut. Gujarati and TMV-2 were the two least important varieties in the control villages of Dhenkanal district.

Overall it is seen that Gujarati variety is gaining importance among the groundnut farmers at the expense of Amravati and AK 12-24 in the adopted villages and in case of control villages, though percentage area under Gujarati variety is increasing, but the change is slow at the expense of AK 12-24. Percentage area under Smruti remained stagnant at around 29% in the control villages during the period under study.

Table 3.15Allocation of area under different cultivars/varieties in the last three seasons (%)

Year	Variety	Jajpur		Dhenkanal	
		Adopted	Control	Adopted	Control
2009-10	AK 12-24	0.00	0	60.72	100.00
	Gujarati	41.46	48.31	33.21	0.00
	Amravati	48.38	1.75	1.24	0.00
	TMV-2	0.76	0.00	1.79	0.00
	Padmapuri	8.38	2.21	0.00	0.00
	Smruti	0.00	47.74	3.04	0.00
	NSC seeds	1.01	0.00	0.00	0.00
2010-11	AK 12-24	0.00	0.00	59.44	99.23
	Gujarati	53.70	48.24	34.56	0.77
	Amravati	44.57	3.79	1.29	0.00
	TMV-2	0.00	0.00	1.07	0.00
	Padmapuri	1.48	0.30	0.00	0.00
	Smruti	0.00	47.67	3.64	0.00
	Karnataki	0.25	0.00	0.00	0.00
2011-12	AK12-24	0.00	0.00	57.15	91.46
	Gujarati	60.80	46.74	35.72	4.57
	Amravati	38.05	1.39	2.52	0.00
	TMV-2	0.00	3.65	1.71	3.96
	Padmapuri	1.15	0.00	0.00	0.00
	Smruti	0.00	47.23	2.90	0.00
	Rajasthani	0.00	0.99	0.00	0.00

Table 3.16: Composition of groundnut varieties in the sample, 2011-12 (ha)

Variety	Jajpur		Dhenkanal		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
AK 12.24	0.00	0.00	38.05	27.91	38.05	27.91
Gujurati	49.13	19.08	19.63	1.21	68.76	20.29
Amravati	30.74	0.57	1.38		32.12	0.57
TMV-2		1.49	1.10	1.05	1.10	2.54
Padmapuri	0.93				0.93	0.00
Smruti			1.60		1.60	0.00
Baragarhi		19.28			0.00	19.28
Rajasthani		0.40			0.00	0.40
Total	80.8	40.82	23.71	30.17	104.51	70.99

Among the groundnut varieties, Gujarati occupied highest area of 68.76 ha in the adopted villages followed by AK 12-24 (38.05 ha), Amravati (32.12 ha) and other varieties of least significance were TMV-2 (1.10 ha), Padmapuri (0.93 ha), Smruti (1.60 ha) during 2011-12 as depicted in Table 3.16. In case of control villages, AK-12-24 is still found to be ruling variety and it had an area of 27.91 ha followed by Gujarati (20.29 ha) and Smruti (19.28 ha). Other varieties of minor importance were TMV-2(2.54 ha), Amravati (0.57 ha) and Rajasthani (0.4 ha).

3.5 Perception on productivity of groundnut among the respondent farmers

Among the sample farmers, groundnut yield is found to be high even better than the national average in the bad years. As perceived by the farmers, yield of groundnut in the worst years stood at 12.47 qt/ha and 12.40 qt/ha respectively for adopted and control villages of Jajpur districts (Table 3.17). While, the yield was 12.51 qt/ha and 13.28 qt/ha during the bad years respectively for adopted and control villages of Dhenkanal district. In the good years, yield was found to be quite high at 22.66 qt/ha and 19.95 qt/ha for adopted and control villages of Jajpur district respectively. Best yield was observed to be 26.27 qt/ha among the adopted farmers of Jajpur district. Overall, groundnut yield was found to be 21.09 qt/ha, 12.49 qt/ha and 24.87 qt/ha respectively for the good, bad and best years among the adopted villages and 19.64 qt/ha, 12.84 qt/ha and 23.57 qt/ha respectively for the good, bad and best years among the control villages.

Table 3.17: Productivity levels of groundnut (Qtls/ha) perceived by the sample, 2011-12

Perceived Yield	Jajpur		Dhenkanal		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
Rain fed						
Good	22.66	19.95	19.51	19.32	21.09	19.64
Bad	12.47	12.40	12.51	13.28	12.49	12.84
Best	26.27	24.62	23.47	22.53	24.87	23.57

3.5.1 Productivity of groundnut by major varieties

Productivity level of groundnut by variety is presented in Table 3.18. It is evinced that among all the major groundnut varieties being cultivated by the farmers, Gujarati variety performed better and its yield recorded was 2482 kg/ha and 2597 kg/ha among the adopted and control villages respectively. Few isolated varieties like Rajasthani also outperformed other varieties and its yield was observed to be 2717 kg/ha in the control villages. Padmapuri also did pretty well at 2580 kg/ha among the adopted villages. The yield of Amravati variety recorded at 2355 kg/ha and 1894 kg/ha respectively for adopted and control villages.

Table 3.18: Productivity of groundnut by varieties in groundnut sample, 2011-12 (kgs per ha)

Variety	Jajpur		Dhenkanal		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
AK 12-24	-	-	1772	1815	1772	1814
Amravati	2357	1894	2290	-	2355	1894
Gujarati	2594	2640	2190	2038	2482	2597
Padmapuri	2580	-	-	-	2580	-
Rajasthani	-	2717	-	-	-	2717
Smruti	-	2184	2399	-	2399	2184
TMV2	-	1896	2449	2228	2449	2054

The oldest variety i.e., AK 12-24 which is still widely grown in Dhenkanal district, recorded 1772 and 1814 kg/ha for the adopted and control villages respectively. The other older variety TMV 2 recorded yield of more than two tons per ha irrespective of adopted(2449 kg/ha) or control villages(2054 kg/ha). One of the newest varieties released by OUAT, i.e., Smruti also performed better with about 2400 kg/ha and 2184 kg/ha respectively for adopted and control villages. During the course of survey, it was found that the post rainy season groundnut crop was exceptionally good for the 2011-12 and was best among the last 10-15 preceding years. During kharif season, majority

of the groundnut area was flooded in Jajpur and to certain extent in Dhenkanal which might have caused silt deposition and retaining moisture for better crop growth that might have resulted in exceptional yield achieved by the groundnut farmers in the studied area. The genetic potential of AK 12-24 has declined significantly. Also it has become susceptible to pest and diseases and that may be reason for lower yield than rest of the varieties.

3.6 Economics of groundnut and other competing crops

The gross returns from the crops normally grown in the sample villages are furnished in Table 3.19. In Jajpur district, though rice is the main kharif season crop, the return was abysmally low because of flooding. Majority of the respondent farmers in Jajpur district opined that they do not rely on kharif season rice crop as these areas are frequently subjugated to flood and over the years, groundnut has emerged as the most lucrative crop enterprise and as such they are putting sand to heavier clay and clay loam soil to make them enable to raise groundnut. The gross return per ha in Jajpur was found to be Rs 101083 and Rs 96357 respectively for adopted and control villages, whereas, for Dhenkanal it was observed to be quite lower at Rs 76211 and Rs 74636 respectively. Lower return was observed in Dhenkanal mainly because of low yield of the old and degenerated seeds used by the farmers. However, the farmers face lower cost of production in terms of low seed and fertilizer cost and labour expenses. In Jajpur, seed is purchased at exorbitant rate from the seed trader on the condition that the output will be delivered to the seed trader. Here the seed traders act both as seed as well as output merchant. Higher seed price though compensate in terms of higher yield observed and better farm gate price realized. In Dhenkanal, majority of the seeds are procured locally either from the farmers who raise groundnut during kharif or traders who procures the locally produced seeds.

Table 3.19: Gross returns from different crops grown by sample farmers, 2011-12(Rs/ha)

Gross Income from Crop	Jajpur		Dhenkanal		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
Groundnut	101083	96357	76211	74636	91547	86068
Rice	2463	4028	27966	26305	15391	14606
Black gram	16687	11927	13803	18262	15779	17312
Pigeon pea	-	-	17811	27788	17811	27788
Mung	16210	22544	15024	15542	15300	20310
Horsegram	5459	29057	8898	11490	7866	17037
Sugarcane	165931	-	152792	148410	156077	148410

The gross return from mung bean was found to be Rs 15300 and Rs 20310 per ha respectively for adopted and control villages while in case of black gram, it was Rs 15779 and Rs 14606 per ha respectively for adopted and control villages. Another important pulse crop, horse gram, recorded gross return of Rs 7866 and RS 17037 per ha for adopted and control villages. Pigeon pea is mainly grown in the uplands during kharif season in Dhenkanal district and the gross return was Rs 17811 and Rs 28888 per ha respectively for adopted and control villages. Sugarcane was found to be grown mainly in Dhenkanal district with lift irrigation facility and the gross return was Rs 156077 and Rs 148410 per ha respectively for adopted and control villages.

3.6.1 Cost of cultivation of groundnut by variety among the sample farmers (Rabi season)

Costs of cultivation of groundnut for different varieties have been placed in Table 3.20(a) and Table 3.20(b) respectively for Jajpur and Dhenkanal districts. In the adopted villages of Jajpur district,

total cost of production of groundnut varied between Rs 50979/ha for Amravati to Rs 55499/ha for Gujarati variety. Bulk of the costs ranging from 25 to 27% was meant for rental value of landfollowed by seed costconstituting 21 to 26% of the total costas entire seed is purchased and harvesting and threshing cost (20 to 21% of the total cost). Fertilizer cost ranged from Rs 3291 in case of Amravati to Rs 4457 in case of Padmapuri variety. The yield of different varieties for which cost of cultivation was recorded stood at 2339, 2597 and 2561 kg/ha respectively for Amravati, Gujarati and Padmapuri for adopted villages of Jajpur district.

Table 3.20(a): Economics of Rabi seasongroundnut by variety, 2011-12 (Rs per ha)

Operation	Jajpur						
	Adopted			Control			
	Amravati	Gujarati	Padmapuri	Amravati	Gujarati	Smruti	TMV2
No of plots	71	68	3	3	15	15	12
Land preparation	3939(7.7)	3770(6.8)	3973(7.2)	3881(9.3)	3691(6.0)	2930(4.8)	3255(9.7)
FYM/Compost	0	0	0	0	0	0	0.0
Seed costs	12047(23.6)	14327(25.8)	11813(21.3)	6616(15.8)	14726(23.7)	12319(20.4)	0.00
Sowing costs	2584(5.0)	2556(4.6)	2470(4.5)	2646(6.3)	3055(4.9)	3746(6.2)	2749(8.2)
Fertilizer costs	3291(6.5)	3767(6.8)	4457(8.0)	2867(6.8)	3691(6.0)	2936(4.9)	1920(5.7)
Micro-nutrient costs	15	26	0	0	315(0.5)	1261(2.0)	0.00
Inter-culture costs	5025(9.9)	4918(8.9)	4994(9.0)	4764(11.4)	6295(10.1)	6737(11.1)	3222(9.6)
Weeding costs	0	0	0	0	0	0	0.00
Plant protection costs	610(1.2)	709(1.3)	644(1.2)	706(1.7)	358(0.6)	1663(2.7)	644(1.9)
Irrigation costs	0	20	0	618(1.5)	123(0.2)	0	906(2.7)
Watching expenses	0	0	0	0	0	0	0.00
Harvesting costs	5570(10.9)	5975(10.8)	5960(10.8)	4499(10.7)	5795(9.3)	4568(7.6)	5202(15.4)
Threshing costs	4873(9.6)	5321(9.6)	6014(10.9)	2911(7.0)	4222(6.8)	4568(7.6)	3524(10.5)
Marketing costs	0	0	0	0	0	0	0.00
Rental value per season	13025(25.5)	14110(25.4)	15088(27.2)	12350(29.5)	19760(31.9)	19765(32.7)	12283(36.4)
Others costs if any	0	0	0	0	0	0	0
Total cost	50979	55499	55413	41858	62031	60493	33705
Grain yield (kgs)	2339	2597	2561	1888	2609	2350	1755
Grain price/kg	40	40.3	40.3	40	42	40.8	40.00
Fodder yield (kgs)	786	874	865	635	862	786	594
Fodder price/kg	1	1	1	1	1	1	1

Note: Figures in the parentheses indicate percentages to the total cost of production

For control villages of Jajpur district, the total cost of cultivation of different varieties varied between Rs 33705/ha in case of TMV 2 to Rs 62031/ha in case of Gujarati. Lower cost of production in case of TMV 2 was attributed mainly to the fact that the seed variety was demonstrated for the first time with the support extended through government agricultural department. Seed cost of Gujarati variety was found to be Rs 14726 per ha followed by Rs 12319 in case of Smruti. Sowing cost was found to be higher in case of control villages than that of adopted villages. However, fertilizer cost was comparatively less than the adopted villages. Harvesting and threshing cost ranged between 15 % in case of Smruti to 26 % in case of TMV 2 of the total cost.

Groundnut being cultivated as a commercial crop, exorbitant rental value of land has been observed. The yield of different varieties for which cost of cultivation information was estimated, varied from 1755 kg per ha in case of TMV 2 to 2609 kg/ha for Gujarati. Among the varieties grown in the control villages, Gujarati fetched the highest price of Rs 42/kg followed by Smruti (Rs 40.8/kg).

Table 3.20 (b): Economics of rabi season groundnut by variety, 2011-12 (Rs per ha)

Operation	Dhenkanal							
	Adopted					Control		
	AK12-24	Amravati	Gujarati	Smruti	TMV2	AK12-24	Gujarati	TMV2
No of plots	57	4	27	1	1	41	4	2
Land preparation	3670(7.4)	3720(6.9)	3404(7.4)	4234(8.4)	2555(4.1)	3018(7.2)	3129(6.8)	2724(6.5)
FYM/Compost	0.00	0	2334(5.1)	1411(2.8)	0.00	599(1.4)	906(1.9)	0
Seed costs	8405(16.9)	11346(21)	13346 (29.2)	12844 (25.6)	11179 (18)	8514 (20.2)	13420 (29.2)	10715 (25.6)
Sowing costs	2615(5.3)	2902(5.4)	2228(4.9)	1694(3.4)	3194(5.2)	2422(5.7)	2223(4.8)	2543(6.1)
Fertilizer costs	2744(5.5)	2827(5.2)	2229(4.9)	3529(7.0)	5323(8.6)	1908(4.5)	1515(3.3)	2179(5.2)
Micro-nutrient costs	9.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inter-culture costs	4677(9.4)	4464(8.3)	3892(8.5)	4940(10)	5323(8.6)	3537(8.4)	2305(5.0)	4795(11.5)
Weeding costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plant protection costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Irrigation costs	67.00	372 (0.7)	149 (0.3)	0.0	3194 (5.2)	32.00	0.0	0.0
Watching expenses	0.00	0	15	0.0	0.00	0.00	0.0	0.0
Harvesting costs	3533(7.1)	4055(7.5)	2081(4.6)	3529(7)	4791(7.7)	2497(5.9)	2388(5.2)	2543(6.1)
Threshing costs	5571(11.2)	5803(10.7)	4006(8.8)	5646 (11.3)	7985 (12.9)	5424 (12.9)	7739(16.8)	3996(9.6)
Marketing costs	0.00	0	0	0	0.00	0.00	0	0
Rental value per season	18347(37)	18525 (34.3)	12063 (26.4)	12350 (24.6)	18525 (29.9)	14273 (33.8)	12350 (26.9)	12350 (29.5)
Others costs if any	0	0	0	0	0	0	0	0
Total cost	49638	54014	45747	50177	62069	42224	45975	41845
Grain yield (kgs)	2185.0	2477	2152	2258	2449.0	2014.0	2017	2216
Grain price/kg	39.00	38	38.8	42	39.00	40.00	39.5	40
Fodder yield (kgs)	736.00	830	720	776	820.00	681.00	687	726
Fodder price/kg	1	1	1	1	1	1	1	1

Note: Figures in the parentheses indicate percentages to the total cost of production

Cost of cultivation of groundnut in adopted as well as control villages in Dhenkanal district was found to be comparatively lower than that of Jajpur district. Total cost per hectare varied between Rs 45747 in case Gujarati to Rs 54017 in case of Amravati for adopted villages, whereas, for control villages, it ranged between Rs 41845 in case of TMV 2 to Rs 45975 for Gujarati. Seed cost of Gujarati variety accounted for 29% of the total cost of production in both adopted and control villages. AK 12-24 being locally procured, costedmuch less than the other varieties and it varied between Rs 8405 for adopted villages to Rs 8514/ha for control villages. Smruti variety having attractive peal colour is costlier also and the seed cost was Rs 12844 per ha in adopted village. Fertilizer costs accounted for 5 to 8.5% of the total cost in case of adopted villages whereas, for control villages, its share was 3 to 5%. Harvesting and threshing cost together accounted for 13 to 20% of the total costs for adopted villages and for control villages, the two components shared 16 to 22%. In case of TMV 2, since it was irrigated, yield was comparatively higher at 2449 kg per hectare. The average yield per hectare of other groundnut varieties in the adopted villages varied from 2152 kg to 2258 kg and for control villages, it ranged between 2014 kg to 2216 kg.

3.6.2 Economics of groundnut cultivation

Average yield of groundnut per hectare in Jajpur districts was 2484 kg and 2402 kg respectively for adopted and control villages whereas, it was comparatively low in Dhenkanal and estimated at 2155 kg and 2017 kg respectively for adopted and control villages. Cost of cultivation per hectare was quite high at Rs 53541 and Rs 58410 respectively for adopted and control villages in Jajpur as compared to Rs 46226 and Rs 42486 respectively for adopted and control villages of Dhenkanal district. Though gross return was quite higher in case of Jajpur district, it has got low BC ratio, because of higher cost of cultivation pertaining mainly to seed and fertilizer. BC Ratio was 1.13 and 1.43 respectively for adopted and control villages in Jajpur district while it was much higher at 1.83 and 1.89 respectively for adopted and control villages in Dhenkanal district. BC Ratio for irrigated

groundnut in adopted village of Dhenkanal district was found to be lower at 1.72 than that of rainfed crop (Table 3.21).

Table 3.21Cost and returns in groundnut farming among the sample farmers, 2011-12

Cost /returns	Jajpur (Rs per ha)		Dhenkanal (Rs per ha)	
	Adopted	Control	Adopted	Control
Rain fed				
Yield (kg/ha)	2484	2402	2155	2017
COC(Rs/ha)	53541	58410	46226	42486
Gross returns(Rs/ha)	100739	99134	84600	80483
Net returns (Rs/ha)	47197	40724	38373	37996
BCR	1.13	1.43	1.83	1.89
Irrigated				
Yield (kg/ha)			2216	
COC (Rs/ha)			50584	
Gross returns (Rs/ha)			86842	
Net returns (Rs/ha)			36258	
BCR			1.72	

3.7 Crop utilization among the sample farmers

Groundnut utilization pattern in sample villages is placed in Table 3.22. Groundnut output per household was highest in case of adopted villages of Jajpur. Of the total grain output of 2256.58 qts per Hh in the adopted villages of Jajpur, more than 86% is sold whereas, for control villages, about 89.5 % was sold. In Dhenkanal, grain output per Hh was 1407 kgs and 609.33 kgs respectively for adopted and control villages. About 77% of the crop output per Hh was sold in case of adopted villages of Dhenkanal district, whereas, the figure for the control village was estimated at 80%. It is obvious that when the crop output is low a highly commercial crop like groundnut, higher percentage of the output was sold as in case of control villages of both Jajpur and Dhenkanal district. Others uses mainly takes the form of labour payment and recorded 301 kgs and 243.67 among the adopted farmers of Jajpur and Dhenkanal district respectively and for control villages it was 104.33 kg and 89.06 kgs respectively. In Dhenkanal, farmers grow both kharif and Rabi season groundnut. So seed is kept for the next season crop. About 3.75% and 2.72% of the crop output was kept for seed purpose respectively for adopted and control villages of Dhenkanal district. Sale price of groundnut was found to be higher in Jajpur than that of Dhenkanal. It varied from Rs 40.24 to Rs 40.98/kg respectively for adopted and control villages of Jajpur district, whereas, it ranged between Rs 38.87 to Rs 39.62/kg respectively for adopted and control villages of Dhenkanal district.

Table 3.22: Crop utilization (main product) per HH (kgs)

Particulars	Jajpur		Dhenkanal	
	Adopted	Control	Adopted	Control
Grain output (Kg)	2256.58	1098.17	1407	609.33
Consumed (Kg)	10.31(0.46)	10.83(0.99)	31.39(2.23)	14.44(2.37)
Other uses	301.00(13.34)	104.33(9.50)	243.67(17.32)	89.06(14.62)
Kept as own seed (Kg)	0.00	0.00	52.83(3.75)	16.56(2.72)
Sold as seed (Kg)	0.00	0.00	0.00	0.00
Seed sale price (Rs/kg)	0.00	0.00	0.00	0.00
By-product (Kg)	14.94	0.00	0.00	0.00
By-product own use (Kg)	0.00	0.00	0.00	0.00
By-product sold (Kg)	0.00	0.00	0.00	0.00
By-product sale price (Rs/Kg)	0.00	0.00	0.00	0.00
Qty sold in the market (kg)	1945.27(86.20)	983.00(89.51)	1079.11(76.70)	489.28(80.30)

Note: Figures in the parentheses indicate percentages to the total grain output

3.8 Preferred traits of Groundnut and price premiums for traits

Irrespective of the adopted or control villages in both the districts, high yield remains the preferred trait of the varieties (Table 3.23). In adopted villages of Jajpur district, the second most important trait being the determinate type. Since groundnut in post rainy season is purely rainfed, with indeterminate type pegging, the crop is subject to drought and subsequently results in poor yield. Groundnut is priced as per shelling percentage. A shelling percentage above 70 fetches a remunerative price. Since groundnut is a cash crop and high shelling percentage provide better price and hence higher income. Also majority of the groundnut farmers have low resource base. As such they heavily relied on seed traders for seed and other monetized input. Also because of inadequate time for planting groundnut immediately after the harvest of autumn paddy to avail the residual moisture in the soil, there remains huge rush to get quality seeds and since there is limited scope of getting kharif harvested seeds within the state within the fixed period of planting, seed traders resort to bring seeds from major kharif grown states of Gujarat, Maharashtra, Karnataka, Andhra Pradesh etc which automatically raises the cost of seeds to an exorbitant level. Majority of the farmers are unable to procure seeds at that level which is in excess of Rs 60/kg. So low seed cost was given priority in the adopted villages of Jajpur district. Majority of the farmers in the adopted villages of Jajpur district have started cultivating groundnut even in heavier soils by adding river bed sand to make them enable for groundnut cultivation. Still farmers face difficulty in harvesting groundnut at times because of uncertain rain or some other reasons. In heavier soils, farmers also face diseases in the pod as well as in the peg which makes them difficult to harvest the entire produce and so strong peg has become one of the preferred traits. Since seeds are costly, low seed rate has emerged as one of the traits. In control villages of Jajpur district, drought occurrence is common and as such drought resistance and short duration have been the preferred traits. Low seed cost was not found to be the preferred traits in control villages, as Smruti and TMV 2 seeds were locally available from the government seed centres and from the inland producing district of Baragarh.

In adopted villages of Dhenkanal, drought resistance was found to be preferred variety as the soil is mostly sandy besides the river embankment and with poor moisture retaining capacity, crop suffers due to drought. For the same reason, short duration and determinate type of varieties are preferred.

Table 3.23: Production traits preferred by groundnut sample farmers, 2011-12

Production preferred Traits	Jajpur		Dhenkanal	
	Adopted	Control	Adopted	Control
High Yield	7.00	6.67	6.28	6.81
Short Duration	-	2.00	3.19	3.78
Disease Resistance	2.75	-		
Pest Resistance	-	-		
Drought resistance	-	3.00	6.38	2.54
HighestShelling (%)	5.27	5.27	4.76	5.78
High oil content	-	-	-	-
Fits in to cropping system	-	2.11	3.09	
Determinate	5.35	4.79	4.31	4.16
Strong peg	5.09	5.09		
Low Seed Cost	5.19			
Low Seed rate	4.03	4.00	2.63	

4. Synthesis of results and policy options

During the 2nd phase of the TL-II Prject, two districts viz., Jajpur and Dhenkanal of Odisha were chosen for implementation of the program for groundnut crop. In each of these two districts, three villages were selected for intervention and were designated as 'adopted' villages and three more villages were chosen as non-intervention villages, which were termed as 'control' villages. From each of the adopted villages, a sample of 30 farmers was chosen, while this number was 15 in case of the control villages. Thus, in of these two districts, a sample of 90 farmers was drawn from adopted villages and 45 farmers were chosen from control villages. A baseline survey was conducted during 2011-12, immediately after the cropping season, to assess the socioeconomic status of the farmers, adoption and yield levels and benefit/cost ratios of groundnut crop.

The inferences taken from the baseline study suggest that groundnut crop is the dominant crop during the post-rainy season irrespective of the two districts. In Jajpur district, groundnut is the leading crop which sustains the farming community. In both the districts, it contributed significantly to the farm incomes. However, it was found that farmers are hugely constrained in getting quality seeds at the appropriate time. In Jajpur district, farmers entirely depend on seed traders for the seed which is procured mainly from the states of Gujarat, Maharashtra, Karnataka and Andhra Pradesh and farmers hardly have any idea about the varieties being grown by them. Since they are in hurry to plant the crop because of fear of moisture depletion from the soil, whatever seed is being provided to them by the seed traders are sown. Seed traders have also taken it as granted and hardly find any incentive to provide quality seeds of designated varieties. They are also in a hurry to arrange for seeds and are mostly lifted from mandis of respective states and so the varieties are not ensured and farmers and traders designate the varieties as per the source of arrival of seeds. In Dhenkanal district, decades old AK 12-24 is still the dominant variety. Though government is supplying TMV-2, farmers hardly find any difference between the two varieties and still go with AK 12-24 though now it has become susceptible to pests and diseases.

During 2011-12, Jajpur experienced severe flooding during October, and it suited well for groundnut crop during the post rainy season for groundnut crop and also the season during the crop growth period was exceptionally good resulting in very high yield which was not realized for over a decade. Similar was the situation in Dhenkanal also. However, due to traditional varieties being grown in the district and to poor soil quality than that of Jajpur, yield was comparatively low in Dhenkanal district.

B:C ratio for groundnut crop was found to be low in Jajpur as compared to Dhenkanal mainly because of higher cost of cultivation in Jajpur pertaining to seed and labour cost though yield was higher. Fellow farmers are the main source of information for new cultivars and fertilizer management. Input dealers also play role in providing information related to pest and disease controls. Preferred traits for groundnut varieties among the respondent farmers were found to be higher yield, determinate type, drought tolerance, bold grain, high shelling percentage and strong peg.

So releasing of varieties having above desirable traits suitable to the agro-climatic conditions of the state is of outmost importance. Releasing the variety is not enough, efficient seed delivery system has to be developed for making available desired seed at appropriate time with certain incentives in form of subsidies and market invention to encourage farmers to increase the area under the croptherebyenhancing the production. There is need for developing technologies to advance sowing

in Odisha to escape high temperature stress at the later stages of the crop growth and to protect the crop from unseasonal rains.Suitable technology pertaining to use of machineries in groundnut cultivation must be introduced so as to reduce the dependence on human labour as labour cost is becoming exorbitant in the face of vanishing labour force from the rural masses.

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Increasing Productivity and Profitability in Legumes Cultivation: Opportunities, Challenges and Lessons Learnt from Tropical Legumes- II (Phase 1 and 2) project

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ABSTRACT

The Tropical Legumes II (TL-II) project, funded by the BMGF, aims to improve the lives and livelihoods of smallholder farmers in the drought-prone areas of sub-Saharan Africa (SSA) and South Asia through improved productivity and production of six major tropical legumes – chickpea, common bean, cowpea, groundnut, pigeonpea and soybean. It has been implemented in ten target countries that included in WCA, ESA and SA regions in two phases (Phase 1: 2007-08 to 2010-11; Phase-2: 2011-2014). But, the present paper discusses about only three legumes (chickpea, pigeonpea and groundnut) crops and the interventions carried out in India only. Specifically, this initiative has been focusing on proper targeting for development of improved cultivars of food legumes, promotion of their adoption, proactive public sector policies and finally linking these small holders to markets and value chains. A number of studies have been completed in six states (Andhra Pradesh, Maharashtra, Bihar, Karnataka, Odisha and Tamil Nadu) in India and Barind region of Bangladesh during last eight years (2007-2014) of project implementation. The main objective of this paper is to summarize those key findings across crops and also to identify various potential opportunities and challenges for promotion of legumes in the future. These studies have examined and documented the existing situation in legumes cultivation, constraints faced by the farmers, market linkages, potential opportunities for their expansion etc. In close association with crop improvement scientists, Farmers' Participatory Varietal Selection (FPVS) approach was implemented for assessing farmers preferred traits in these crops. These preferred varieties were identified, released formally, multiplied and supplied as seed samples to legume growers in intervention sites. Subsequently, studies were also conducted on monitoring early adoption of newly introduced improved cultivars and their performance in the targeted locations. All those findings emanated from various studies along with lessons learnt during the process are highly valuable to share among NARS partners, researchers, academicians and donors.

Keywords: Legumes in South Asia, Income and Nutritional security, Lessons learnt, TL-II Project

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1. Introduction

Legumes are integral part of cropping systems and farmers' livelihoods. Besides enriching soil fertility, food legumes also provide substantial income to the farm households and also contribute towards household nutritional security.The Tropical Legumes II (TL II) project, funded by the Bill & Melinda Gates Foundation, aims to improve the lives and livelihoods of smallholder farmers in the drought-prone areas of sub-Saharan Africa (SSA) and South Asia (SA) through improved productivity and production of six major tropical legumes – chickpea, common bean, cowpea, groundnut, pigeonpea and soybean. It is anticipated that productivity would increase by 20% and improved varieties would occupy 30% of all tropical legumes covered in the project.

TL II is jointly implemented by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), CIAT (International Centre for Tropical Agriculture), IITA (International Institute of Tropical Agriculture) and National Agricultural Research Systems (NARS).The project was implemented in 15 target countries that included Western and Central Africa, Eastern and Southern Africa and South Asia. Since 2007, the project has been implementing in two phases: Phase-1 (2007-2010) and Phase-2 (2011-2014) across the three regions and crops. However, the project has been planned for three phases totalling 10 years[2].

The project approach for improving the productivity and production of tropical legumes includes, among others: 1.Understanding the legumes' environment (through baseline, market and impact studiesand effective monitoring and evaluation systems) and leveraging existing knowledge; 2. Developing farmer-and market-preferred crop varieties and integrated crop management technologies; 3. Establishing sustainable seed production and delivery systems; 4. Capacity building for NARS; and 5. Creating awareness and reaching farmers with available technologies.

2. Target regions and interventions

The project supports applied breeding programs for each of the crop/country combinations and has been highly successful at releasing varieties in nearly all geographies – more than 120 varieties have been released by the project to date (2007-2013). These breeding programs have been considerably strengthened over the past eight years but need further modernizing to take advantage of the advances in molecular breeding sweeping across the discipline.

Table 1 summarizes the major crop-country combinations for targeting the research and project interventions over the last eight years period. However, the present paper confines to South Asia region (India and Bangladesh) and three targeted crops (chickpea, pigeonpea and groundnut) only. The subsequent sections of this paper document the initial impacts on project interventions in South Asia and those legumes. Among several interventions, the

[2] For more details access on http://www.icrisat.org/tropicallegumesII/pdfs/EngagingSmallholders.pdf

present paper focuses and highlights onfour major activities carried out across regions. Overall, the project targeting and scaling-outefforts are summarized and depicted in Fig 1.

Table 1 Country and crop focus under TL II project (phase 1 & 2)

Country	Bean (Common)	Chickpea	Cowpea	Groundnut	Pigeonpea	Soybean
WCA						
Burkina Faso		X		X		
Mali			X	X		
Niger			X	X		
Nigeria			X	X		X
Senegal				X		
Ghana			X	X		
ESA						
Ethiopia	X	X				
Kenya	X	X				X
Malawi	X			X	X	X
Mozambique			X	X		X
Tanzania	X	X	X	X	X	
Uganda	X			X	X	
Zimbabwe	X					
SA						
Bangladesh		X		X		
Bihar (India)		X			X	
Odisha (India)				X	X	
Andhra Pradesh (India)		X			X	
Karnataka (India)		X		X		
Tamil Nadu (India)		X		X		
Maharashtra (India)		X			X	

2.1 Fast-tracking and variety release

Under each crop, large number of participatory varietal selection (PVS) trials was carried out in the targeted countries using released varieties or pre-released advanced lines, in comparison with one or more local check(s), over the three to four seasons. A total of 120 varieties have been released during 2007-2013. All of these are farmers-and market-preferred varieties that have been identified through the PVS trials in those respective countries. Their yield advantages over the checks ranged from 5% to 300%. Some of these varieties have been released in more than one country.

2.2 Seed production and delivery systems[3]

The seed production and delivery system has identified more than two dozen types of seed production models across target countries. Eight, eight and ten seed production systems have been reported for breeder/foundation seed, certified seed and other quality seed production systems in the target countries.

Systems varied from country to country. NARS research centres' are responsible for breeder and foundation seed production across target countries, with few exceptions. It has been observed that there is no much enthusiasm by large seed companies to engage in grain

[3] For more details access on http://www.icrisat.org/tropicallegumesII/pdfs/J401_2013.pdf

legume seed production because of low margin of profit, as farmers could recycle their own saved seed for up to five years. Much attention is therefore paid to strengthening community-based and farmer level seed production systems. Overall, a total of 20-25 seed delivery models have been identified in the 15 target countries. These too varied from country to country.

The availability and access to seeds are crucial factors in the adoption of improved technologies by farmers. TL II project invested significant amounts of time and efforts on this aspect during phase 1 & 2 and will continue to further strengthen it (see Table 2). Considering each crop (and seeding rate in kg per ha) for common bean (100), groundnut (90), chickpea (70), soybean (60), cowpea (20), and pigeonpea (8.5), this amount of seed would be sufficient to plant a minimum of 3.7 million ha. Considering an average of 0.25 ha of the legumes per household, this would mean coverage of more than 14.8 million households under the project directly.

Table 2 Different classes of seed produced and distributed (MT) in target countries

Crop	2007-2011	2011-12	2012-2013	Total
Chickpea	55,756	45329.9	66223.5	167,309
Groundnut	25,968	1367.5	14317.1	41,653
Common bean	9030	8006.8	3928.7	20,966
Soybean	871	621.5	1098.9	2,591
Pigeonpea	698	1593.1	2051.0	4,342
Cowpea	568	370.6	479.9	1,419
Grand total	**92,891**	**57289.4**	**88099.0**	**238,280**

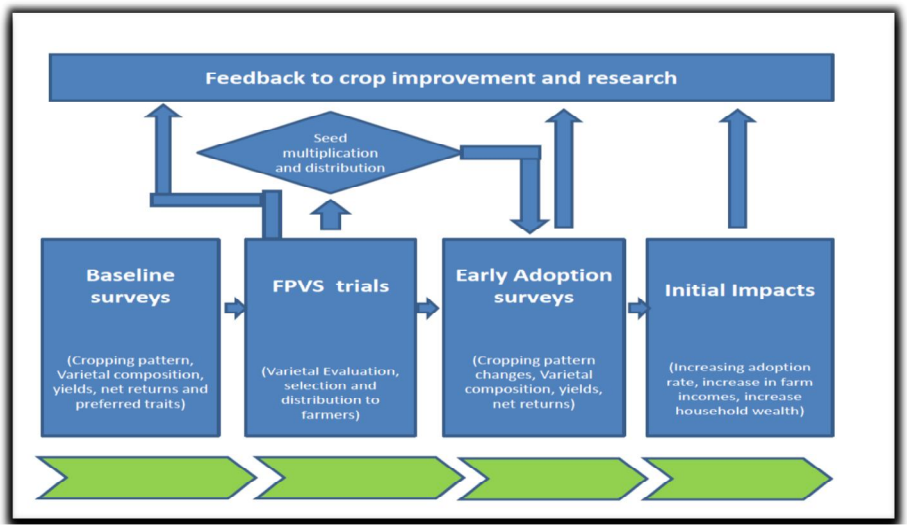
2.3 Capacity building

Good progress has been made in terms of both physical and human capacity building in the NARS of target countries. Laboratory and office equipment has been purchased and submitted to the NARS; irrigation facilities for conducting research on drought tolerance have been installed or upgraded in all countries. Seed storage facilities have been renovated and are in use in the countries which needed these. Additionally, the NARS capacity has been improved significantly at national, regional and overseas universities.

2.4 Creating awareness

Awareness creation has been effected through field days, demonstrations, seed fairs, agricultural shows, dealing with farmers' research groups/farmer field schools, and distribution of small pack seed samples. The project has been able to reach approximately5.0 million farmers during its first and second phases.

Fig 1: Targeting and diffusion interventions under TL II project



3. Impact on adoption, productivity and profitability in South Asia

As mentioned earlier, the present paper confines more to South Asia and three major legumes crops only. Numerous studies have been completed in six states (Andhra Pradesh, Karnataka, Maharashtra, Bihar, Odisha and Tamil Nadu) in India and Barind region of Bangladesh during the eight years of project implementation (2007-2014).These studies have examined and documented the existing situation in legumes cultivation, extent of adoption, constraints faced by the farmers, market linkages, potential opportunities for their expansion etc. Some, studies were also conducted for monitoring early adoption of newly introduced improved cultivars and their performance in the targeted locations. However, the present section highlights the initial impact of those TL II project interventions on extent of adoption, productivity and profitability by crop wise in the targeted sites.

3.1 Chickpea[4]

Chickpea has been targeted in two major states (Andhra Pradesh and Karnataka) of India and Bangladesh. The project interventions have been progressing in India since 2007 whereas they were initiated only from 2012 in Bangladesh. In India, the baseline surveys were carried out during 2007-08 while the early adoption studies completed in 2009-10. FPVS trials were taken-up from 2007 to 2009 in different locations in these two states. Thousands of free seed samples were distributed between 2007 and 2012 in project intervention sites across two study states. A real-time tracking survey was undertaken in 2013 to track the adoption of project introduced cultivars in these locations and to deeply understand the patterns of diffusion among farmers and villages. All these efforts over a period of eight years significantly enhanced the adoption, productivity and profitability of chickpea cultivation in these states. The summary of those findings are furnished below:

3.1.1 Andhra Pradesh

Table 1 & 2 summarizes the extent of adoption of project introduced cultivars in Prakasam and Kurnool districts of Andhra Pradesh respectively. Between 2007-08 and 2009-10, the sample farmers in Prakasam showed more preference towards kabuli types because of price

[4] For more details refer Suhasini et al. (2013)

premiums than desi types. The productivity of JG 11 has improved significantly (50%) in targeted sites. The extent of adoption of JG 11 has increased remarkably (53 to 90%) in Kurnool district between 2007 and 2009. However, the improvement in productivity was around 38 per cent. The traditional old variety 'Annigeri' has been replaced within span of three years.

Table 1: Performance of chickpea in the sample villages of Prakasam district of AP

Varieties	Varietal composition (%)		Yield (kg per ha)	
	BL-2007	EA-2009	BL-2007	EA-2009
Annigeri	24.48	2.62	1072	1420
ICCV-2	9.87	0	1200	-
KAK-2	26.37	78.5	1317	1912
JG-11*	39.28	18.88	1241	1877
JAKI 9218*	0	0	-	-
Overall	100.0	100.0	-	-
* introduced through the TL-II project; BL: Baseline in 2007-08; EA: Early Adoption survey in 2009-10				

Table 2: Performance of chickpea in the sample villages of Kurnool district of AP

Varieties	Varietal composition (%)		Yield (kg per ha)	
	BL-2007	EA-2009	BL-2007	EA-2009
Annigeri	45.35	10.13	1015	1235
ICCV-2	0	0	-	-
KAK-2	1.43	0	1112	-
JG-11*	53.22	89.45	1356	1869
JAKI 9218*	0	0.42	-	1766
Overall	100.0	100.0	-	-
* introduced through the TL-II project; BL: Baseline in 2007-08; EA: Early Adoption survey in 2009-10				

Due to increased yields of chickpea by 2009-10, the weighted average cost of production per quintal decreased (18%) from Rs.1552 to Rs.1275 in the sample villages of Kurnool. The reduction in UCR of was even higher at 23% in Prakasam district (Suhasini et al. 2013). Table 3 clearly visualizes the profitability of chickpea in the state. The net returns per ha was significantly higher in case of Prakasam than Kurnool district. The pooled benefit-cost ratio (BCR) for chickpea cultivation in the state was estimated at 2.39. The increased income as a share of net crop income was around 52% and 66% respectively for Kurnool and Prakasam districts (Suhasini et al. 2013 & also see Box 1).

Table 3 Profitability of chickpea cultivation in Andhra Pradesh, 2009-10 (Rs/ha)

Particulars	Cost of Cultivation		
	Kurnool	Prakasam	Pooled
Labour cost	17485	17760	17622
Material cost	4905	5832	5369
Total cost of cultivation	22390	23592	22991
Cost of production per 100 kg	1232	1245	1238
Grain yield	1818	1895	1857
Gross returns	50904	58745	54825
Net returns	28514	35153	31834
Benefit cost ratio	2.27	2.49	2.39

Box 1: Chickpea impact study in Andhra Pradesh

A comprehensive chickpea technology adoption and impact study was taken-up in Andhra Pradesh with partial support from SPIA during 2012-13. About 810 chickpea growers were tracked across 90 villages in 30 mandals from seven districts of Andhra Pradesh with a structured questionnaire. The study has concluded that the extent of adoption JG 11 was nearly 85% in the state. It is the single dominant variety followed by Vihar and KAK 2. Nearly 98% of cropped area is under chickpea improved cultivars. The farm-level productivity gain was estimated at 37 per cent. The translated unit cost reduction was calculated at $ 144 per ton. The accrued benefits due to adoption of 'short-duration improved chickpea technology' were assessed at US $ 358.9 million. The internal rate of returns (IRR) on research investment was estimated at 28%.

Source: Bantilan et al. (forth coming)

3.1.2 Karnataka

In Karnataka, Annigeri was a long entrenched variety of the region for nearly four decades. It was evolved in Karnataka and became popular quickly and remained the favourite of farmers even in 2006-07, when baseline survey was conducted. Under TLII project, researchers also supplied small quantities of the chickpea seeds of farmer preferred varieties to the sample farmers in adopted and control villages of Dharwad and Gulbarga districts. But there was no much large scale effort to organize the seed production and distribution of preferred varieties by the State Seed Corporation in Karnataka. As a result, these varieties did not enter the seed supply chain in a big way.

Table 4: Performance of chickpea in the sample villages of Dharwad district of Karnataka

Varieties	Varietal composition (%)		Yield (kg per ha)	
	BL-2007	EA-2009	BL-2007	EA-2009
Annigeri	91.5	41	1023.8	1030
Bhima	2.4	2	686.2	1113
Kabuli (KAK 2)	4.9	2	992.9	1019
Local or others	1.2	2	1009.4	-
JG 11*	0	23	-	1314
BGD 103*	0	18	-	1374
JAKI 9218*	0	12	-	1250
MNK-1*	0	0	-	889
Overall	100.0	100.0	-	-

* introduced through the TL-II project;
BL: Baseline in 2007-08; EA: Early Adoption survey in 2009-10

There was remarkable increase in adoption of TL II project introduced cultivars in both the study districts (see Table 4 & 5). More than 50% of Annigeri area has been replaced by JG 11, BGD 103, JAKI 9218 and MNK 1. On an average, the productivity per ha has been increased 25-30% (Suhasini et al. 2013).

Table 5: Performance of chickpea in the sample villages of Gulbarga district of Karnataka

Varieties	Varietal composition (%)		Yield (kg per ha)	
	BL-2007	EA-2009	BL-2007	EA-2009
Annigeri	94.2	42	1148.4	1097
Bhima	0	0	-	-
Kabuli (KAK 2)	1.6	5	1007.8	1175
Local or others	4.2	3	955.1	748
JG 11*	0	22	-	1398
BGD 103*	0	18	-	1405
JAKI 9218*	0	0	-	1333
MNK 1*	0	10	-	1227
Overall	100.0	100.0	-	-

* introduced through the TL-II project;
BL: Baseline in 2007; EA: Early Adoption survey in 2009-10

Table 6 Profitability of chickpea cultivation in Karnataka (Rs/ha)

Costs and Returns	Dharwad		Gulbarga	
	BL-2007	EA-2009	BL-2007	EA-2009
Fixed Cost	3721	4054	3603	4711
Variable Cost	12463	13473	12330	13527
Total Cost	16184	17527	15933	18238
Yield (Kg/ha)	1024	1152	1102	1277
Gross Return	25194	33125	25058	36739
Net Return	9010	15598	9125	18501
Benefit Cost Ratio	1.56	1.89	1.57	2.01

Table 6 summarizes the profitability of chickpea cultivation in Karnataka state. Due to marginal increase in yield per ha and significant increase in costs of cultivation per ha, the benefit-cost ratio improved slightly. Only 4% reduction in the cost of production was noticed in Dharwad while the same fell at 1% for Gulbarga district. The increased income as a share of net crop income was estimated at 29% and 49% respectively for Dharwad and Gulbarga districts (Suhasini et al. 2013).

3.1.3 Real-time tracking surveys

Two massive real-time tracking surveys covering 500 Hh each were initiated in the phase-1 locations i.e., in Andhra Pradesh and Karnataka states respectively for deeper understanding about TL-II project introduced improved cultivars adoption in the targeted sites as well as their further diffusion across seed sample beneficiaries from the project. Based on preliminary field insights, the adoption of chickpea improved cultivars in Prakasam and Kurnool districts of Andhra Pradesh is in its peak (nearly 99%). In case of Karnataka, remarkable diffusion of JG 11 (nearly 60-70%) was observed in both Dharward and Gulbarga districts. The chickpea farmers are significantly benefited through enhanced yields, improved soil fertility, increased household nutrition and fodder availability.

3.2 Groundnut[5]

Groundnut has been targeted in two major states (Karnataka and Tamil Nadu) of India and Bangladesh. The project interventions have been progressing in India since 2007 whereas they were initiated only from 2012 in Bangladesh. In India, the baselines were conducted during 2007-08 while the early adoption studies completed in 2009-10. FPVS trials were

[5] For more details refer Karunakaran et al. (2013)

taken-up from 2007 to 2009 in different locations in these two states. Thousands of free seed samples were distributed between 2007 and 2012 in project intervention sites across two study states. A real-time tracking survey was undertaken only in Tamil Nadu during 2013 to track the adoption of project introduced cultivars and to deeply understand the patterns of diffusion among farmers and villages. However, the tracking study did not undertake in case of Karnataka. Very low penetration of project introduced cultivars was observed in both the targeted states due to various constraints. All these systematic efforts over the project period are summarized below:

3.2.1 Karnataka

Table 7 summarizes the extent of penetration of TL II project introduced groundnut improved cultivars in Karnataka. TMV 2 is a single dominant cultivar occupying more than 90% area in both the study districts. The new cultivars could hardly able to replace TMV 2 in targeted sites. This low adoption was possibly due to the inability of the farmers to access the information about new cultivars and in believing them to be superior (Karunakaran et al. 2013). Even though the productivity of R2001-2 was impressive than TMV 2 in both the locations but its adoption was rather low (4%).

Table 7 Performance of groundnut improved cultivars in the sample villages of Karnataka

Varieties	Raichur				Chitradurga			
	Composition (%)		Yield (kg per ha)		Composition (%)		Yield (kg per ha)	
	BL-2007	EA-2009	BL-2007	EA-2009	BL-2007	EA-2009	BL-2007	EA-2009
TMV-2	100	95.42	1240	1297	100	90.79	782	846
ICGV-91114 *	-	-	-	-	-	7.36	-	1350
R2001-2 *	-	3.26	-	1473	-	1.84	-	1250
ICGV-00350 *	-	1.32	-	1401	-	-	-	-
Pooled	100.0	100.0	-	-	100.0	100.0	-	-
* Project introduced cultivars								

Table 8 Profitability groundnut cultivation in Karnataka (Rs/ha)

Costs and returns	TMV-2	Improved cultivars
Cost of cultivation (Rs/ha)	21600	27120
Grain yield of groundnut (kg/ha)	1072	1391
Gross returns (Rs/ha)	31681	42306
Net returns (Rs/ha)	10081	15186
Benefit cost ratio	1.47	1.66
COP (Rs per 100 kg)	2015	1950

The improved varieties which made a small dent on the sample farms reported better yields than TMV 2. The reduction in the unit cost of production of groundnut was marginal. The fell in UCR was 12.6% and 1% respectively for Raichur and Chitradurga districts. The pooled estimate for entire state was around 7.6%. The increased income as a share of net crop income in baseline was only 5 and 17% respectively for Raichur and Chitradurga (Karunakaran et al. 2013).

3.2.2 Tamil Nadu

Table 9 summarizes the extent of adoption of groundnut improved cultivars in targeted sites of Tamil Nadu between 2007-08 and 2009-10. It is evident from the table that the penetration of TL II introduced cultivars almost negligible. The new cultivars failed to make a dent in the groundnut areas of sample farmers, even though there was a churning between the old varieties (Karunakaran et al. 2013). However, signs of hope were visible as seen in the promising yield of new varieties.

Table 9 Performance of groundnut cultivars in Erode and Thiruvvanamalai districts

Varieties	Erode district				Thiruvvanamalai district			
	Composition (%)		Yield (kg per ha)		Composition (%)		Yield (kg per ha)	
	BL-2007	EA-2009	BL-2007	EA-2009	BL-2007	EA-2009	BL-2007	EA-2009
CO2	50.94	32.71	1255	1286	0	13.77	-	-
JL24	2.83	0	-	0	1.06	0	-	0
TMV1	0.47	0	-	0	-	-	-	-
TMV2	10.38	0	-	0	-	-	-	-
TMV7	1.89	3.74	-	-	42.33	21.02	-	-
VRI2	33.49	62.62	-	-	0	0	-	-
POL 2	-	-	-	-	56.61	64.49	1086	1402
TVG 0004 *	0	0.93	0	2482	0	0	0	0
ICGV00351 *	0	0	0	0	0	0.72	0	1693
Pooled	100.0	100.0	-	-	100.0	100.0	-	-
* project introduced cultivars								

Table 10 Profitability of groundnut cultivation in Tamil Nadu (Rs/ha)

Costs and Returns	Erode		Thiruvannamalai	
	CO-2	TVG0004	POL-2	ICGV00351
Fixed Cost	2600	2750	2550	2618
Variable Cost	14860	17847	14240	16777
Total Cost	17460	20597	16790	19395
Yield (Kg/ha)	1286	2482	1402	1693
Gross Return	42749	54481	43447	48423
Net Return	25289	33884	26657	29028
Benefit Cost Ratio	2.45	2.65	2.59	2.50

Table 10 summarizes profitability of groundnut cultivation in the targeted districts of Tamil Nadu. The improved varieties were grown in small areas only due to the limited seed availability. In Erode, TVG0004 recorded higher yield than CO 2 and reported a high benefit/cost ratio of 2.65. ICGV00351 performed better than that of POL 2 in terms of yield but its BCR ratio was marginally lower.

3.2.3 Real-time tracking survey

The real-time survey has been conducted in the three targeted districts of Tamil Nadu covering approximately 500 sample households during 2012-13. Only 7% of groundnut cropped area was covered with TL project introduced cultivars while the rest occupied with old cultivars. Recurrent droughts coupled with improper seed distribution systems failed to make a dent in the state. Small quantities (5-10 kg) of seeds distributed to sample farmers could not able to influence them significantly.

3.3 Pigeonpea[6]

Pigeonpea has been targeted in two major states (Andhra Pradesh and Maharashtra) of India. The project interventions have been progressing in India since 2007 in Andhra Pradesh whereas they were put-off by 2010-11 in Maharashtra. The baselinesurveys were conducted during 2007-08 while the early adoption studies completed in 2009-10. FPVS trials were taken-up from 2007 to 2009 in different locations in these two states. Thousands of free seed samples were distributed between 2007 and 2010 in project intervention sites across two study states. Partialpenetration of project introduced cultivars was observed in both the targeted states due to some constraints.

3.3.1 Andhra Pradesh

Table 11 furnishes the details of pigeonpea improved cultivars adoption in Andhra Pradesh during 2007-2009. Old cultivars like Abhaya and Maruti lost significant cropped area and it was replaced by project introduced cultivars (LRG 41 and PRG 158). LRG 41 and PRG 158 have showed their superiority in the FPVS trials on par with superior variety 'Asha'.

Table 11 Varietal composition of pigeonpeacultivars in Andhra Pradesh, 2009-10.

Variety	EA, 2009-10		Change in area over baseline (ha)	EA, 2009-10 Yields (kg/ha)	Yield increase (%) over baseline
	Area (ha)	% area			
Asha	128.68	43	-75.89	1250	8.6
Abhaya	-	-	-36.83	-	-
Durga	-	-	-6.48		
LRG 30	8.97	3	6.54	1150	7.4
LRG 41*	59.85	20	57.83	1170	25.8
Maruti	14.96	5	-9.93	1100	15.7
PRG 158*	23.94	8	23.94	1120	NA
Lakshmi	14.96	5	-1.23	1050	8.2
Local (Nallakandi)	47.88	16	10.77	820	9.3
White pigeonpea	-	-	-	-	-
Total	299.24	100	-32.46	-	-
* project introduced cultivars					

Asha and LRG 41 performed very well in study districts of Andhra Pradesh (Table 12). Nearly 20-30% increase in productivity was noticed when moved from local variety to improved cultivars. The net returns per ha increased significantly in case of TL II project introduced cultivars. A reduction (14-20%) in unit cost of production per quintal was estimated in the analysis (Kumara Charyulu et al. 2014).

Table 12 Profitability of pigeonpea cultivation in Andhra Pradesh (Rs/ha)

Particulars	Local cultivar	Asha	LRG 41
Fixed cost (Rs ha^{-1})	3200.50	3250.40	3310.50
Variable cost (Rs ha^{-1})	11525.50	11100.50	11500.50
Total cost of cultivation (Rs ha^{-1})	14726.00	14350.90	14811.00
Cost of production (Rs per 100 kg)	1600.6	1148.07	1384.2
Grain yield (Kg ha^{-1})	920	1250	1070
Gross returns (Rs ha^{-1})	41400	56250	48150
Net returns (Rs ha^{-1})	26674.0	41899.1	33339.0
Benefit-cost ratio	2.81	3.91	3.25

[6] For more details refer Kumara Charyulu et al. (2014)

3.3.2 Maharashtra

Maruti used to be the single dominant variety before the introduction of TL II project. The project introduced new cultivars successfully replaced the old and dominant variety. Nearly 30-40% of 'Maruti' area was replaced by BSMR 736, BSMR 853 and PVK-Tara (see Table 13). Significant pigeonpea cropped area have been shifted towards new cultivars because of farmers' preferred traits between 2007 and 2010. The profitability of pigeonpea cultivation in the state is furnished in Table 14. The average productivity in the targeted sites has increased by 15% than check variety 'maruti'. The benefit-cost ratio has increased marginally from 2.53 (Maruti) to 2.90. This clearly indicates the potential for TL II introduced cultivars in the state.

Table 13: Varietal composition of pigeonpeain Maharashtra

Variety	Early adoption, 2009-10					
	Adopted villages		Change in area over baseline (ha)[1]	Control villages		Change in area over baseline (ha)
	Area (ha)	% area		Area (ha)	% area	
Asha	29.2	13	13.48	18.4	15	15.16
Maruti	105.7	47	-71.0	67.6	55	-20.64
BSMR 736*	56.3	25	56.3	20.8	17	20.8
BSMR 853*	22.5	10	22.5	12.4	10	12.4
PVK Tara*	11.3	5	11.3	3.7	3	3.7
Durga	-	-	-1.22	-	-	0.00
Vipula	-	-	-3.76	-	-	-1.62
Total	225.0	100.0	27.6	122.9	100.0	29.8
* project introduced cultivars						

Table 14 Profitability of pigeonpea cultivation in Maharashtra (Rs/ha)

Particulars	Maruti	BSMR 736	BSMR 853
Fixed cost (Rs ha^{-1})	5300	4950	5200
Variable cost (Rs ha^{-1})	12967	12534	11987
Total cost of cultivation (Rs ha^{-1})	18267	17484	17187
Cost of production (Rs per 100 kg	1773	1561	1482
Grain yield (kg ha^{-1})	1030	1120	1160
Gross returns (Rs ha^{-1})	46350	50400	52200
Net returns (Rs ha^{-1})	28083	32916	35013
Benefit-cost ratio	2.53	2.88	3.03

4. Challenges, opportunities and lessons learnt in South Asia

Section three has summarized the initial impacts of project interventions on three legume crops in the targeted sites between 2007 and 2010. The findings from three real-time tracking surveys (chickpea in AP and KA and Groundnut in TN undertaken during 2012-13) were also summarized by crop. Simultaneously, three baselines were undertaken for three new targeted locations for chickpea (Bihar in India and Bangladesh) and Groundnut (in Odisha, India) crops between 2011 and 2014. Several challenges and opportunities have been identified across crops during the implementation of the project period. The lessons learnt from these studies in the project would not only benefit ICRISAT but also helps several partners, researchers and academicians in South Asia. It is worthwhile to summarize and present by crop in this section.

4.1 Chickpea

Challenges and lessons learnt

The previous sessions have shown clearly the huge penetration of TL II introduced cultivars in the targeted states and their impact on adoption, productivity and profitability on sample households between 2007 and 2014. However, the major challenge in case of chickpea is sustaining the production and productivity in those states beyond project interventions. After attaining the confidence of adoption of improved cultivars, chickpea growers are indiscriminately using various inputs (seeds, fertilizers and pesticides) leading to unsustainable cultivation of chickpea. The per unit output prices have decreased or stabilized over the last three years due to (duty free) imports from Australia and Canada. The farmers are eagerly waiting for 'tall growing cultivars' for their easy mechanical harvesting of chickpea crop. Resistant to terminal moisture stress and heat tolerant traits are most desirable to sustain the crop in future in these states.

Some of the lessons learnt are: 1. Enough care is required in the selection of adopted and control villages in the targeted sites to avoid any potential bias in various studies 2. The FPVS trails have demonstrated potential of new cultivars, hasten-up their formal release and encouraged farmers' to quickly adopt those 3. Besides the physical yields, the prices should also be considered to give the farmers those varieties that can improve their profits 4. Attractive net returns are the best bets for adoption and impact creation rather than physical yields of cultivars 5. Attractive seed subsidies given by respective state governments have motivated the farmers significantly to enhance adoption.

New opportunities

During the phase-2 of the Tropical Legumes (TL-II) Project, two new locations (Bihar in India and Barind region in Bangladesh) were identified for targeting and introduction of new technologies. The baseline surveys in Bihar were completed in Bhagalpur and Banka districts with reference to 2010-11.Subsequently FPVS trials were carried out during 2012-13. The mother trials conducted in different locations have concluded that JG 14, Shubhra and KAK 2 are the most preferred cultivars in Bihar. Deshla Plain and DeshlaRoon were the preferred dominant local cultivars noticed during the baseline survey. Similarly, the chickpea baseline surveys were also implemented in Rajshahi and ChapaiNawabganj districts of Bangladesh in 2010-11. BARI Chola 5 and BARI Chola 9 are the most common cultivars (occupied nearly 85%) observed in the baseline sample households. Among the different BARI Chola varieties, BARI Chola 9 gave the highest productivity in the study locations. Mustard is the most competing crop with chickpea during post-rainy season period. Both these locations and other rice-fallows in India has huge potential for chickpea expansion in the country.

4.2 Groundnut

Challenges and lessons learnt

Section three has visibly highlighted the low adoption of TL II introduced cultivars in both Karnataka and Tamil Nadu states. Enhancing the adoption in Groundnut crop is the biggest challenge in the project. Seed multiplication and distribution is critical in groundnut due to frequent crop failures with recurrent droughts and poor seed multiplication ratio. The existing formal seed systems in the targeted sites are weak. There was severe competition from other

rainy season crops like soybean, cotton and maize etc. Poor marketing and value chain facilities also limiting crop spread in the study states.

The major lessons learnt are: 1. The FPVS trails conducted at several places established that the new varieties outshone the check varieties, but farmers did not always select the varieties with the highest yield potential. For instance, farmers in Raichur were not in favour of R2001-02 and R2001-03 because of their poor pod characteristics and low market acceptance. In Chitradurga, ICGV 91114 preferred over R2001-02 due to positive attributes of short-duration, drought tolerance and good pod characteristics 2. The FPVS trails were conducted for one season in Karnataka while they were carried out for three seasons in Tamil Nadu to reach a logical conclusion 3. The delay in formal release of selected cultivars and their subsequent limited seed multiplication (in seed chains)with respective state agriculture agencies hampered adoption 4. The provision of small quantities (2 kg) of groundnut seed to the farmers by the project staff did not yield the expected benefit, and it is speculated that the small quantities were inadequate in the attempt to encourage the farmers to grow and bulk the seed 5. A community seed systems approach may also be tried to hasten the process of diffusion of the varieties selected by the farmers 6. The government departments should be approached to extend the benefit of subsidy for the new varieties, instead of extending the same repeatedly to the same old and ruling varieties
7. Finally, the adoption pathway in case of groundnut would be much longer than other two legumes crops in the study.

New opportunities

During the phase-2 of the project, groundnut improved cultivars have been targeted additionally in Odisha state of India and in Bangladesh. However, the baseline was conducted only in Odisha state during 2012-13. The study has concluded that more than 90 % of cropped area in the state was covered by local varieties. It indicates huge potential for further penetration of TL II project improved cultivars in this state. The FPVS trails conducted in Bangladesh also clearly showed their superiority over existing check varieties in the country. There are ample opportunities for spread of groundnut but drought and seed availability are the major constraints.

4.3 Pigeonpea

Challenges and lessons learnt

As summarized earlier, the TL II project has partially succeeded in promotion and adoption of new improved cultivars in the targeted sites. Frequent droughts are the major constraints for limited spread and lower productivity of crop in the study states. Most of the farmers' preferred to grow pigeonpea as intercrop rather than sole crop. The major challenge in pigeonpea is development of medium duration cultivars which can escape terminal moisture stress during maturity stage.

The major lessons learnt are: 1. FPVS trails have helped ICRISAT and NARS partners to demonstrate the potential of technology and enhancing their adoption as well 2. Concerted efforts are required for demonstrating the hybrid pigeonpea technology along with seed production and multiplication training programs 3. Timely availability of quality seed of improved cultivars is another constraint limiting adoption 4. Seed village concepts or community seed systems approach can be attempted for further diffusion of varieties selected by the farmers in the FPVS trails.

New opportunities

During the phase-2 of the Tropical Legumes (TL-II) Project, two new locations (Bihar and Odisha) in India were identified for targeting and introduction of new technologies. But, baseline surveys were only taken-up in Bhagalpur and Banka districts of Bihar with reference to 2010-11. Subsequently FPVS trials were carried out during 2012-13. The mother trials conducted in different locations have concluded that Asha, ICP 7035 and ICPH 2740 were most preferred varieties over traditional variety 'Bahar'.There were no systematic efforts in the state of Bihar for crop improvement of pigeonpea by State Agricultural Universities. TL II has provided a way for the small holder farmers to have access to high yielding varieties suitable for their niches.

5. Summary and conclusions

Tropical Legumes II (TL II) seeks to improve the livelihoods of 60 million smallholder farmers (SHF) in 15 countries through enhanced productivity of chickpea, common bean, cowpeas, groundnut, pigeonpea and soybeans. It is expected to enhance productivity by at least 20% through increased adoption covering 30% of legume area, strengthen national breeding programs and generate at least $ 1.3 billion in added value as a result. More, than 258,000 tons improved seed was produced between 2007 and 2013, enough to reach 51.6 million farmers in 5kg pockets. Since 2007, improved varieties disseminated have been adopted on 2,007,889 ha and generated US $ 513 million from direct project funding and nearly $ 2 billion from project and partners investments.

Among the three legumes in South Asia, the FPVS trails paved way to adoption of new varieties preferred by farmers and fast-track release of those varieties. The extent of adoption of project introduced cultivars was highly successful in case of chickpea followed by pigeonpea and groundnut. More robust seed system-models are needed for up-scaling adoption of new varieties, especially for groundnut. All these new cultivars should be encouraged with sizable seed subsidies till they replace the ruling varieties. All the new cultivars showed a minimum (> 15-30%) of enhanced productivity than previous cultivars. The new cultivars have visibly showed the profitability of legume cultivation in different targeted sites. The study also proved that the cultivation of pulses not only increase production but also increases household income and nutritional security. Thus, the viability of SHF increased significantly in South Asia. Huge opportunities are still exists for further penetration of these three legumes in South Asia.

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